Vertical Integration and Information Technology Investment

in the Insurance Industry

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Abstract

In this paper, we examine whether frictions created by differences in firm boundaries affect the speed with which firms adopt new Information Technology (IT). Using a rich data set on organizational characteristics and Internet investment by over 100 firms in the insurance industry, we show that vertical integration in distribution has a significant impact on the speed with which insurers adopt consumer Internet applications that complement the existing distribution relationship. Vertical integration, however, has no effect on the adoption of tools that enable electronic communication between an insurer and its sales force. Furthermore, vertical integration has no affect on the adoption of Internet technologies, such as basic access, that are not used in distribution.

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1. Introduction

A considerable body of analytical and theoretical work examines the determinants of firm boundaries. Yet, relatively less is known about the implications of vertical integration for firm performance (Lafontaine and Slade 2007). [1] In particular, one issue not widely explored is the ways in which downstream, or forward, vertical integration affect how firms respond to new technologies. For example, one particular vertical structure may have higher costs that alter the net benefits to adopting a new innovation. These frictions may have important implications for the success of firms when such investments alter their productivity or influence their business models, as was the case of information technology (IT) investments in the late 1990s.

We study the significance of frictions arising from different vertical sales force relationships by examining the adoption of Internet technology among property-casualty insurers.[2] This setting is an attractive one in which to study the effects of vertical integration on new technology adoption for two reasons. First, IT comprises a significant portion of an insurer's capital investments. Second, longstanding differences in the degree of vertical integration in insurance distribution between insurers provide a natural way to examine the effect of vertical structure on technology adoption.

Our empirical analysis tests whether differences in adoption costs arising from vertical integration are significant enough to influence the IT adoption rate while controlling for business mix and initial technology. We examine the adoption rates of several Internet technologies that differ in the extent and manner with which they are influenced by frictions arising from differences in vertical integration. First, we examine the adoption of consumer Internet applications that enable direct communication with customers. In our setting, because of regulatory restrictions and product complexity, insurance products are not sold directly online, and consumer applications complement rather than substitute existing

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[1] For some notable examples, see Anderson 1988; Muris, Scheffman, and Spiller 1992; Jin and Leslie 2008.

[2] Property-casualty insurers sell insurance to individuals and businesses covering property and liability risks. The major lines of business covered are automobile insurance (individual and commercial), homeowner's, general business policies (also called *commercial multiple peril policies*), general liability, and medical malpractice.

distribution channels. Independent insurance agents, however, own their own client list. By not being vertically integrated, these agents can appropriate some of the value of insurer consumer application investments through opportunistic behavior. For example, independent agents can sell a competitor's insurance products to customer referrals received from an electronic commerce Web site. This reduces the net benefits of adoption for insurers that are not vertically integrated in distribution.

Next, we look at the adoption of Internet-enabled agent-insurer communication tools that facilitate coordination between agents and insurers but do not involve direct communication with customers. Again, insurers that are less vertically integrated in distribution will have higher frictional costs of adoption, due in large part to the need for relationship-specific investments. For example, because electronic interfaces between insurers and agents are not standardized, insurance agents adopting these technologies need to make relationship-specific investments to successfully execute new business processes. Moreover, less vertically integrated insurers will face higher coordination costs because they must negotiate any changes to their technology infrastructure with these agents. In short, the presence of larger frictions for less vertically integrated insurers leads to a set of testable predictions that insurers that are vertically integrated into distribution will adopt consumer Internet applications and agent-insurer communication tools more quickly than an equivalent and less vertically integrated insurer.

Using a sample of over 120 insurers for the period 1996 to 2002, we examine the speed of adoption for these Internet technologies by estimating survival models. Our results show that insurers with exclusive agents adopt consumer applications significantly more quickly: The median time to adopting consumer Internet applications is 2.69 years lower for insurers with exclusive agents than for an otherwise similar insurer with independent agents. In contrast, vertical integration has no effect on the adoption of agent-insurer communication. These results are robust to a variety of different specifications.

An important feature of our study is that insurer decisions on vertical integration were made historically and not in response to anticipated Internet investments. Nevertheless, a key identification assumption is that there are no unobservables correlated with vertical integration that increase the net benefits to Internet adoption. We directly address the most likely source of omitted variable bias:

Unobserved differences in product line complexity. First, though we add many controls for observable product line differences, the results do not change. Second, as a falsification test, we compare adoption of the above distribution applications with a margin of Internet investment that does not require coordination with agents, namely, basic Internet access. We find no correlation between vertical integration and the time to adopt basic access. Third, we re-estimate our models over a subset of the sample for which unobservable product line differences are likely to be very low, namely, insurers that write predominately homeowner and personal auto insurance. Our results are qualitatively similar, and, in fact, stronger over this sample.

In addition to informing the study of firm boundaries—and in particular the vertical integration of sales forces—our results also have significant implications for insurers. Insurer IT investments were associated with significant productivity gains during our sample period (Stiroh 2002; Triplett and Bosworth 2002), which contained the late 1990s U.S. productivity acceleration. Insurers that delayed Internet investments as a result of frictions arising from independent agents were at a competitive disadvantage relative to those that reacted to the availability of Internet applications more quickly. More broadly, our results show how historical firm boundary decisions can have unintended consequences for a firm's ability to react to new circumstances.

The rest of the paper is organized as follows. The remainder of Section 1 discusses this paper's relationship to prior work. Section 2 provides background on the insurance industry and its use of IT, while Section 3 presents our hypotheses and predictions. Section 4 describes our data, and Section 5 presents our estimation methodology. In Section 6 we present our results; and in Section 7, we provide a conclusion.

1.1 Related Literature

This paper informs several areas of research related to the empirical analysis of vertical integration. We not only advance research on the vertical integration of sales forces—in particular we examine the implications of vertical integration for firm behavior—but we also continue an examination of the relationship between firm boundaries and investment in information technology, which has been central to recent work.

There have been numerous studies of the decision to vertically integrate sales and retailing activities.[3] Of this research, our work is most closely related to that which analyzes an insurer's use of independent or exclusive agents for distribution (e.g., Marvel 1982; Grossman and Hart 1986; Regan 1997; Regan and Tennyson 1996). Unlike other empirical papers in this literature, however, we do not examine the determinants of vertical integration decisions. Instead, we take organizational choices as given for historical reasons (indeed, no significant insurer has altered the extent of vertical integration in distribution in the past several decades) and use prior theory on the benefits and costs of vertical integration of sales forces to make predictions about how firm boundaries influence IT investment. We hypothesize that firms made vertical integration decisions for a variety of reasons that are unrelated to IT adoption. Differences in frictions for direct writers, that is, the more vertically integrated insurers, and agency insurers, that is, insurers that use independent agents, will lead to differential rates of adoption by distribution type. Thus, our research provides one example of how vertical integration can influence firm behavior when firm boundaries are relatively fixed.

In the literature on the implications of vertical integration for firm behavior, Gertner and Stillman's (2001) investigation of the effect of vertical integration on retailers' adoption of online retailing is most closely related to our paper. Like Gertner and Stillman, we also investigate how different vertical relationships shape IT investments. Gertner and Stillman, however, examine the impact of firm boundaries on a firm's ability to react to a new IT-enabled channel that may substitute for existing distribution relationships. In contrast, our study examines how the adoption of IT will complement the existing distribution relationship. Furthermore, by studying different margins of IT investment, we are better able to shed some light on the mechanisms through which vertical integration influences IT adoption.

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[3] Of course, this literature is far too large to summarize here. Several excellent summaries include Joskow (1988), Masten (1996), and Whinston (2003)

Insurance industry publications have previously reported that direct writers adopted other, older, cost-saving distribution changes sooner than agency insurers (Webb et al. 1984; Holtom 1978; Nordhaus and Brown 1978; Stanford Research Institute 1967). Most significant for our paper, Etgar (1977) demonstrates that the mean percentage of computerized data processing was greater for exclusive agents than for independent agents. Yet, Etgar's analysis differs in several ways from ours. First, his analysis is essentially descriptive; he identifies agency frictions but does not seek to identify from whence these agency costs are most likely to arise. Second, his analyses do not control for heterogeneity in insurer and agent features, which we do.

Some papers have examined how the adoption of manufacturing automation technologies is shaped by differences in supplier relationships. Lane (1991) and Helper (1995) examine how closer ties to customers affect a firm's adoption of other automation technologies such as computer numerical control and automated mining machinery. Although these papers examine the effect of the strength of vertical relationships on technology adoption, ours is unique in the *way* that we study how vertical relationships shape adoption decisions. For example, previous literature examines whether closer customer relationships raise the total net benefit of adoption by increasing the stability of demand.[4] In contrast, we study the setting in which closer vertical relationships reduce transaction costs, coordination costs, and risks of opportunistic behavior, thereby increasing the net benefits to insurer adoption of new technologies.

More broadly, our paper is related to a branch of literature that focuses on firm boundaries and IT investments. While cross-industry studies have generally found that increases in IT investment are associated with less vertical integration (e.g., Dewan Michael, and Min 1998; Hitt 1999), some recent single-industry studies have demonstrated that IT investments can, under certain circumstances, lead to

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[4] In Helper's setting, concentration among automotive manufacturers also presents the potential for 'hold-up' which is removed when suppliers have closer ties to automotive manufacturers. And, in a related study, Mullainatahn and Scharfstein (2001) examine how integrated versus non-integrated chemical firms allocate production capacity.

more vertical integration (Baker and Hubbard 2003). Our paper contributes to this latter line of research by showing the short run relationship between IT and vertical integration within sales force relationships. While we acknowledge that our theoretical predictions rely on features specific to sales force relationships, we hope to highlight how the relationship between IT and vertical integration may depend in a nuanced way on the institutional features of firms and industries in which IT investments are embedded.

2. Vertical Integration and IT Use in Insurance Distribution

In this section, we describe the two primary kinds of distribution relationships found in the insurance industry. We then briefly describe the use of IT in insurance distribution and provide anecdotal evidence on agent resistance to two types of distribution IT, mainframes and the Internet.

2.1 Vertical integration in distribution in the property casualty insurance industry

The property-casualty insurance industry is composed of insurers who sell insurance covering property and liability claims. These are sold to individuals and households (referred to as *personal lines* coverage) and to businesses (referred to as *commercial lines*). In terms of premium volume, or revenues, the largest categories of personal lines are automobile and homeowners' multiple peril, and the largest categories of commercial lines are workers' compensation and general liability. Insurance is generally sold through agents who represent the insurer to the buyer.[5] There are two primary forms of agency relationships between insurers and their agents: (1) Insurers that use agents representing several different, competing insurers and (2) Insurers that use agents representing one company exclusively. The former

[5]Property-casualty insurance is also sold through company representatives via the phone or by mail. Insurers using these methods still comprise a relatively small share of the market. For the purposes of this paper we will ignore this distinction, and group these insurers with the other more-vertically integrated insurers, the direct writers. Insurance brokers are intermediaries that represent the buyer, and comprise a relatively small share of total insurance sold. Brokers are generally used for more complex, commercial insurance purchases.

are known as *agency insurers* and their agents are called *independent agents* while the latter are called *direct writers* and their agents are known as *exclusive agents*.

An important difference between the two types of agency relationships is that the independent agent owns the client list while the exclusive agent does not. This means that an insurer using independent agents must defer to the agents' choice of insurer for the policyholder. This ownership right, along with nonexclusivity, gives the independent agent increased bargaining power with individual insurers and has enabled them to resist past changes that reduce the role of the agent in marketing insurance.[6] In contrast, exclusive agents do not retain ownership of the client list; the direct writer insurer owns the client list. Thus, if an exclusive agent stops representing a particular direct writer, that agent cannot use any specific information on a policyholder such as the expiration date to solicit new business. The courts have upheld independent agents' property rights to their client list.[7]

For the purposes of this study, it is useful to put the evolution of these two distribution systems in perspective. Historically, U.S. property casualty insurers sold insurance directly to consumers in local markets. In the early part of the twentieth century, as insurers began to diversify outside of their local markets, they utilized independent agents to sell to policyholders farther away from their home base.[8] Independent agents provided an effective way to reach distant policyholders, as independent agents could generate sufficient volume by representing a number of different insurers and would require less local investment by the insurer. In the early part of the twentieth century, agency insurers attempted to use their relationships with independent agents to limit entry into their local markets.[9] Lacking access to independent agents in new markets, direct writers expanded using agents who represented only their own companies.

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[6] See, for example, Hensley (1962), Joskow (1973) and Webb et al. (1984).

[7] *National Fire Insurance Company v. Sullard*, 89 N.Y.S. 934; App. Div. 233 (17 Insurance Digest 360).

[8] See, for example, the discussion in Barrese and Nelson (1992) and references therein.

[9] In the late 1800s and early 1900s, some of the larger insurers tried to restrict competition in several ways, including using their rating bureaus to limit entry.

A number of studies investigate the continued coexistence of these two distribution forms. We review these studies briefly, as their theories for coexistence will shape our identification strategy.

2.1.1 Product-Quality Hypothesis

One line of research, the product-quality hypothesis, has argued that both systems persist because they serve different market segments. For example, the independent agency system may be more expensive, but it may offer greater service to the customer (e.g., Smallwood, 1975) or be better suited for a subset of the market (Marvel 1982; Regan and Tennyson 1996). This line of research explores the role of agency costs on firm boundary decisions.

Marvel (1982) argues that exclusive dealing will be most efficient when promotional investments are extremely important. An independent agent can shift customers to lower-cost insurers that are not participating in a costly promotional investment, while an exclusive agent cannot. In other words, risk of opportunistic behavior by agents reduces the value of promotional investments for agency insurers. Grossman and Hart (1986) expand upon this idea by arguing that ownership of the client list is allocated to the party for whom ex ante non-contractible investments in the client list are most valuable. That is, insurers own the client list when insurer investments (such as advertising) are most valuable, whereas agents own the client list when agency investments in service and renewals are particularly important.

More recent work has explored from other perspectives how variation in the importance of agent investment incentives (relative to insurers) is associated with the prevalence of agency insurers. Reagan and Tennyson (1996) argue that agents provide an information-gathering role by providing insurers with information about customer risk; and vertical integration influences the incentives to gather information. Thus, they argue, agencies will prefer independent agents to exclusive agents when an agent's information-gathering function is particularly important. Regan (1997) argues that the vertical integration decision can be viewed through the lens of transaction costs economics (Williamson 1975, 1985). Transaction costs economics argues that vertical integration is appropriate when relationship-specific investments are significant, while independent agency is more prevalent when it is relatively more important for agents to have profit-maximizing incentives. In particular, independent agents will be more common when product complexity is high (so that agents will have appropriate incentives to evaluate risk) and when environmental uncertainty related to the transaction is high (because independent agents can diversify and will share in the residual profits from successful placements).

Sass and Gisser (1989) argue that forward integration decisions can be rationalized using a simple model of agent effort. They argue that exclusive agency lowers the opportunity cost of the sales effort devoted to the insurer's product, however to achieve these benefits the insurer must be able to guarantee the agent sufficient business. Thus, exclusive agency is more likely to be found in large insurers.

Recent work has argued that these systems coexist due to differences in the agent-customer relationship, in contrast to the focus in earlier work on the insurer-agent relationship. In particular, independent agents may offer their clients lower search costs in locating the appropriate insurer (Posey and Yavas 1995; Posey and Tennyson 1997). Alternatively, independent agents may be more likely to act on behalf of the customer, and so may be more willing to assist in the claims process than exclusive agents. As a result, riskier customers may prefer independent agents (Venezia, Galai, and Shapira 1999).

2.1.2 Market Imperfection Hypothesis.

A seminal study in the area of independent versus exclusive agents is that of Joskow (1973), who finds that direct writers have significantly lower distribution costs than agency insurers. He concludes that the direct writers' distribution costs (agent commissions as a percentage of premium revenues) in the early 1970s averaged 11% lower than those of agency insurers.

It is interesting to note that subsequent studies expanding upon Joskow's work find that the cost difference persists (although it appears to have declined over time), perhaps due to competition from direct writers. For example Braeutigam and Pauly (1986) generally find that direct writers still have lower selling costs a decade after Joskow's study and after further controlling for quality differences. Moreover, studies that try to measure quality differences find little concrete evidence of service differentials (Doerpinghaus, 1991; Barrese, Doerpinghaus, and Nelson 1995), although there are challenges to measuring quality (Berger, Cummins, and Weiss, 1997). The difficulty in accurately measuring insurer quality and efficiency has led to difficulty distinguishing between the efficiency for particular segments and the market imperfection hypotheses.

For our purposes we will not assume either the product-quality or market imperfection hypothesis. Indeed, there may be elements of both at work. Rather, we examine whether frictions between independent agents and their insurers are large enough relative to any relational efficiencies to slow the adoption of new information technologies that require cooperation among agents and insurers.

The prior literature informs our empirical strategy, however. Literature following the product-quality hypothesis has found that independent agency is more common in environments where agent effort is important relative to insurer effort. These tend to be policies or transactions where insurance products are complex and nonstandardized, customer risks are higher, and environmental uncertainty is greater. Furthermore, if the lack of standardization among these policies makes them less amenable to digitization, then the net benefits to IT adoption may be lower among the insurers writing them. Under these conditions, we may observe a correlation between vertical integration and IT investment for reasons unrelated to frictions arising from vertical integration. To address these concerns, we include a variety of controls for nonstandard insurance policies. We also perform a variety of robustness checks. In particular, we examine the robustness of our results to a set of insurers for which variations in product line complexity is low. Furthermore, by examining the association between vertical integration and IT across several margins of investment, we utilize several falsification tests to improve the confidence that our results are not a result of unobservable differences in the net benefits to adoption.

2.2 IT Investment in Insurance Distribution

Insurance is one of the most IT-intensive industries in the U.S. economy. Over our sample period, the percentage of capital spending on IT in insurance, over 53%, was high relative to several key benchmarks: Specifically, the average across all industries (almost 27%), the average in service industries (almost 36%), and the average across the finance, insurance, and real estate sectors (about 38%).[10] Overall, insurance ranks number 20 out of 123 three-digit National Income and Product Account (NIPA) industries in terms of IT intensity using this metric.

Over the past several decades, there have been two important IT[11] innovations affecting insurance distribution. The first was the mainframe computer technology of the 1970s and early 1980s. Insurers adopting mainframes could place dedicated terminals with agents to transfer information from agent to insurer, thereby increasing the efficiency and accuracy of the transactions.[12]

The second IT investment affecting distribution was the Internet. Investments in IT and, in particular, Internet-related investments have been widely cited as one reason for the acceleration in productivity in services over our sample period; by some estimates, labor productivity growth in the insurance industry increased from -2.6% over the period 1977–1995 to 3.5% over the period 1995–2000 (Triplett and Bosworth 2002).

2.2.1 Consumer Applications.

Some insurers conduct electronic commerce by allowing the new customer origination process to begin online, with follow-up from an agent. For example, some insurers allow customers to submit their information online, and then an agent will contact the customer within a couple of days with a quote

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[10] Source: 1997 BEA capital flow tables.

[11] Note that IT represents information technology, which is an umbrella term that includes Internet technology. When specifically referring to Internet technology, we will not use the acronym *IT*. This is important because some insurers invested in earlier IT before investing in Internet technology.

[12] Etgar (1977) reports that exclusive agencies report fewer errors in policy applications and communications relative to independent agents and that exclusive agencies are more likely to use automated data processing. Note that Etgar is unable to identify automated data processing that involves communication with agents from other forms of data processing that does not involve agent-insurer interaction, such as rating, word processing, or accounting, which. according to some surveys are the most popular forms of agent software (Coffin 1997). Furthermore, Etgar's hypothesis is that the reason for agency variance is due to insurers' unwillingness to provide support services such as training, market research, and computerized data processing.

(Franzis 2000). Alternatively, for more standard policies such as auto insurance, the customer can immediately receive a quote, with the agent making a follow-up contact for final policy sales.

Although some new customer originations can begin over the Internet, for the vast majority of cases, purchase of an insurance policy continues to require interaction with agents (Goch 2002). One of the reasons for this lack of Internet originations has been product complexity. Related reasons include lengthy and complicated applications, as well as state regulatory requirements that effectively prohibit online sales (McDonald and Ostermiller 1998). Even Internet originations of term life, the simplest product in the industry and the one most commonly associated with Internet sales, represented less than 1% of originations in 1999 (Dunsavage 2000; Clemons and Hitt 2001). Thus, consumer electronic commerce in our setting complements rather than substitutes the existing distribution relationship.

Insurers also publish information online to provide a set of tools that educate customers about the insurer's offerings and make it easier to access key information. For example, insurers can publish the latest policy forms, contact information, product descriptions, and underwriting standards. Their Websites might also include agent locators (Clemons and Hitt 2001). In addition, insurers can provide a series of customer service applications that their customers could use, for example, to access claim status information, determine whether a claim has been paid, and calculate the liability for a claim.

These tools increase the value of the insurer for consumers and, in doing so, create a beneficial externality for the insurer's agents. Because new customer originations must end with interaction with agents, consumer electronic commerce investments will lead to greater demand for agent services. Yet, independent agents can take actions that reduce the value of these investments by, for example, redirecting new customers to the policies of other insurers (Marvel 1982). In other words, under independent agency, agent actions can reduce the net benefits to adopting consumer applications. Thus, because of the necessity for agent interaction with the customer, frictions created by differences in firm boundaries are important to understanding how the speed of Internet adoption is affected.

2.2.2 Agent-Insurer Communication.

In addition to adopting basic access, the insurer can invest in Internet technology and applications that facilitate the transfer of information between agent and insurer. Such applications are commonly known as *business-to-business commerce* or *extranet*. For example, the insurer can provide Web pages or interfaces that present timely and accurate communication and can even provide insurance quotes for the agent to use. These interfaces also automate the transfer of information to the insurer that was previously accomplished through hard-copy forms. For example, Travelers Property Casualty developed a Web-based business system that offered the ability to key in information directly into a browser interface for new transactions (Convey 2000). Insurers have also developed functionality for billing, sales leads, product descriptions, real-time quotes, and a rate and issuance system. Such tools can allow agents to upload application information to insurers and download information (such as policy details) from insurers. They may also offer the capability to access claim status reports, reconcile electronic transfer balances, and submit monthly premium reports (Convey 2000; Panko 2001; Strazewski 1999; MacSweney 2000). To be valuable, these investments require complementary investments by agents who must learn and use the new system.

These systems have the promise of further reducing errors, redundant work, and the time taken to issue a policy, as many policies are slowed by agents using outdated policy forms, relying on old product descriptions or leaving out part of the needed information. One industry publication asserted that

> In its role as a pervasive low-cost communication network, the Internet can drastically cut transaction costs. It can be viewed as a link with the various people with whom insurers interact, improving the efficiency and timeliness of interactions within a value chain. It ultimately provides an opportunity to redefine the insurance value chain and can transform how carriers and producers work together for the benefit of the customer. (Annis 2000, p. 90)

Despite these purported benefits, observers note that the property-casualty insurance industry has been slower to adopt Internet technology that facilitates sales transactions than some other financial services industries. Some industry observers attribute this to the industry's greater product complexity (Annis 2000); however, agent resistance is also often cited. As noted in one industry publication:

> Insurance carriers are in a bad spot when it comes to automating the sales process. One step to the left toward Internet B2C, and the insurer risks falling off

> the cliff of agency disintermediation. A step to the right towards automating the agency with B2B plays, and the carrier receives "push-back" from agents who do not want to learn another carrier's system—thus risking the loss of business to other carriers. (MacSweeney 2000, p. A2)

One reason for agents' resistance has been the costs of learning new IT systems that are not standardized across vendors. Patrick Kellner, an executive at Applied Systems, a company that develops agency systems observed:

> 'In the late 1980s, carriers were setting up terminals in agencies…. Each terminal would require an agent to learn a different system. We are seeing a lot of carriers doing the same today, except it is over the Internet…. If each system operates independently, the agent would have to go to each system and enter info separately. Agents want to stay in their systems and then share information with the carriers through their systems.' (quoted in MacSweeney 2000, p. A2)

Insurers using independent agents might overcome some of these issues by adopting a common Internet interface. Indeed, an industry organization, ACORD (Association for Cooperative Operations Research and Development), developed common standards to provide such an interface and third-party vendors have developed single interface applications for multiple insurers. For example, ACORD has been working on Extensible Markup Language (XML) standards so that agents can use their own agency management system rather than the insurer's system.[13] A problem for the industry initiative is that even some companies involved directly in the process feel that working on a joint interface may communicate strategic information to rivals and similar concerns tend to slow adoption of third-party applications.[14] Even several years after the end of our sample, penetration of ACORD standards has been far from universal: According to a Celent 2004 Chief Information Officer (CIO) Survey, over 60% of large property and casualty insurers and 46% of mid-sized insurers were using ACORD standards (anonymous 2006).

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[13] XML is a standard that describes the content of information sent over the Internet. ACORD standards have been developed to determine the family of transactions that are to be permitted and the exact syntax and structure of each transaction.

[14] For example, the chief executive officer of SAFECO noted that "if we spend a lot of time and effort doing universal EDI [electronic data interchange] what do we give the competition?....It's like talking to the competition, how much do you want to say?" (quoted in Tarnoff 1998, text in brackets added).

Independent agents have been resistant to adopting new Internet technology for reasons other than learning costs. For one, most third-party vendors providing a single interface for agents and multiple insurers charge fees per transaction that are likely to result in lower commissions for agents. Moreover, independent agents may be concerned that changes in the insurer-agent interface will change the relationship with the insurer; for example, it might be set up so that the agent assumes an increasing amount of the administrative work on policies and it may make the agent more dependent upon one insurer.[15] Thus, again, the frictions arising from firm boundaries play a role in the speed of Internet technology adoption.

2.2.3 Basic Access

Insurers can also invest in generic electronic communication such as basic Internet access. Basic access allows employees of the insurer to do research and facilitates connectivity between geographically dispersed establishments (Forman 2005). As an enabling technology, basic access offers few direct benefits to consumers or agents.[16]

3. Testable Hypotheses of Internet Technology Adoption

In this section we present a set of testable predictions on how variations in the extent of vertical integration in distribution shape the adoption of Internet technology within the insurance industry. We expect agency insurers to face greater transactions costs in the adoption of agent-insurer communication technologies because (1) agents are less vertically integrated in distribution and (1) agents sell insurance

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[15] As Etgar (1977) writes with respect to independent agents' willingness to change the activities they perform, "[I]ndependent insurance agents may view the activities they have traditionally performed as proprietary and may insist on performing them even if the insurers can perform them at lower costs or if they in essence duplicate those of the insurer. Independent agents may react in this manner because of fear that forsaking the performance of some activities … will make them more dependent upon insurers and may endanger their rights to expirations." (pp. 212–13.)

[16] As a result, concerns about frictions arising from relationship-specific investments or concerns arising from the potential for opportunistic behavior should not influence its adoption.

for competing insurers. In this paper, we define transaction costs broadly, in the sense that Coase (1937) used them, arising from coordination costs. These coordination costs may or may not precipitate hold-up in the sense that Williamson (1985) defines.

Transaction costs arise for both consumer applications and agent-insurer communications. Insurer investments in consumer applications can provide new tools to customers, which increase the value of the insurer's brand and refer new customers to agents. More broadly, by referring online customers to agents, insurers are undertaking efforts that will increase the value of the client list. Yet, opportunistic behavior on the part of insurance agents can reduce the value of new Internet investments in several ways ways. For example, when agents receive new customer referrals from the Internet they can sell policies from other insurers to these referrals (Marvel 1982). Furthermore, they can engage in shirking behavior. Specifically, if consumer applications provide agents with a steady stream of new customers through electronic commerce, then that may reduce the perceived marginal return to effort by insurance agents. As a result, agents may allocate relatively less effort to acquiring new customers (Sass and Gisser 1989). These risks will reduce the insurer's private value of investing in consumer applications.

In the case of agent-insurer communication, coordination costs arise from agents facing multiple proprietary systems combined with the difficulties of working with other insurers or third-party vendors to create common standards. Agency insurers can also face higher coordination costs since they must negotiate any such changes to technology infrastructure with their independent agents. Such coordination is likely to be more costly when the agent controls the client information. These coordination costs raise the costs of adoption and reduce the private value of adoption more for agency insurers. Independent agents may also demand compensation for relationship-specific investments they must make to use the new technology. These actions further reduce the private value of the previous IT investment made by agency insurers.

To be clear, our study is unable to identify whether transactions costs arise from generic coordination costs or from potential hold-up generated by relationship-specific investments in IT made by insurers and agents. Furthermore, we are unable to distinguish between transaction cost economics (Williamson 1985) and property rights theories (Grossman and Hart 1986; Hart and Moore 1990; Whinston 2003). In our paper, these different theories generate an observationally equivalent prediction: Namely, agency insurers will be less likely to invest in insurance distribution Internet technology.

Vertical integration can only influence IT adoption when insurers and agents are unable to contract on future technology investments, such as the Internet, and on potential opportunistic behavior. As noted in many contemporary accounts, businesses did not anticipate the unexpectedly rapid diffusion of the commercial Internet. Moreover, we only observe a relationship between IT investments and vertical integration if insurers do not organize themselves to minimize the costs of present and future IT opportunities, otherwise certain combinations of IT adoption and independent agents would represent an off-the-equilibrium-path combination—and therefore would be unobserved. In contrast to other recent studies that have examined how IT investments influence the optimal organization of firms (Baker and Hubbard 2003, 2004; Hitt, 1999), we assert that insurers made firm boundary decisions for reasons unrelated to Internet investments and that these decisions are fixed for historical reasons. Therefore, some firms are better organized to take advantage of new Internet technology than others.

3.2. Other Characteristics Influencing Adoption

The total benefits of Internet adoption vary with insurer characteristics. Prior work emphasizes that firm size often increases the likelihood of technology adoption (e.g., Astebro 2002). In addition, the benefits of Internet adoption may also vary with the type of insurance the insurer sells. Thus, we control for the percentage of premiums written in different lines of insurance. In some models, we also control for insurer costs and profitability.

Another important characteristic for adoption of Internet technology is the existing IT infrastructure. Newer IT infrastructure is generally client/server (henceforth C/S) technology, which is more compatible with Internet technologies (Bernard 1996). Mainframe technology, in contrast, is incompatible with Internet technology. Remote mainframe terminals placed with agents function similarly to personal computers (PCs) and insurer-specific consumer applications, so prior investment in such IT reduces the incremental benefit of Internet technology adoption.

3.3 Basic Access, Consumer Applications, and Agent-Insurer Communication

Controlling for insurer size, prior IT investments, and the types of insurance sold, we examine the effects of vertical integration on the time to adopt three types of Internet technology: (1) consumer applications, (2) agent-insurer communication, and (3) basic access. The value of investments in consumer applications may be less for agency insurers if independent agents behave opportunistically by shirking or by selling policies from other insurers to new customer referrals obtained through electronic commerce channels. Furthermore, agent-insurer communication requires more insurer-specific investment on the part of the agent and requires greater overall agent cooperation to successfully implement. The presence of these frictions arising for agency insurers when adopting new Internet applications will lower their net benefits to adoption, thus leading to slower rates of adoption than that for direct writers, other things being equal. In contrast, since adoption of basic access involves little formal coordination with agents, the frictions arising from variance in vertical integration are likely to be low. Thus, we expect no association between vertical integration and the speed of basic access adoption. We include analysis of the adoption of basic access as a falsification test to circumscribe the potential effects of unobserved heterogeneity on our results. If, for example, there exist unobservables related to technological sophistication or prior IT infrastructure of insurers that are correlated both with independent agency and Internet adoption, these unobservables should be associated with faster adoption of basic access.

4. Specification

We examine adoption decisions using a continuous-time survival model measuring the time to first use of Internet technology.[17] Adoption increases over time as the net benefit of adoption increases

[17] Numerous studies use survival models to measure technology adoption see, for example, Hannan and McDowell (1984) and Karshenas and Stoneman (1993). Heckman and Singer (1984) provide a description of the advantages of continuous-time survival models over discrete-time models when the econometrician observes a discrete number of failure times.

either through increases in gross benefits or through declines in adoption costs. The survival model allows us to capture variations in the average adoption rates caused by differences in observed characteristics such as vertical integration.

The beginning of the at-risk period is 1994. An observation is said to "fail" in a year when the insurer adopts Internet technology. The hazard rate, $h(t, x_i)$, is the probability of adoption (failure) in any period t conditional on not adopting prior to time t and is a function of time, t, and the vector of firm characteristics, x_i. Specifically, it is the ratio of the probability of adoption in time t, $f(t, x_i)$ (the density function) and the probability of getting to time t without adopting, $S(t, x_i)$, namely $h(t, x_i) = \frac{f(t, x_i)}{S(t, x_i)}$, where we define the survival function as $S(t, x_i) = 1 - F(t, x_i)$, and $F(t, x_i)$ is the cumulative density function of $f(t, x_i)$.

As is now well known, we must account for observations that are right-censored and left-censored. Right-censored observations are those where adoption never occurs during our period of observation. Observations that exit at t_i before adopting are included in the likelihood function using the survival function, $S(t_i, x_i)$. Because of sampling constraints imposed on us by the data, we also have observations entering the data set after the beginning of the at-risk period (1994). For those observations who enter at some time $t_{0i} > 1994$, we must also condition on the fact that the subject has survived until t_{0i}, which has probability of $S(t_{0i}, x_i)$. The likelihood function for our sample is then:

$$L = \prod_{i=1}^{N} \frac{S(t_i \mid x_i, \beta)}{S(t_{0i} \mid x_i, \beta)} [h(t_i \mid x_i, \beta)]^{(1-y_i)} , \qquad (1)$$

where $S(t_i \mid x_i, \beta)$ is the survivor function, $h(t_i \mid x_i, \beta)$ is the hazard rate, and y_i is an indicator variable equal to one if the observation is right-censored. Note that $S(t_{0i} \mid x_i, \beta) = 1$ if $t_{0i} = t_0$.

To estimate this model we need to specify a form for the hazard function. We use a proportional hazard model of the form $h(t \mid x_i, \beta) = h_0(t) \exp(x_i, \beta)$ that separates the time and firm characteristics into a constant proportional hazard component, $h_0(t)$, and a component based upon both firm characteristics, x_i, and a vector of parameters, β. We use a baseline hazard function, $h_0(t)$, that allows for increasing adoption over time to reflect the increasing rate of Internet adoption over our sample period and the fact that our covariates do not capture all of the factors affecting Internet adoption. In particular, we assume a Weibull distribution, which gives us a baseline hazard of the form $h_0(t) = pt^{p-1}\exp(\beta_0)$, where the parameter p determines whether the hazard rate is increasing or decreasing, with $p > 1$ indicating an increasing hazard rate. We estimate the model using maximum likelihood.[18]

We require several assumptions for identification. First, we require the choice of organizational form to be exogenous with respect to the Internet investment decision. The insurers in our database are from established groups that have been in existence for years prior to the commercialization of the Internet.[19] As has been noted elsewhere, the rapid consumer diffusion of the Internet was unexpected by technology producers as late as 1995. Thus, it is highly unlikely that organizational decisions were made with future Internet investments in mind.

Second, we also require the unobserved benefits of adopting Internet applications to be similar for direct writers and agency insurers once we control for agency and other insurer features. As noted above, one particular concern may arise if direct writers tend to write a greater share of insurance in standardized policies that are more amenable to digitization. To address this possibility, we include a variety of controls for insurer features, including product mix, profitability, local market characteristics, and technology infrastructure. Furthermore, we compare our results across two groups: Those insurers that write predominately low-complexity insurance policies (i.e., those that have a high percentage of personal auto insurance and homeowner's insurance compared to total net premiums) and those that write very few of these policies (those with a low percentage). By dividing our sample in this way, we reduce the extent

[18] We also estimate a Cox proportional hazard model to demonstrate the robustness of our results to alternative distributional assumptions for the baseline hazard.

[19] Among sites that reported this information, the average age of entry into the CI database was 1989.

of unobserved product heterogeneity in our low-complexity group, since auto and homeowner's insurance policies are mostly standardized. Also, by examining the effects of vertical integration across multiple margins of Internet investment, we can circumscribe the way in which unobserved heterogeneity might influence our results. For example, if independent agency is associated with slower adoption of consumer applications but not with slower adoption of agent-insurer communication, then this suggests that unobserved product line complexity influences adoption of one application but not the other. Since use of both applications benefits from standardized insurance policies, it is difficult to identify what the source of this unobserved heterogeneity might be.

Third, we require our controls to be exogenous. This will particularly be a concern for prior IT investments and insurer profitability. To alleviate concerns about the endogeneity of controls, we do not use time-varying covariates. All of our variables are calculated using the first observation of each establishment in our sample.[20] Only one of our specifications includes a control for insurer profitability, and all of our results are robust to the exclusion of this control.

Moreover, our base econometric specification assumes that adoption decisions are made at the firm level. This assumption may be questionable if some Internet decisions are decentralized within multi-establishment firms. This is particularly a concern for basic access, which has lower investment costs (and so may be within the budget authority of individual groups) and heterogeneous benefits (so some establishments may not adopt it). To test the robustness of our results to this assumption, we re-estimate our models using establishment-level data.

5. Data

Our primary data on Internet adoption and insurer characteristics come from the Harte Hanks CI

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[20] Our complete sample begins in 1995 prior to the widespread commercialization of the Internet, so that the majority of our IT variables are fixed at their 1995 values. Netscape's initial public offering, a widely used starting date for widespread commercial Internet use, occurred in August 1995.

Technology Database (hereafter CI database). The CI database contains data for U.S. establishments on characteristics such as size, industry, and location, as well as technology purchases such as computers, networking equipment, printers, and other office equipment. This data is widely regarded as one of the best sources of firm-level IT expenditures available, and for that reason has been used in a variety of earlier studies on IT investment and productivity (e.g., Bresnahan and Greenstein 1996; Bresnahan, Brynjolfsson, and Hitt 2002; Dewan, Shi, and Gurbaxani 2007; Forman 2005; Forman, Goldfarb, and Greenstein 2005). Harte Hanks obtains these different components of the CI database at different times of year; we assemble our sample by obtaining the most current information as of December of each year. For example, the observation for an establishment in 1996 will contain information on the establishment's characteristics and technology usage as was recorded in the CI database in December 1996. After 1996, our sample of the CI database occurs every two years, so we observe adoption decisions in 1996, 1998, 2000, and 2002.[21]

The unit of observation in the CI database is an establishment. Establishments correspond to individual locations within a firm, and are similar to the establishment concept used in U.S. Census data.[22] The database will often have data on multiple establishments for a given firm. These establishments may be branches, divisions, or the headquarters of a multi-establishment firm, or they may represent the characteristics of an entire firm in the case of single-establishment firms.[23]

We use the firm as the unit of analysis because decisions related to electronic integration with agents and consumer applications are decisions that affect all of the consumers related to a firm, and so

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[21] The CI database did not track Internet use prior to 1996, so we observe no adoption decisions before then. Figure 1 suggests that while this may bias our estimates of time to adoption for a small fraction of basic access adopters, it should have no impact on the timing of adoption for consumer applications.

[22] For further discussion of Harte Hanks and U.S. Census establishment definitions, see Forman, Goldfarb, and Greenstein (2002).

[23] 59.1% of the establishments in our sample are from multi-establishment firms, comprised of branches (30.0%), division headquarters (16.7%), and firm headquarters (12.8%). The remaining 40.9% of establishments are from stand-alone (single-establishment) firms.

adoption decisions are likely to be made at the firm level. Thus, we aggregate establishment-level adoption data and characteristics to the firm level in a manner described below. Nevertheless, as a robustness check, we also reestimate all models using establishment-level data, and the results remain qualitatively similar. Our sample includes all establishments in the CI database with over 100 employees from the property and casualty segment of the insurance industry (SIC 633).[24]

We augment these data with additional information on insurers' characteristics. Our data on distribution type (agency or direct writer) comes from A.M. Best's listing of "1997 Property/Casualty Companies and Groups of Fleets," which categorizes major insurance companies and groups in one of four ways: (1) national agency company, (2) state agency company, (3) national direct writer, or (4) state direct writer.[25] The state and national distinctions are based upon the size of the insurer, thus we classify national and state agency insurers together and treat them both as organizational type "agency." [26]

We match establishments from the CI database with companies and groups in the Best's database using names from both databases. We initially attempt to match using company names from the Best's database, but when these are not available we match on the basis of group names. This might occur either when groups have no separate companies (subsidiaries) or when we are unable to find a match. In these cases, we use the code for the group. Overall, we are able to match 458 of 576 unique names in the CI database. Many of the unmatched insurers are either very small insurers that are not tracked by Best's

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[24] Because of its bias toward large establishments, our sample may overstate the true fraction of insurance establishments investing in basic access. Prior work has shown that adoption of complex Internet applications such as consumer applications occurs primarily among larger establishments (Charles, Ivis, and Leduc, 2002; Forman, Goldfarb, and Greenstein, 2005); thus, our sample may overstate the unconditional probability of adoption, but it most likely captures the correct margin of consumer applications investment.

[25] Insurance firms are organized as groups, with individual companies as subsidiaries of the larger groups. Thus, for example, Allstate Insurance Company and Allstate Property and Casualty are both companies that are part of the larger Allstate Insurance Group.

[26] As a robustness check, we allow the speed of adoption to differ from national and state insurers. The results are qualitatively similar.

(e.g., Lawrence Group) or insurance subsidiaries of larger firms (e.g., Merrill Lynch).[27]

5.1. Dependent and Independent Variables

We use two questions from the Harte Hanks Market Intelligence (hereafter Harte Hanks) survey to measure Internet use. One is a question related to whether the insurer has an Internet service provider (ISP). Another is its use of Internet applications. Harte Hanks surveys establishments on several dimensions of Internet use, reflecting the heterogeneity in the way insurers apply the Internet as a general purpose technology to business needs. In particular, Harte Hanks surveys establishments on their use of the following applications: Business electronic commerce, home electronic commerce, generic commerce (does not identify business or home), customer service, email, education, extranet, homepage, intranet, publishing, purchasing, research, and technical support.

If at least one establishment has adopted basic access, agent-insurer communication, and consumer applications, then we count the firm as having done so. First, for our purposes, use of an ISP indicates adoption of basic Internet access. Next, agent-insurer communication is a form of business-to-business electronic commerce, so we define firms that adopt business electronic commerce or an extranet as having adopted agent-insurer communication. [28] Finally, an establishment is counted as having adopted consumer applications if it has adopted any of the following: Commerce, home electronic commerce, customer service, education, and publishing. These applications are consistent with the consumer electronic commerce tools described above. We also include the category technical support as one of the consumer Internet applications, because the insurer may need to solve consumer problems with

[27] There are two challenges with our matching algorithm. First, the names of some insurers are very similar. To minimize the risk of misclassification, we pursued a conservative approach and matched only names where it was clear to us what the right name could be, or where similar names in the Best's database produced observationally equivalent organizational types. Second, we matched establishments in the CI database with one year of Best's data and then checked company changes and name changes in the CI database against a list of name and group changes in the Best's database for other years of our sample and adjusted market codes where appropriate.

its Website; however, our results are robust to the exclusion of this category. We allocate generic commerce to consumer applications because of the larger share of insurers that are performing consumer applications in our sample (see below). We have run robustness checks excluding insurers that report performing generic commerce, and the results remain qualitatively similar. In fact, they are stronger.[29]

Figure 1 shows the cumulative adoption rates for basic access, consumer applications, and agent-insurer communication over our period of investigation, 1996–2002. The diffusion of basic Internet access in the insurance industry is rapid: By 1996, over 35% of firms have adopted, and by 2002, over 92% of firms have adopted. In contrast, the adoption of consumer applications is slower: In 1996, there is almost no adoption (2.6%), and by 2002, 38.6% of firms have adopted consumer applications. Adoption of agent-insurer communication is even slower: By the end of our sample, only 30.1% of firms have adopted.

We include several controls for insurer heterogeneity in our analysis. Using the CI database, we measure at the establishment level the number of employees and various technology variables (e.g., number of terminals per employee, number of PCs per employee). . The number of terminals per employee is a measure of the establishment's legacy investment in mainframe technology, while the number of PCs per employee is a measure of an establishment's investment in C/S technology. The log of establishment employment is a measure of establishment scale.

Our data on group size, product mix, and profitability are from the National Association of Insurers Commissioners (NAIC) database and from A.M. Best's Aggregates and Averages. We use Best's data on insurer size, and for other variables use NAIC data from insurance companies that report to state

[28] Extranets are commonly used as a synonym for business electronic commerce, particularly business electronic commerce that involves electronic sharing of information.

[29] There are eight insurers who report using generic commerce.

insurance departments.[30] [31] We matched the NAIC and Best's data to the CI database on names, using a procedure similar to that used for the Best's data.[32] The log of group net premiums (measured in thousands of dollars) is a measure of group scale. We include controls for the percentage of premiums written in the following categories of insurance: Homeowner's multiperil, commercial multiperil, workers' compensation, and all other premiums not written in automobile insurance. Automobile insurance is the omitted category. To control for differences in costs across insurers, in some specifications we include net commissions to agents and managers, normalized by total assets. As a robustness check, we have also explored the use of a finer classification of policies written, and the results remain qualitatively the same. To control for differences in profitability, in some specifications we include net income divided by total assets. As additional controls for heterogeneity in the types of policies written within commercial and automobile lines, we identify whether the insurer was involved in writing specialty lines of insurance. We obtain this information from a 1995 directory of nonstandard and specialty lines called "The Insurance Marketplace," a publication of the Rough Notes Company.[33] Furthermore, we identify insurers involved in writing nonstandard automobile policies from the list of insurers identified by Best's Aggregates and Averages as "Non-Standard Automobile Predominating."

We provide summary statistics for the dependent and independent variables in Table 1, as well as

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[30] The vast majority of insurers selling insurance in a state reports to state insurance departments. The exceptions are insurers selling insurance as reinsurers (insurance for insurers) and groups that fall outside insurance department oversight, such as self-insured groups.

[31] Both data sources report at the company level. Yet, because we believe that these variables are likely to influence adoption at the group level, we aggregate these data up to the group level.

[32] We also experimented with controls from the NAIC database for investment in electronic data processing equipment normalized by total assets. Unfortunately, this flow variable displayed a large amount of year-to-year variation and explained little variation in adoption decisions. To control for differences in an agent's outside opportunities (Sass and Gisser 1989), we also included a control for the population density per square mile in each of the states served by the insurer, weighted by the percentage of premiums in that state. Again, this variable was dropped because it had little explanatory power. All of the results are robust to the inclusion of these variables.

[33] We also experimented with a count of the number of specialty lines written, and the results remain qualitatively similar.

how the means of each of these variables vary by distribution type. Agency insurers have more PCs per employee (0.7743 v. 0.6529). Thus, agency insurers have greater investments in IT architecture relative to their employment that would be compatible with Internet technologies. These differences are statistically significant. The size of agency insurers is much smaller than that of direct writers. Average group net premiums is $321.3 million for agency insurers and $474.9 million for direct writers.[34] Consistent with research that has explored explanations for the coexistence of direct writers and agency insurers, agency insurers have a greater percentage of premiums in commercial insurance lines, such as commercial multiperil (0.0979 v. 0.0425) and workers' compensation (0.1579 v. 0.0474), while direct writers have a greater percentage in automobile insurance (the omitted category).

In Table 2, we explore the correlations among our independent variables. In the vast majority of cases, the correlations remain within acceptable levels. One instance where correlations are high is between our various measures of size: log(employment), log(net premiums), and our multi-establishment data. We have estimated our models without including controls for employment and the results are qualitatively similar. The correlations between net income and net commissions are also high (0.869); we have experimented with regressions both including and excluding these measures, and the results remain qualitatively similar.

6. Results

6.1. Vertical Integration and Technology Adoption

In Table 3, we report the results of survival models in which adoption of consumer applications is the dependent variable. The coefficient on the agency insurer dummy is negative and statistically significant across all specifications, though due to our limited number of observations (127 subjects)

[34] One potential concern is that establishments that are direct writers may perform some agency activities. Although we are unable to measure the types of activities that are performed at each establishment, we do have some evidence that the data we use attempts to separate insurance and agency functions performed at the same location: There are 11 instances in our sample in which an insurer (SIC 633) and an agent (SIC 641) from the same firm are located within the same nine-digit zip code.

significance falls to the 10% level in the specification with the full set of 23 controls. These estimates translate into a decrease in the hazard of adoption of between a 60.3 and 65.0 percentage points. In Table 5, we show the results of a change in each of the variables in column 3 of Table 3 on the median time to adoption. Agency insurers have median time to failure that is 2.69 years longer than that of direct writers.[35] In Figure 2, we use the results of the same model to show how the cumulative survival probability is shaped by agency status.

The value of *p*, the parameter that determines if the hazard is increasing, decreasing, or constant in the baseline hazard, ranges between 2.73 and 2.95 and is significantly different from 1 (at the 1% level) in all regressions, indicating that the hazard rate is monotonically increasing over time. This is consistent with our priors on the pattern of Internet adoption over this period.

Columns 1 through 3 of Table 4 present the estimation results for agent-insurer coordination technologies. In contrast to the results on consumer applications, vertical integration plays no role in the adoption of these technologies. That is, we find no evidence that agency insurers experienced slower adoption of agent-insurer coordination technologies. This result is robust to a variety of different specifications.

The results in columns 4 through 6 of Table 4 show no evidence that variance in vertical integration influences the adoption of basic access. The insignificant impact of agency insurers on access adoption is consistent with vertical integration having little impact on the adoption of technologies that do not require coordination with downstream channels. These access results are a falsification test; if the status of agency insurers was correlated with the timing of consumer application adoption due to unobserved factors correlated with firm boundaries and IT use (such as managerial ability), then these same unobservables are likely to be correlated with adoption of access as well. That they do not increases our confidence that our results do not reflect unobservables uncorrelated with being an agency insurer.

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[35] All calculations for the marginal effects are made using mean values for the other variables. Although our model examines adoption decisions in two-year intervals, we converted these marginal effects into years for ease

6.2. Robustness Checks

In this section we explore the results of a variety of robustness checks. The results of these robustness checks are included in Tables 6 and 7. For brevity, in Table 7 we include only the results for the agency insurer coefficient.[36]

As was previously noted, our results depend upon several identification assumptions. Perhaps our most crucial assumption is that we adequately control for differences in the types of services performed by direct writers and agency insurers. In particular, theoretical and empirical work on firm boundaries in the insurance industry has suggested that use of independent agents is more prevalent when products are more complex, customer risks are higher, and environmental uncertainty is greater. If these differences are inadequately controlled for, then our results could reflect differences in the net benefits to adoption across different policy lines. In support of this assumption, we include a large number of product-line controls as well as other variables that have traditionally been associated with the risk of policies written by the insurer, such as whether the insurer is publicly traded (Mayers and Smith 1988) and local per capita income (Regan and Tennyson 1996). We further note that our results for agent-insurer communications help to circumscribe the way in which unobserved heterogeneity may influence our results. The net benefits of adopting agent-insurer communications and consumer applications are both higher when insurance products are relatively standardized. There is no clear endogeneity story to explain why unobserved product differences would increase the net benefits of adopting consumer applications but not increase those for agent-insurer communication.

To further address concerns about omitted variable bias, we reestimate our consumer applications models for a group of insurers where there is likely to be little unobserved product variation. For these analyses, we computed the percentage of premiums written by the insurer in homeowner's and personal automobile insurance; we label this variable *percent standardized lines.* These two types of policies are the most standardized in the property-casualty insurance industry and exhibit relatively little variation in

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of interpretation.

the services offered by agents in support of these policies. We then estimate our survival models over the top and bottom thirds of our sample in percent standardized lines. The mean percentage of percent standardized lines is 84.6% in the top third of the sample, while the mean percentage in the bottom third is 15.4%.

The results of these regressions are displayed in Table 6. Our core results continue to hold among the subsample of insurers specializing in standardized lines of insurance. In fact, they are much stronger: The hazard rate for agency insurers is between 86.7% and 88.5% less than that for direct writers. In contrast, there is no significant difference in the hazard rate for insurers specializing in more complex lines of business. This may suggest that appropriations risks are greatest for insurers specializing in standardized products. That is, it may be more difficult for independent agents to switch customers to another insurer when policies are particularly complex.[37]

Table 7 includes the results of the rest of our robustness checks. Another identification assumption is that firm decisions to adopt Internet technology are exogeneous to the firm boundary decision. We are comfortable with this assumption because decisions on distribution relationships in this industry were made many years prior to the arrival of the commercial Internet. To explore this assumption further, however, we examine the incidence of corporate changes and retirements over our sample period, as these events are the ones most likely to lead to a change in firm boundaries. Our data came from the 1999 and 2004 reports of "Mergers, Voluntary Liquidations, and Retirements, Conservatorships, Receiverships, Conversations, and Name Changes" from A.M. Best's Insurance Reports: Property/Casualty.[38] Using these data, we identify the set of insurers involved in a merger or acquisition over our sample period. This set totaled 10 insurers, or 7.9% of our sample for consumer

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[36] The complete set of coefficient estimates for these models are available from the authors upon request.

[37] We also ran this regression by interacting a "High Standardization" dummy with agency. The results are qualitatively similar to those in Table 6.

[38] These reports cover changes over the previous five years so these two editions include our entire sample period.

applications. We reestimated our survival models for the decision to adopt consumer applications excluding these insurers, and the results, shown in the first column of Table 7, are qualitatively similar to our baseline results in Table 3.

We perform several additional analyses to examine the robustness of our results to the choice of dependent variable, unit of analysis, and assumptions for the baseline hazard. First, we estimate survival models of the adoption of intranet technology. An intranet is an internal network that is compatible with the Internet's TCP/IP protocols. Like basic access, intranet adoption indicates that an establishment has invested in an Internet infrastructure that will have little impact on the distribution relationship per se. We examine this additional margin of investment as an additional falsification check, which shows that vertical integration has no impact on adoption of an Internet technology that does not affect the distribution relationship The adoption of intranet was slower than basic access—11.0% of establishments had adopted by 1996—and more costly, so these results examine the alternative hypothesis that the results for basic access were due to its low costs of adoption and the small variation in adoption across the margin of interest. The results for intranet adoption, shown in column 2 of Table 7, further confirm our finding that vertical integration has no impact on the decision to adopt Internet applications that do not involve coordination with agents.

Our measure of consumer applications includes applications other than electronic commerce because insurers provide many tools to customers, which do not involve transactions and which provide benefits to agents. One potential concern may be that our definition of consumer applications is too broad and may include things that do not involve insurer-agent interaction. When we use a measure of consumer applications including only electronic commerce and customer service our results are similar to those including a broader definition of consumer applications (see column 3 of Table 7) to those. One further concern is that some insurers report the adoption of generic commerce. In our data we counted these insurers as adopting consumer applications; however, it is possible these reflect investments in agent-insurer communication. We show the results of regressions that exclude insurers who report the use of generic commerce in column 4 of Table 7. The qualitative results remain similar.[39]

To examine the robustness of our results to the assumption of a Weibull distribution for the baseline hazard, we reestimated the model using the Cox proportional hazard model. The Cox model requires no assumptions on the baseline hazard, because it identifies parameter estimates by using variation in adoption at different failure times. One disadvantage of the Cox model, however, is that when the number of observed points of failure is small, the econometrician is unable to identify the sequence with which subjects adopt. The presence of such "ties" in time to adoption across firms requires further assumptions to identify parameters. We utilize the exact marginal method: At each point of failure in the model, we assume there is an equal probability for each possible sequence of adoption that is consistent with our data and use this assumption to identify the parameters. Again, the results of both the consumer applications and access models are very similar to those of our baseline models.[40]

One assumption of our baseline models was that Internet adoption decisions were made at the firm level. This assumption may not hold if individual units within a firm make separate adoption decisions. This is most likely to be true for technologies, such as basic access or intranet, that are used internally and have lower investment costs, but it may also be true for adoption of consumer applications or agent-insurer communication in large multidivisional insurers in which managerial decisions are decentralized.[41] We reestimated our models for basic access, consumer applications, and agent-insurer communication using establishment-level data, and the qualitative results remain similar.

7. Discussion and Conclusions

We demonstrate that frictions caused by differences in vertical integration in sales force

[39] We also experimented with using a measure of consumer applications that excluded generic commerce and in which we estimated our model over the entire sample. Again, the qualitative results remain similar.

[40] Use of other methods to address ties yield qualitatively similar results.

[41] For example, McElheran (2008) provides evidence of when IT investment decisions are likely to be decentralized in the context of large sample of manufacturing firms.

relationships can influence the speed with which firms can react to new innovations. Risks of opportunistic behavior reduce the expected net benefits of adopting consumer Internet applications, leading to slower adoption among agency insurers. In contrast, vertical integration in distribution has no impact on the adoption of insurer-agent communication, suggesting that transaction costs related to relationship-specific investments do not significantly influence the adoption of Internet technology in our setting.

Our study advances the understanding of the implications of vertical integration in sales force relationships. In contrast to most studies in this area, we examine the implications of vertical integration for firm performance. Firm boundary decisions in this industry are fixed due to historical reasons. Differences in vertical integration influence the speed with which insurers reacted to new Internet technology. Recent industry-level studies conducted over our sample period suggest that the productivity benefits to insurers from adopting Internet applications are significant (Stiroh 2002; Jorgenson, Ho, and Stiroh 2005; Triplett and Bosworth 2002). Thus, this variation in adoption times has significant performance implications for insurers.

Researchers have been cognizant for some time about the potential for channel conflict between Internet-enabled and traditional channels (e.g., Gertner and Stillman 2001; Geyskens, Gielens, and Dekimpe 2002). Yet, there has been less appreciation of the frictions influencing adoption of new e-commerce technologies that complement existing distribution relationships. More speculatively, the frictions identified here are likely to shape the adoption and benefits of any distribution IT (such as electronic commerce or customer relationship management software) in settings where independent sales forces are active.

Our work also complements recent research on the relationship between IT and firm boundaries. While a variety of cross-industry studies have provided evidence that, on average, IT investment and vertical integration are strategic substitutes, recent work has shown how this relationship may depend upon the features of the industry in which IT investments are embedded (Baker and Hubbard 2003; Ray, Wu, and Konana 2009). Our research findings are driven by some of the institutional characteristics of sales force relationships, and so one should be cautious about generalizing our results to other settings. They do suggest, however, that such features can play an important role in determining the relationship between IT and vertical integration, and that further single-industry studies are needed in this important area.

References

A.M. Best's listing of "1997 Property/Casualty Companies and Groups of Fleets."

Anderon, Erin and David C. Schmittlein. 1984. Integration of the Sales Force: An Empirical Examination. *RAND Journal of Economics* 15(3): 385–95.

Annis, David. 2000. From Inkwells to the Internet. *Best's Review*. 100(10): 87–90.

Anonymous. 2006. Back to the Future: V2 XML. March 9, 2006. available at http://www.acord.org/news/NewsDetail.aspx?Type=1&aid=1588.

Astebro, Thomas. 2002. Noncapital Investment Costs and the Adoption of CAD and CNC in U.S. Metalworking Industries. *RAND Journal of Economics* 33(4): 672–88.

Baker, George P. and Thomas N. Hubbard. 2003. Make Versus Buy in Trucking: Asset Ownership, Job Design, and Information. *American Economic Review* 93(3): 551–72.

——— and ————. 2004. Contractibility and Asset Ownership: On-Board Computers and Governance in U.S. Trucking. *Quarterly Journal of Economics* 119: 1443–79.

Barrese, James, Helen I. Doerpinghaus, and Jack M. Nelson. 1995. Do Independent Agent Insurers Provide Superior Service? The Insurance Marketing Puzzle. *Journal of Risk and Insurance* 62: 297–308.

———and Jack M. Nelson. 1992. Independent and Exclusive Agency Insurers: A reexamination of the Cost Differential. *Journal of Risk and Insurance* 59(3): 375–97.

Berger, Allen N., J. David Cummins, and Mary A. Weiss. 1997. The Coexistence of Multiple Distribution Systems for Financial Services: The Case of Property-Liability Insurance. *The Journal of Business* 70(4): 515–46.

Bernard, Ryan. 1996. *The Corporate Intranet: Create and Manage an Internal Web for your Organization.* New York: Wiley Computer Publishing.

Braeutigam, Ronald R. and Mark Pauly. 1986. Cost Function Estimation and Quality Bias: The Regulated Automobile Insurance Industry. *RAND Journal of Economics* 17: 606–17.

Bresnahan, Timothy, Erik Brynjolfsson, and Lorin Hitt. 2002. Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-level Evidence. *Quarterly Journal of Economics* 177: 339–76.

——— and Shane Greenstein. Technical Progress and Co-Invention in Computing and in the Use of Computers. 1996. *Brookings Papers on Economics Activity: Microeconomics* 1996, p. 1–78.

Bureau of Economic Analysis. 1997. Capital Flow Data: 1997 Investment by Using Industries. available at http://www.bea.gov/industry/capflow_data.htm.

Charles, Sandra, Matthew Ivis, and André Leduc. 2002. Embracing E-Business: Does Size Matter? Research Report, Statistics Canada.

Clemons, Eric K. and Lorin M. Hitt. 2001. Financial Services: Transparency, Differential Pricing, and Disintermediation. In *The Economic Payoff from the Internet Revolution*, eds. Robert E. Litan and Alice M. Rivlin, 87–128. Washington, DC: Brookings Institution Press. .

Coase, Ronald H. 1937. The Nature of the Firm. *Economica* 4: 386–405.

Coffin, Bill. 1997. Agents' Favorite Software. *Best's Review* 98(1): 34, 36–37.

Convey, Mary Christine 2000. Travelers Debuts Web-Based Agent System. *National Underwriter,* July 21.

Dewan, Sanjeev, Steven C. Michael, and Chung-ki Min. 1998. Firm Characteristics and Investments in Information Technology: Scale and Scope Effects. *Information Systems Research* 9(3): 219–32.

Dewan, Sanjeev, Charles Shi, and Vijay Gurbaxani. 2007. Investigating the Risk-Return Relationship of Information Technology Investment: Firm-Level Empirical Analysis. *Management Science* 53(12): 1829–42.

Doerpinghaus, Helen. 1991. An Analysis of Complaint Data in the Automobile Industry. *Journal of Risk and Insurance* 58: 120–27.

Dunsavage, Jeff. 2000. Complexity Limits Life Sales on the Web. *Best's Review* 100(10): 85.

Etgar, Michael. 1977. Cost Effectiveness in Insurance Distribution. *Journal of Risk and Insurance* 44: 211–22.

Forman, Chris. 2005. The Corporate Digital Divide: Determinants of Internet Adoption. *Management Science* 51(4): 641–54.

———, Avi Goldfarb, and Shane Greenstein. 2002. Digital Dispersion: An Industrial and Geographic Census of Commercial Internet Use. NBER Working Paper #9287.

———, ———, and ———. 2005. How Did Location Affect Adoption of the Commercial Internet? Global Village vs. Urban Leadership. *Journal of Urban Economics* 58: 389–420.

Franzis, John P. 2000. The Use of the Internet and Electronic Commerce with the Property and Casualty Insurance Industry. *CPCU Journal (*Summer):90–101.

Gertner, Robert H. and Robert S. Stillman. 2001. Vertical Integration and Internet Strategies in the Apparel Industry. *Journal of Industrial Economics* 44(4): 417–40.

Geyskens, Inge, Katrijn Gielens, and Marnik Dekimpe. 2002. The Market Valuation of Internet Channel Additions. *Journal of Marketing* 66(2): 102–119.

Goch, Lynna. 2002. What Works Online. *Best's Review* 103(1): 24–26, 28, 30, 32–34.

Grossman, Sanford J. and Oliver D. Hart. 1986. The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy* 94(4): 691–719.

Hannan, Timothy and John McDowell. 1984. The Determinants of Technology Adoption: The Case of the Banking Firm. *RAND Journal of Economics* 15 (Autumn): 328–35.

Hart, Oliver and Moore, John. 1990. Property Rights and the Nature of the Firm. *Journal of Political Economy* 98(6): 1119–58.

Heckman, James J. and Burton Singer. 1984. Econometric Duration Analysis. *Journal of Econometrics* 24: 63–132.

Helper, Susan. 1995. Supplier Relations and Adoption of New Technology: Results of Survey Research in the U.S. Auto Industry. NBER Working Paper #5278.

Hensley, Roy F. 1962. Competition, Regulation and the Public Interest in Nonlife Insurance. Berkely, CA: University of California.

Hitt, Lorin M. 1999. Information Technology and Firm Boundaries: Evidence from Panel Data. *Information Systems Research* 10(2): 134–49.

Holtom, Robert B. 1978. Producer Compensation Patterns. *CPCU Journal* 31: 70–75.

Jin, Ginger and Phillip Leslie. 2009. Reputation Incentives for Restaurant Hygiene. *American Economic Journal (Microeconomics)* 1(1): 237-67.

Jorgenson, Dale W., Mun S. Ho, and Kevin J. Stiroh. 2005. *Productivity: Information Technology and the American Growth Resurgence*. Cambridge, MA: MIT Press.

Joskow, Paul. 1973. Cartels Competition and Regulation in the Property Liability Insurance Industry. *Bell Journal of Economics and Management Science* 4: 375–427.

———. 1988. Asset Specificity and the Structure of Vertical Relationships: Empirical Evidence. *Journal of Law, Economics, and Organization* 4: 95–117.

Karshenas, Massoud and Paul Stoneman. 1993. Rank, Stock, Order, and Epidemic Effects in the Diffusion of New Process Technologies: An Empirical Model. *RAND Journal of Economics* 24(4): 503–28.

Lafontaine, Francine and Margaret Slade. 2007. Vertical Integration and Firm Boundaries: The Evidence. *Journal of Economic Literature* 45(3): 631–687.

Lancaster, Tony. 1992. *The Econometric Analysis of Transition Data*. Cambridge: Cambridge University Press.

Lane, Sarah. 1991. The Determinants of Investment in New Technology. *American Economic Review* 81(2): 262–65.

MacSweeney, G.. 2000. Nobody Said Agency Automation Would Be Easy. *Insurance + Technology* 25(6): A2–A4.

Marvel, Howard P. 1982. Exclusive Dealing. *Journal of Law and Economics* 25: 1–25.

Masten, Scott E., ed. 1996. *Case Studies in Contracting and Organization*. New York: Oxford University Press.

Mayers, David and Clifford W. Smith. 1988. Ownership Structure Across Lines of Property-Casualty Insurance. *Journal of Law and Economics* 31: 351–78.

McDonald, Lee and Marilyn Ostermiller. 1998 A Report from the E-Commerce Frontier. *Best's Review* 99(1): 5–18.

McElheran, Kristina Steffenson. 2008. Delegation in Multi-Divisional Firms: Determinants of the Organizational Structure of IT Purchasing Authority. Working Paper, Harvard Business School.

Mullainathan, Senhil and David Scharfstein. 2001. Do Firm Boundaries Matter? *American Economic Review* 91(2): 195–199.

Muris, Timothy J., David T. Scheffman, and Pablo T. Spiller. 1992. Strategy and Transaction Costs: The Organization of Distribution in the Carbonated Soft Drink Industry. *Journal of Economics and Management Strategy* 1(1): 85–128.

National Fire Insurance Company v. Sullard, 89 N.Y.S. 934; App. Div. 233 (17 Insurance Digest 360).

Nordhaus, George, and Stephen Brown. 1978. *Marketing Property-Casualty Insurance*. Santa Monica CA: Insurance Marketing Services.

Panko, Ron. 2001. Revenge of the Bricks. *Best's Review* 102(1): 27–37.

Posey, Lisa L. and Sharon Tennyson. 1998. The coexistence of distribution systems under price search: Theory and some evidence from insurance. *Journal of Economic Behavior and Organization.* 35(1): 95-115.

Posey, Lisa L. and Abdullah Yavas, 1995. A Search Model of Marketing Systems in Property-Liability Insurance. *Journal of Risk and Insurance* 62(4): 666-689.

Regan, Laureen. 1997. Vertical Integration in the Property-Liability Insurance Industry: A Transaction Cost Approach. *The Journal of Risk and Insurance* 64(1): 41-62.

Regan, Laureen and Sharon Tennyson. 1996. Agent Discretion and the Choice of Insurance Marketing System. *Journal of Law and Economics* 39: 637–66.

Ray, Gautam, Dazhong Wu, and Prabhudev Konana. 2009. Competitive Environment and the Relationship Between IT and Vertical Integration. Forthcoming, *Information Systems Research.*

Rough Notes. 1995. The Insurance Marketplace. The Rough Notes Company.

Sass, Tim R. and Micha Gisser. 1989. Agency Cost, Firm Size, and Exclusive Dealing. *Journal of Law and Economics* 32: 381-400.

Smallwood, Dennis. 1975. Competition, Regulation, and Product Quality in the Automobile Industry, in Promoting Competition. In *Regulated Markets*, ed. A. Phillips, 241–99. Washington, D. C.: The Brookings Institution.

Stanford Research Institute. 1967. The Stanford Report, prepared for the National Association of Insurance Agents.

Stiroh, Kevin. 2002. Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say? *American Economic Review* 92(5): 1559–76.

Strazewski, Len. 1999. Unclipping their Wings. *Insurance Networking* (July/August): 32–34, 36–40.

Tarnoff, Stephen. 1998. Steering a Steady Course. *Insurance Networking and Data Management.* 30 (April).

Triplett, Jack E. and Barry P. Bosworth. 2002. Baumol's Disease Has Been Cured: IT and Multifactor Productivity in U.S. Services Industries. Working Paper, The Brookings Institution.

U.S. Census. 2007. E-Stats Report. www.census.gov/estats.

Venezia, Itzhak, Dan Galai, and Zur Shapira. 1999. Exclusive vs. independent agents: a separating equilibrium approach. *Journal of Economic Behavior and Organization* 40(4): 443-456.

Webb, Bernard, JJ Launie, Willis P. Rokes and Norman A Baglini. 1984. *Insurance Company Operations.* Malvern, PA: American Institute for Property and Liability Underwriters.

Whinston, Michael D. 2003. On the Transaction Cost Determinants of Vertical Integration. *Journal of Law, Economics, and Organization* 19: 1–23.

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

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

Figure 1
Cumulative Adoption of Access and Internet Apps

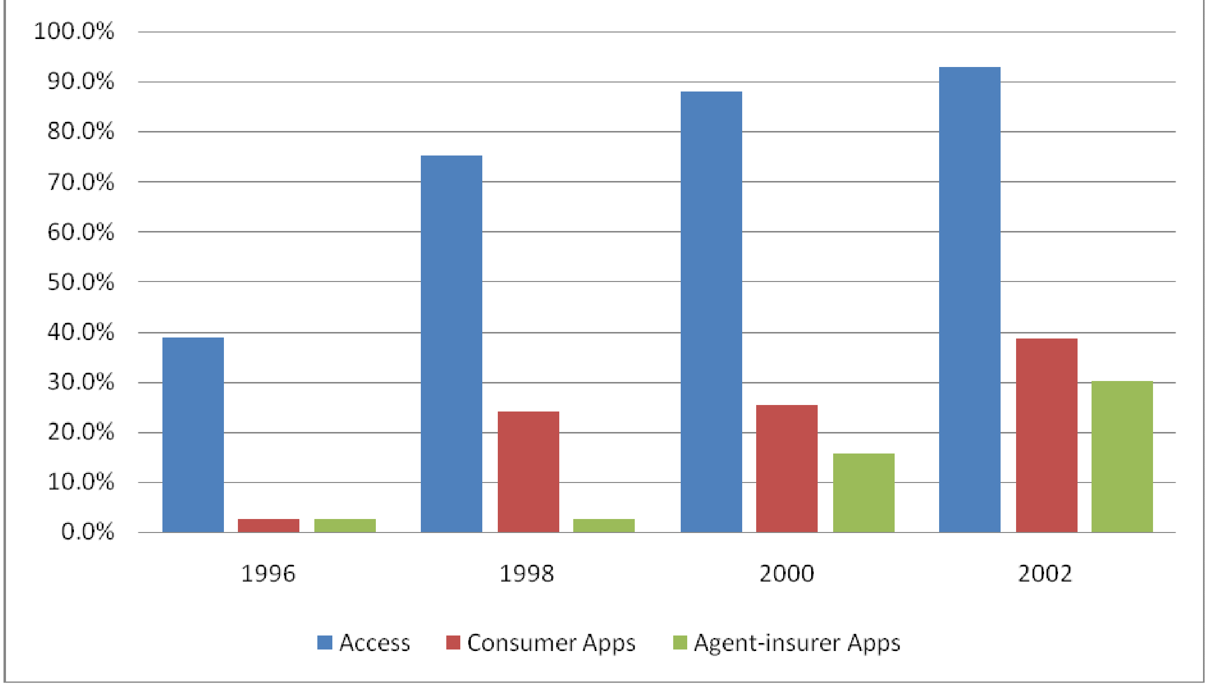

Figure 2: Cumulative Survival Probability for Consumer Applications

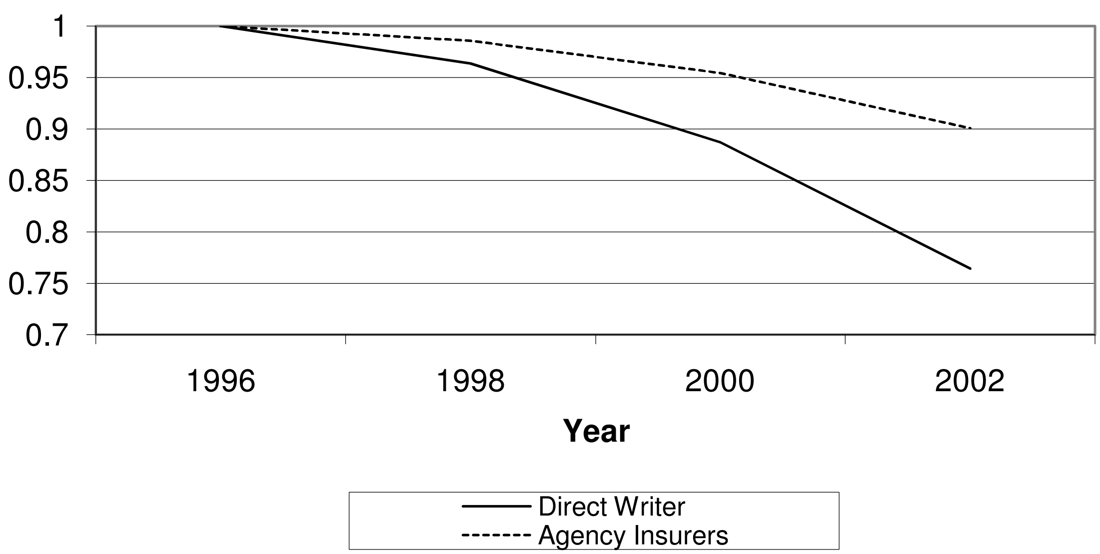

Table 1: Descriptive Statistics

	Total Sample					Mean by Distribution Type	
	Mean	Std Dev	Min	Max	Number Subjects	Direct Writer	Agency
Indicates agency insurer	0.7465	0.4216	0	1	127	0	1
Log of establishment employment	6.3626	1.2385	4.6052	10.4731	127	6.5339	6.3142
Indicates multi-establishment firm	0.3228	0.4694	0	1	127	0.1786	0.3636
% establishments in metropolitan statistical area (MSA)	0.8695	0.3196	0	1	127	0.8929	0.8629
Log of group net premiums	12.7664	1.4941	10.2197	17.3214	127	13.0708	12.6803
% of group premiums written in homeowners' multiperil insurance	0.1047	0.1081	0	0.7009	127	0.1017	0.1056
% of group premiums written in commercial multiperil insurance	0.0857	0.0955	0	0.5911	127	0.0425	0.0979
% of group premiums written in workers' compensation insurance	0.1335	0.1916	0	1	127	0.0474	0.1579
% of all other premiums not written in automobile insurance	0.2194	0.1993	0	0.9943	127	0.1966	0.2258
PCs per employee	0.7475	0.5734	0	3.8075	127	0.6529	0.7743
Mainframe terminals per employee	0.3804	0.3241	0	1.6990	127	0.4026	0.3741
Net commissions/total assets	0.1727	0.8570	-0.0195	8.2087	127	0.2222	0.1587
Net income/total assets	0.2209	1.9998	-0.3860	22.5261	127	0.0926	0.2572
Writes specialty lines	0.0630	0.2439	0	1	127	0.0357	0.0707
Writes nonstandard auto insurance	0.0409	0.1795	0	1	127	0	0.0525
Publicly traded	0.4272	0.4878	0	1	127	0.3182	0.4581
Average per capita income	23189.56	1808.009	18861	28878.53	127	22657.07	23340.17

Notes: Table shows descriptive statistics using the first observation for each establishment in the sample.

Table 2: Correlation Matrix

	Agency	Log (Emp)	Multi-Est	MSA	PC Per Emp	Ter Per Emp	Log (NP)	% HMP	% CMP	% WComp	Pct Oth	Net Comm	Net Inc	Specialty	Non-Std	Public?	Avg Inc	National
Agency	1.000																	
Log (Emp)	-0.161*	1.000																
Multi-Est	0.040	0.696**	1.000															
MSA	-0.015	0.111	0.138+	1.000														
PC Per Emp	0.089	-0.017	0.015	0.139+	1.000													
Ter Per Emp	0.013	-0.118	-0.125	-0.171*	-0.279**	1.000												
Log (NP)	-0.194*	0.866**	0.602**	0.178*	0.035	-0.098	1.000											
% HMP	0.024	-0.198*	-0.168+	-0.164+	-0.158+	0.221*	-0.188*	1.000										
% CMP	0.246**	-0.124	0.063	0.064	0.068	-0.117	-0.012	-0.004	1.000									
% WComp	0.249**	0.011	0.082	0.154+	0.178*	-0.157+	0.059	-0.361**	0.178*	1.000								
% Oth	0.063	-0.029	0.018	-0.120	0.093	-0.180*	0.008	-0.189*	-0.010	-0.127	1.000							
Net Comm	-0.019	-0.145	-0.099	0.048	-0.089	0.068	-0.072	0.104	-0.082	-0.088	-0.100	1.000						
Net Inc	0.042	-0.125	-0.063	0.039	-0.068	-0.016	-0.134	0.072	-0.059	-0.068	-0.070	0.869**	1.000					
Specialty	-0.041	0.257**	0.244**	0.096	-0.086	-0.088	0.206*	-0.156+	-0.011	0.122	-0.037	-0.043	-0.026	1.000				
Non-Std	0.075	0.061	0.153+	0.025	-0.008	0.082	0.032	-0.136	-0.129	-0.120	-0.076	-0.032	-0.020	0.196*	1.000			
Public	0.071	0.334**	0.415**	0.241**	0.064	-0.215**	0.392**	-0.271**	0.010	0.087	0.246**	-0.007	-0.075	0.269**	0.145+	1.000		
Avg Inc	0.141	0.088	0.013	0.103	0.014	-0.023	0.137	0.035	0.161+	0.205*	-0.163+	-0.129	-0.184*	0.008	-0.113	0.122	1.000	
National	0.080	0.557**	0.460**	0.155+	0.011	-0.152+	0.652**	-0.111	0.221*	0.116	0.068	-0.046	-0.051	0.201*	-0.074	0.294**	0.113	1.000

Notes: HMP=Homeowner's Multiperil; CMP=Commercial Multiperil; WComp=Worker's Compensation; Net Comm.=Net Commissions; Net Inc.=Net Income;

Table 3: How Does Vertical Organization Affect Adoption of Consumer Applications?

	(1)	(2)	(3)	(4)
Indicates agency insurer	-1.0504	-1.0365	-0.9442	-0.9237
	(0.3813)**	(0.3818)**	(0.4587)*	(0.5020)+
Log of establishment employment	0.2077	0.1139	0.0502	0.1340
	(0.3280)	(0.3379)	(0.3710)	(0.3744)
Indicates multi-establishment firm	0.9753	1.0146	1.0356	0.9570
	(0.3852)*	(0.3872)**	(0.4504)*	(0.4694)*
% establishments in MSA	-1.1855	-1.2530	-1.2973	-1.2809
	(0.4478)**	(0.4608)**	(0.5026)**	(0.5521)*
Log of group net premiums	0.0249	0.0777	0.0657	0.0219
	(0.2398)	(0.2440)	(0.2634)	(0.2722)
% of group premiums written in homeowners' multiperil insurance	0.1953	0.2165	2.1889	5.0830
	(2.1560)	(2.1453)	(2.4875)	(2.9818)+
% of group premiums written in commercial multiperil insurance	0.0434	-0.3729	-0.8218	0.9047
	(2.0422)	(2.1091)	(2.2365)	(2.8506)
% of group premiums written in workers' compensation insurance	1.7560	1.7132	1.9469	3.2905
	(1.0678)	(1.0736)	(1.1995)	(1.8755)+
% of all other premiums not written in automobile insurance ^	-0.0565	-0.1858	-0.6304	
	(0.8396)	(0.8590)	(0.9893)	
PCs per employee		-0.0698	-0.0058	0.1852
		(0.2948)	(0.2944)	(0.3042)
Mainframe terminals per employee		-0.5189	-0.2244	0.0324
		(0.5761)	(0.5972)	(0.6762)
Net comissions/total assets			-8.4184	-8.6795
			(6.7587)	(7.0051)
Net income/total assets			-5.3551	-5.9105
			(4.6335)	(4.9589)
Indicates writes specialty lines			0.3118	0.4616
			(0.5574)	(0.5971)
Indicates writes nonstandard auto insurance			-0.4524	-0.3171
			(1.0008)	(1.0589)
Publicly traded company			0.3713	0.3194
			(0.4109)	(0.4136)
Average per capita income			-0.0001	-0.0002
			(0.0001)	(0.0001)
Constant	-4.8269	-4.5565	-0.4578	-2.0414
	(1.8472)**	(1.8814)*	(2.9529)	(3.5726)
Number of subjects	127	127	127	127
Time at risk	384	384	384	384
Log-likelihood	-71.7185	-71.2744	-67.8751	-65.0448
P	2.7300	2.7316	2.8452	2.9455
	(0.3341)**	(0.3347)**	(0.3493)**	(0.3619)**

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%. ^ Column 4 contains additional controls that are not shown for percentages of personal automobile liability, personal automobile damage, inland marine, commercial auto liability, fire, allied lines, and other liability.

Table 4: Do the Effects of Vertical Integration Matter for Other Margins of Internet Investment? (Agent-Insurer Communication and Basic Access)

	Agent-insurer communication			Basic access		
	(1)	(2)	(3)	(4)	(5)	(6)
Indicates agency insurer	0.9876	0.9175	1.8377	-0.2109	-0.2367	-0.0589
	(0.7650)	(0.7615)	(1.1351)	(0.2478)	(0.2542)	(0.2925)
Log of establishment employment	0.2373	0.2850	0.2627	0.2523	0.3902	0.2136
	(0.4264)	(0.4416)	(0.5678)	(0.1910)	(0.2082)+	(0.2387)
Indicates multi-establishment firm	0.5021	0.4465	0.0155	0.8387	0.8574	0.9821
	(0.6697)	(0.7136)	(1.0001)	(0.2654)**	(0.2629)**	(0.3025)**
% establishments in MSA	0.4524	0.0725	0.8008	0.1380	0.2201	0.4658
	(1.0272)	(1.0442)	(1.3435)	(0.3112)	(0.3186)	(0.3448)
Log of group net premiums	0.3671	0.4371	0.7449	-0.1476	-0.2444	-0.0390
	(0.3591)	(0.3597)	(0.4764)	(0.1425)	(0.1538)	(0.1820)
% of group premiums written in homeowners' multiperil insurance	2.3128	3.3359	11.1687	3.0072	3.2808	2.9613
	(2.3942)	(2.5911)	(6.1041)+	(1.1304)**	(1.1495)**	(1.4688)*
% of group premiums written in commercial multiperil insurance	4.9359	5.4001	8.0221	-1.1263	-0.7630	-1.2129
	(3.4582)	(3.2325)+	(5.4748)	(1.1676)	(1.2067)	(1.4557)
% of group premiums written in workers' comp insurance	-6.3266	-8.6693	-6.5635	1.2215	1.1139	0.4516
	(3.9557)	(4.0753)*	(6.3270)	(0.6182)*	(0.6499)+	(1.0461)
% of all other premiums not written in auto insurance ^	-0.6470	-0.8488		0.4587	0.7015	
	(1.4113)	(1.3701)		(0.5059)	(0.5302)	
PCs per employee		1.0164	1.3370		0.2777	0.2780
		(0.4337)*	(0.5259)*		(0.1507)+	(0.1561)+
Mainframe terminals per employee		-0.8211	-1.5367		0.6611	0.6103
		(0.7014)	(1.2421)		(0.3340)*	(0.3593)+
Net comissions/total assets			1.2734			-2.6921
			(3.2132)			(3.3442)
Net income/total assets			-2.6021			0.9877
			(9.4316)			(1.2064)
Indicates writes specialty lines			1.1211			0.8472
			(0.8219)			(0.4406)+
Indicates writes nonstd auto insurance			1.3572			-0.2401
			(1.4868)			(0.6634)
Publicly traded company			-0.2372			-0.4812
			(1.1066)			(0.2726)+
Average per capita income			-0.0007			-0.0000
			(0.0003)*			(0.0001)
Constant	-21.2031	-23.0098	-14.7669	-2.4944	-2.7998	-3.6502
	(4.0532)**	(4.2304)**	(6.5171)*	(1.1729)*	(1.1995)*	(1.8298)*
Number of subjects	128	128	128	125	125	125
Time at risk	443	443	443	217	217	217
Log-likelihood	-20.6607	-17.5836	-10.7995	-60.9248	-58.2482	-48.6631
P	8.5016	8.8818	9.3419	2.8319	2.9083	3.2173
	(1.7645)	(1.8133)	(1.8833)	(0.2034)	(0.2093)	(0.2404)

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%. ^ Columns 4 and 8 contains additional controls for percentages of personal auto liability, personal auto damage, inland marine, commercial auto liability, fire, allied lines, and other liability.

Table 5:
Marginal Effects of Survival Models

Scenario	Consumer Applications	Agent-Insurer Interaction	Basic Access
Indicates agency insurer*	2.6923	-0.9479	0.0492
Log of establishment employment	-0.1895	-0.1772	-0.1340
Indicates multi-establishment firm*	-3.0073	-0.1397	-0.5002
% establishments in MSA*	3.4058	-0.4463	-0.1510
Log of group net premiums	0.0103	-0.5460	0.0257
PCs per employee	0.2269	-0.3906	-0.0933
Terminals per employee	-0.2971	0.2913	-0.1272

Notes: Marginal effects represent changes in median time to failure from one standard deviation increase in each of the variables in model (3), except binary variables indicated by *, which are calculated using a 0 to 1 change.

Table 6: Results for Consumer Applications by Product Line Standardization

	High Percentage Standardized Lines			Low Percentage Standardized Lines		
	(1)	(2)	(3)	(4)	(5)	(6)
Indicates agency insurer	-2.1099	-2.1640	-3.4871	-0.6173	-0.6535	-3.7888
	(0.9271)*	(0.9009)*	(1.8950)+	(0.9071)	(0.9591)	(3.4640)
Log of establishment employment	-0.1126	0.2775	-1.9557	1.0539	1.2720	0.8851
	(0.7599)	(0.7911)	(2.1813)	(0.5693)+	(0.7627)+	(0.9072)
Indicates multi-establishment firm	1.4703	1.3070	1.0515	1.4856	1.8191	6.7013
	(0.8794)+	(0.9176)	(1.3419)	(0.8495)+	(0.9426)+	(3.9906)+
% establishments in MSA	-2.4429	-2.1142	-2.4528	-0.8151	-1.1122	-2.2296
	(0.8612)**	(0.8871)*	(2.7363)*	(1.0823)	(1.1617)	(5.0155)
Log of group net premiums	0.0460	-0.2611	1.2923	-0.8493	-1.1080	-1.2990
	(0.5330)	(0.5618)	(1.5802)	(0.5978)	(0.7763)	(1.2624)
% of group premiums written in HMP	3.1274	2.5890	-13.7310	-5.9467	-4.4622	7.3967
	(4.8176)	(4.8280)	(35.7891)	(8.0032)	(8.4041)	(17.6933)
% of group premiums written in CMP	-14.3753	-22.8238	-58.6193	2.1413	2.1354	11.3977
	(15.1603)	(18.6419)	(52.0050)	(3.1405)	(3.6471)	(9.9711)
% of group premiums WComp	3.0262	14.2464	61.1926	2.3349	2.1839	13.6758
	(16.2069)	(18.7235)	(64.3111)	(1.7842)	(1.8322)	(6.5914)*
% of all other premium not auto ^	1.1128	2.6319		0.8562	0.9414	
	(5.2326)	(5.4619)		(2.2581)	(2.4383)	
PCs per employee		-1.1745	-3.2731		0.3928	2.3005
		(1.2794)	(2.9394)		(0.4429)	(1.1462)*
Mainframe terminals per emp		0.8816	4.3097		0.0605	-1.3801
		(1.1005)	(2.1761)*		(1.8173)	(3.4499)
Net comission/total assets			0.9394			-14.3173
			(5.8245)			(30.1872)
Net income/total assets			-9.4282			7.0337
			(19.6048)			(24.9422)
Indicates writes specialty lines			-33.3124			4.3672
			(2401.473)			(1.8880)*
Indicates writes nonstandard auto			9.7719			
			(5.3930)+			
Publicly traded company			-0.0162			-2.3469
			(1.5406)			(2.4788)
Average per capita income			-0.0002			0.0003
			(0.0004)			(0.0004)
Constant	-2.5161	-1.2169	13.6444	-0.7161	0.9772	-14.7137
	(3.8726)	(4.4587)	(22.7210)	(4.9161)	(5.3962)	(16.9109)
Number of subjects	41	41	41	45	45	45
Time at risk	126	126	126	125	125	125
Log-likelihood	-19.4529	-18.7605	-10.8626	-21.7759	-21.3283	-9.8483
P	3.2412	3.3453	4.4560	2.9920	2.9379	5.0291
	(0.7472)**	(0.7758)**	(1.0614)**	(0.6103)**	(0.6063)**	(1.1225)**

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%. ^ Columns 3 and 6 contains additional controls for percentages of personal auto liability, personal auto damage, inland marine, commercial auto liability, fire, allied lines, and other liability. We computed the percentage of all group policies written in "simple" lines, defined to include homeowner's multiple peril, personal automobile damage, and personal automobile liability. Columns (1) through (3) indicate the results of regressions estimated over the top third of the sample distribution in these lines, while columns (4) through (6) show results from the bottom third of the distribution. Percentage of nonstandard automobile insurance is not identified in columns 6.

Table 7: Results Are Robust to Alternative Measurements of Dependent Variable, Different Stochastic Assumptions, and Different Units of Analysis

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Excludes Mergers: Consumer applications	Intranet	Narrow Consumer applications	Consumer applications excluding generic commerce	Cox Proportional Hazard Model: Consumer Application	Cox Proportional Hazard Model: Agent-Insurer Commun.	Establish. Data: Consumer Appls.	Establish. Data: Agent-Insurer Comm.	Establish. Data: Basic Access
(1)	Indicates Agency Insurer	-1.0440	0.2758	-1.1664	-1.2177	-1.0553	1.0772	-0.6370	0.2234	0.0229
		(0.3947)**	(0.2769)	(0.4708)*	(0.4059)**	(0.3804)**	(0.7729)	(0.2993)*	(0.4032)	(0.1788)
	Number of subjects	117	127	128	119	127	128	273	274	267
	Log-likelihood	-62.5646	-80.7233	-43.7905	-65.5570	-100.7736	-51.8925	-125.6706	-84.3307	-147.5979
(2)	Indicates Agency Insurer	-1.0502	0.2133	-1.1740	-1.1934	-1.0392	0.9835	-0.6630	0.2019	-0.0137
		(0.3968)**	(0.2797)	(0.4733)*	(0.4061)**	(0.3829)**	(0.7620)	(0.3019)*	(0.4053)	(0.1799)
	Number of subjects	117	127	128	119	127	128	273	274	267
	Log-likelihood	-62.2843	-78.1510	-43.7110	-64.9509	-100.1874	-49.0420	-124.5513	-83.4395	-146.0892
(3)	Indicates Agency Insurer	-0.9688	0.1091	-1.2211	-1.0837	-0.9928	2.0382	-0.4886	0.1278	0.1223
		(0.5273)+	(0.3405)	(0.6605)+	(0.5192)*	(0.5131)+	(1.1933)+	(0.3759)	(0.5038)	(0.2083)
	Number of subjects	117	127	128	119	127	128	273	274	267
	Log likelihood	-56.1463	-72.6596	-38.2978	-57.3355	-94.8164	-40.3883	-116.5838	-77.0862	-141.5766

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%. The sets of controls used in rows (1) through (3) correspond to the controls in columns (1) through (3) of Tables 4 and 6, respectively. Column 1 excludes mergers identified in A.M. Best's Insurance Reports: Property/Casualty; column 2 shows the results of models where adoption of intranet is the dependent variable; column 3 uses a measure of consumer applications that includes only electronic commerce and customer service; column 4 excludes observations that report they are engaged in generic commerce; columns (5) and (6) are reestimations of our baseline models using the Cox Proportional Hazard Model; columns 7 through 9 are reestimations of our baseline models using establishment-level data.