The Productivity Benefits of IT Outsourcing

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Abstract

We examine the productivity benefits of IT outsourcing in the credit union industry, using data on the population of U.S. credit unions from 1992-2005. Within-credit union switching from internal IT to outsourced IT reduces operating costs by roughly 30%, once we control for the endogeneity of switches. Less productive firms are more likely to outsource in the cross-section, and more likely to exit. In partial equilibrium, we estimate that outsourcing is responsible for over $6 billion in annual cost savings for the industry as a whole.

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1 Introduction

There is by now a broad consensus that information technology (IT) spurred accelerated productivity growth during the latter half of the 1990s, and perhaps beyond. Much of that acceleration seems well-explained by the mechanics of a model in which the production of IT capital has gotten cheaper, spurring greater IT investment by IT users, shifting the capital/labor ratio and increasing labor productivity.[1] But there is also a growing sense that the full productivity benefits of IT are realized via other channels, often involving the reorganization of productive activities.[2] A canonical example of such reorganization is the outsourcing of IT-related business services.

In this paper we estimate the productivity benefits of IT outsourcing, focusing on the idea that IT outsourcing is motivated by reorganizational benefits above and beyond the benefits accruing just from better technology. The productivity benefit accruing from direct IT investment is a straightforward response to better technology. It is a change in *how well* firms do what they do, holding *how* they do what they do constant. But outsourcing is a change in *how* firms do what they do, holding technology constant. Both internal and outsourced IT-related production could in principal use identical IT capital, and both would become more productive as IT capital becomes cheaper. But a productivity benefit from IT outsourcing reflects a gain from reorganizing production. This may be a response to changes in the efficient scale of IT-related production, or gains from specialization by IT personnel; it may be facilitated by complementary investments that make changing firm boundaries more attractive, and affected by transaction costs of using the market.[3] But regardless of the reason, finding that reorganizing IT-related service production increases productivity is of great value in elucidating the full benefits of IT. While there is substantial anecdotal evidence that such benefits exist, there is little hard empirical evidence on the point—particularly as it applies to IT outsourcing.

To measure the productivity benefits of IT outsourcing, we use a panel of firm-level data from the credit union industry, covering the period 1992-2005. We observe firm-level decisions not only on IT outsourcing but also on IT computerization. Computerization is the adoption of computers, among credit unions with in-house IT; it is akin to the IT capital deepening viewed as the traditional source of IT's productivity benefits. Among credit unions who use computers, there is switching from in-house IT to outsourced IT; that transition is what allows us to identify the

[1] Jorgenson, Ho and Stiroh (2007) provide an excellent recent history of the issue, discussing both how productivity and productivity forecasts changed over the last fifteen years, and the empirical literature establishing the role of IT.

[2] See Brynolfsson and Hitt (2000) for a discussion of these issues, and a survey of prior work.

[3] For theories of outsourcing, see Grossman and Helpman (2002), and Bartel, Lach and Sicherman (2005).

benefits of reorganizing production, conditional on technology. Because we measure the productivity benefits of IT outsourcing using within-firm IT system switching rather than variation in the cross-section, we can control for much of the unobserved heterogeneity that often makes inferring causal relationships difficult. We also treat within-firm variation in IT system choices (internal vs. external) as endogenous; a unique benefit of examining credit unions rather than other institutions such as commercial banks is that for credit unions we have excellent instruments for IT system choices.

We find that outsourcing confers large productivity benefits, but that the magnitude of those benefits varies substantially depending on the time period we examine. Early in the sample period (1992-1997), outsourcing is not much more efficient than in-house IT that is computerized—though among in-house IT systems, there is a large productivity benefit associated with computerization. In the latter period (1998-2005), the relationship shifts: it is outsourcing rather than computerization that confers the largest benefits. Credit unions who outsource have costs over 30% lower than they would if they performed their IT in-house. Overall, the effect of outsourcing is equivalent to $6.5 billion in annual cost savings for the industry as a whole, relative to a counterfactual in which all firms choose in-house (but computerized) IT in 2005. Assuming complete pass-through of these lower costs to consumers, this results in savings of nearly $100 per credit union customer per year.

We find these effects only in our full specification that includes firm fixed effects and treats within-firm variation in IT choices as endogenous. In the cross-section, by contrast, the correlation between IT outsourcing and costs is positive and quite large. We also find that in the cross-section firms who outsource are less productive on average. While it is possible that this finding reflects measurement error in productivity, we also find that firms with lower measured productivity are more likely to exit. We take this as evidence that high-productivity firms are better able to produce IT in-house given available technology, and choose to do so given that using the market also incurs costs.

To our knowledge, ours is the first study to explicitly estimate the productivity benefits of IT outsourcing; it has been a difficult question to pursue because the data used in standard productivity analyses are far from ideal. A few studies have estimated the relationship between productivity and outsourcing defined more broadly; Siegel and Griliches (1992) is an early study that correlates industry-level productivity with purchased service inputs, which is a measure of outsourcing. Fixler and Siegel (1999) also study the outsourcing/productivity relationship using data on purchased service inputs. Both studies are circumspect in their conclusions given the roughness of their data and the lack of useful instruments for outsourcing. In more recent work, Gorg and Hanley (2004) correlate measures of profitability with the use of materials and service outsourcing; they find that low-productivity firms are more likely to outsource. A wider literature focuses on explaining outsourcing in the context of make-buy decisions (e.g., Abraham and Taylor 1996), but that is not the focus of our work.

Our work also adds to the IT/productivity literature in banking and financial services. Again, while the notion that technological change has had profound effects on the industry is well-received, there has been relatively little work directly linking IT (even in its simple capital deepening sense) to financial services productivity.[4] This is of particular concern given that studies of banking productivity often find results that seem inconsistent with the presumed effects of technological change; for example, several studies have found that bank productivity fell during the 1990s, when banks invested heavily in IT capital.[5]

In the broader literature linking IT to productivity, our work is most closely related to other microeconomic studies linking firm-level IT to productivity; much of that work is summarized in Brynolfsson and Hitt (2000). Again, however, the focus of that work is largely (if not exclusively) on IT capital deepening, rather than outsourcing. The notion that reorganization of production is an important aspect of the IT revolution has been advanced by Brynolfsson and Hitt (2000) and others, but largely in the context of the view that within-firm IT investment is accompanied by complementary within-firm investments in organizational restructuring.[6] To our knowledge, the productivity benefit reorganizing of IT-related production *across* firms has not been studied.

A final point raised by our study is that it is unclear whether and how productivity benefits from IT outsourcing would show up in standard productivity measures.[7] Such productivity gains might be measured as TFP growth in IT-using industries, or not measured at all, depending on the data at hand. Some studies have found significant increases in TFP in IT-using industries; reorganizational benefits may show up as TFP growth, if inputs and outputs are measured accurately.[8]

[4] Casolaro and Gobbi (2003) is one exception; they study the effects of IT capital deepening on productivity; their work differs from ours in that they treat IT investment as exogenous and focus on cross-sectional variation rather than within-firm changes in IT and productivity. While they have data on IT outsourcing, they do not focus on the link between outsourcing and productivity.

[5] See Berger (2003) for a review. Berger and Mester (2003) is an example of a study finding that cost productivity declined during the 1990s. Other work shows increasing productivity in banking during the 1990s. See, e.g., Stiroh (2002).

[6] See, for example, Brynolfsson, Hitt and Yang (2002) and Bresnahan, Brynjolfsson and Hitt (2003).

[7] For work examining the aggregate importance of IT, see Jorgenson (2001), Stiroh (2002), Jorgenson and Stiroh (2000), Jorgenson, Ho and Stiroh (2002, 2004), Gordon (2000) and Oliner and Sichel (2000, 2002).

[8] Whether TFP growth is correlated with IT use/investment is unclear. See Stiroh and Botsch (2006), Stiroh (2006) and Stiroh (2002). There is some evidence that IT investment increases TFP in IT-using industries, but with a lag. See Basu et al. (2003, 2007) for a discussion and evidence.

But our results provide evidence that IT-related productivity gains from outsourcing may in fact be negatively correlated with within-firm IT investment, because outsourcing moves that investment outside the firm. An even greater concern is that measurement problems might lead productivity benefits of outsourcing and other forms of reorganization to go unnoticed. The work on complementary investments notes that much of that investment may be unmeasured. A related literature on accounting for "intangible capital" is proving to have a substantive impact on estimates of productivity in general and IT's return.[9] To the extent that IT outsourcing is unmeasured or mismeasured, it may introduce biases similar to those introduced by other omitted prices.[10] A better understanding of the link between IT, outsourcing and productivity may clarify some of the mixed recent evidence regarding the relationship between IT and productivity, particularly in services, where productivity growth has been particularly strong since 2000.[11]

2 Credit Unions, IT and Outsourcing, 1992-2005

Credit unions are financial institutions similar to commercial banks, but smaller and more focused on retail financial services. In most cases a credit union obtains a charter via an affiliation with an entity such as a school or firm, and the employees of that entity are the primary "members" or customers of the credit union.[12] At year-end 2005 nearly roughly 8,800 credit unions operated nationwide, employing roughly 250,000 people full-time, serving over 80 million customers, and holding nearly $700 billion in assets.[13] These numbers reflect both growth in customer base and consolidation among firms over the last fifteen years. By all accounts, credit unions face intense competition from their peers as well as commercial banks and other financial institutions.[14]

[9] See Corrado et al. (2006).

[10] There is concern that omitted changes in import prices may have biased TFP estimates for U.S. manufacturing; see Feenstra et al. (2005).

[11] Bosworth and Triplett (2007) estimate that MFP growth in services is a strong contributor to post-2000 productivity growth. Corrado et al. (2007) find that productivity in finance and business services grew substantially post-2000.

[12] In some cases credit unions can also choose a regional pool from which their "potential members" are drawn, allowing them to serve anyone in that region.

[13] For the purpose of comparison, there are roughly 9,000 commercial banks in the U.S., employing roughly 1.3 million people and holding roughly $10 trillion in assets.

[14] Credit unions are chartered as non-profit entities, but are of course in direct competition with for-profit firms. For both reasons, we maintain the assumption throughout this study that credit unions do not have market power sufficient to make concerns about markups empirically relevant. See Emmons and Schmid (2000) for further details regarding the competitive links between the two types of entity.

The data in our study come from the National Credit Union Administration (NCUA), which requires all credit unions in the United States to submit quarterly reports covering virtually every aspect of their operations. These "Call Reports" are publicly available from 1994-2006; we augment them with data from 1992-1993 obtained under a Freedom of Information Act (FOIA) request to NCUA. We begin the analysis in 1992 because that is the first year in which NCUA asked credit unions to report information about their IT and outsourcing. While complete data are available semi-annually, we use annual data from December of each year; doing so does not lose much information relative to using the full semi-annual data set.

2.1 IT and Outsourcing of Data Processing

The business of providing retail financial services is data-intensive. For credit unions, the primary data processing activity is recording clients' transactions. Information about transactions may enter the credit union via teller transactions, through the mail, on the phone or via the internet. After it is recorded, information needs to be maintained securely, and periodically transmitted back to the customer via monthly statements or at the customer's request. Apart from these straightforward activities, credit unions often analyze their data in order to inform decisions—such as those involving prices or product mix. In recent years, "customer relationship management" has also become quite popular in financial institutions, and the data-based analysis feeding into that is also under the general set of activities that credit unions refer to as "data processing," and is what we refer to as the IT system. In all of these activities speed and accuracy are paramount, making IT system performance a critical input for all financial institutions.[15] Credit unions, along with other financial institutions, moved very quickly to invest in IT; the financial services sector overall is by some measures the most IT-intensive sector of the US economy.[16]

In our data, credit unions have four IT system choices. The simplest is a paper-based "Manual" system, which does not rely on computers. The other three systems all employ computers, but vary in the set of activities performed internally vs. externally. A credit union may perform all of its functions (software development, hardware investment and ongoing IT) internally; this is referred to in our data as a "CU-developed" (or completely in-house) system.[17] There are two

[15] An entire web site ("Credit Union Tech-Talk") is devoted to allowing credit unions to share information about their data processing, about vendors, and other issues. The trade press devotes tremendous energy both to providing IT-related information and to releasing studies about its costs and benefits. See, e.g., www.creditunions.com.

[16] See Berger (2003) for a broad discussion.

[17] It is likely that some software component of a CU-developed system is off the shelf; a credit union might use existing database software such as Microsoft Access as a foundation for its processing, for example.

forms of outsourcing. The first is what credit unions call a "Vendor-supplied in-house" (VIH) system. In a VIH arrangement the credit union purchases a software program and installs it on its own computers; all data reside in-house, and the credit union typically bears responsibility for maintaining the system and analyzing any data in the system. A VIH system often requires internal employment of an IT staff, though the software vendor may provide both up-front training and ongoing tech support, as well as help with upgrades. The second type of outsourcing is more complete, and is called a "Vendor online" (VOL) system. In a VOL system, both hardware and software used for data processing are located off-site at the vendor's service bureau. Credit unions connect to the system through a telecommunications link connected to terminals in the credit union. These may be proprietary terminals supplied by the vendor, or Windows-based PCs owned by the credit union. The vendor generally assumes responsibility for the data.

The costs and benefits of these choices are oft-discussed in the credit union trade press, and while modeling IT system choice is beyond the scope of this paper, the tenor of discussions in the trade press fits what one would expect to see given theories of make/buy economics. An internal system allows customization, control and flexibility, but requires hiring, training and monitoring an IT staff. Going to the market for IT services exposes credit unions to the risk of hold-up, but takes advantage of scale and the expertise provided by specialists. Finding a good "match" with an IT vendor does seem important to credit unions, though by most accounts the market for IT services is quite competitive.[18] For the interested reader, we include at the end of the paper a press release from a vendor describing an IT system switch and its benefits (according to the vendor).

Table 1 tabulates our data. The first column shows the overall number of credit unions nationwide, which falls quite dramatically during the sample period from 12,040 to 8615.[19] This reflects a wave of exit (via consolidation) in the industry, and introduces two empirical concerns. One is that exit is likely correlated with productivity, and should be accounted for in the empirical work. Second, aggregate industry statistics are likely to reflect both within-firm changes over time and changes in sample composition; that is also something we discuss later in the paper. All told, the raw number of observations in the data is 147,032, including data for 13,573 different credit unions.[20]

The next four columns show how IT system choices change between 1992 and 2005. For obvious

[18]For an analysis of vendor switching, see Ono and Stango (2007).

[19]These figures exclude credit unions who choose "other" as their IT system. There are as many as 600 such credit unions each year.

[20]There is essentially no entry during the sample period, although some credit unions "appear" in the data once they switch from "other" IT to one of the four systems mentioned above.

reasons, manual data processing disappears by the end of the sample; in 2005, only 155 credit unions nationwide use a manual system. CU-developed systems are quite popular at the outset of the sample period, but also essentially disappear by the end. VIH systems grow in popularity until the late 1990s; while the total number of CUs using VIH systems then declines, their use as a share remains roughly constant at around 70% until 2005. The share of CUs using VOL systems rises over the sample period from under 20% to close to 30%. As illustrated in the last two columns, credit unions' IT systems have become both computerized and outsourced over time.

In the cross-section one can see a clear relationship between IT system choice and credit union size. Figure 1 illustrates this by showing kernel densities of credit union size (measured by deposits), for each IT system. It is not particularly surprising that manual systems are chosen by the smallest credit unions, given their lack of scale and the labor intensity of manual IT. What is less immediately intuitive is that among those choosing a computerized system, it is the largest credit unions who outsource most completely by choosing VOL; a simple scale-based explanation for outsourcing would predict the opposite. Table A1 in the appendix provides further detail on this relationship. Despite the broad trend, there is substantial overlap in that among mid-sized credit unions both VIH and VOL systems are quite common, and even CU-developed systems retain appeal through the middle years of the sample.

The final source of variation in the data, and the one that provides identification in the empirics, is within-credit union IT system switching. Table 2 tabulates these switches, showing both the number of switches across systems and the average size of switchers in each cell. We measure size using the natural logarithm of total deposits; any other standard measure of size (members, accounts, assets) yields the same pattern. The table reveals a few interesting facts about switches. First, it shows that while switching from in-house to outsourced IT systems is most common, some firms do move the other way; in particular, there is a significant number of switches from VIH to CU-developed, with most of these switches occurring early in the sample. We see no reason to view this as anomalous or exclude these observations, and therefore retain them in the empirical work below.[21] A second fact is that among firms who outsource by moving from internal to external IT, those who switch tend to be the largest; this is also not surprising given the pattern in the cross-section.

In all, these statistics illustrate that in this market, as in so many others, computerization and IT outsourcing have become pervasive. It is the latter trend that most interests us, but the ability to distinguish computerized from manual IT systems is also empirically useful. In

[21] Excluding these switches does not change any of the empirical results discussed below.

particular, it allows us to compare the productivity benefits of computerization—the focus of most IT-related productivity studies—to the benefits of outsourcing. With that in mind, we now turn to a discussion of output measurement, and present some summary data on the relationships between IT outsourcing and simple measures of productivity.

2.2 The Financial Service Output of Credit Unions

We follow the most recent banking literature in viewing credit unions as providing two primary types of service output. The first are services to borrowers: screening and monitoring to resolve asymmetric information about creditworthiness, loan payment processing and other ongoing services associated with loans. The second are services to depositors: providing transaction and payment services, as well as safekeeping and storage of funds. The conceptual underpinning for thinking about bank output this way is clear enough, benefiting from a flurry of methodological research in recent years.[22] The empirical problems faced by all empirical studies of banking productivity are that (1) these services are often intangible, and (2) they are rarely priced explicitly. Deposit services, for example, are often priced via an implicit interest payment from funds held in a checking account. Credit screening may be priced explicitly, but may also be priced into the loan interest rate. This makes measuring output accurately extremely difficult. Most studies of productivity to date use broad measures of deposits or loan balances to measure output; this may account for the mixed evidence on whether banking productivity increased during the 1980s and 1990s.[23]

Fortunately, the NCUA data on financial service output are extremely detailed, allowing us to construct a rich multi-dimensional measure of credit union service output. NCUA requires credit unions to report details of fifteen financial service products. These include checking and savings accounts, although the latter are offered by every credit union; money market deposit accounts (MMDAs), certificates of deposit (CDs) and individual retirement accounts (IRAs); and on the loan side, personal loans, new car loans, used car loans, fixed rate mortgages, variable rate

[22] Early discussion of the issue includes Fixler and Zieschang (1992) and Berger and Humphrey (1992). Fixler (2004) discusses how to measure conceptually the prices paid by consumers (implicitly and explicitly) for loan and deposit services.

Fixler, Reinsdorf and Smith (2003) describe both the conceptual framework and how BLS and BEA measure bank output/productivity differently, and recent changes in the NIPAs. Moulton (2000) discusses details of the change.

Fixler and Zieschang (1999) is an early empirical example illustrating how to apply the new concepts. Wang (2003a, 2003b, 2003c, 2003d) provides an exhaustive treatment of the issue and contrasts her productivity measure with that used by BLS.

[23] See Berger and Mester (1997, 2003) for evidence and discussion.

mortgages, home equity lines of credit (HELOCs), and two types of business loans (agricultural and non-agricultural). We also observe whether the credit union has a web site.[24]

For each product offering, we measure two things: whether the credit union offers the service at all, and the number of customers using each service. Table 3 summarizes these data, by IT system choice across all years. Credit unions with manual systems tend to offer only savings accounts and simple loan products (car, personal and fixed rate mortgage). Among credit unions with CU-developed systems, more sophisticated savings products such as CDs and MMDAs are more prevalent. Credit unions who outsource by using VIH or VOL systems are even more likely to offer these products, and other services such as HELOCs, IRAs, and web sites. The number of such accounts is also substantially higher moving across the columns of the table, although it is does not appear that customers of credit unions with outsourced IT systems are more intensive users of financial service offerings.[25] Of course, these differences do not show a causal link between IT system choice and product offerings, and credit union size is correlated with both IT system choice and product offerings. We show these data merely to illustrate the cross-sectional variety in services offered.

We provide further details on heterogeneity in the cross-section and over time in Figures 2 and 3. Figure 2 shows histograms of the total number of financial service offerings, by IT system type. The median number of financial services offered by CUs with a manual system is 3. The median is 4 for Cu-Developed, 5 for VIH and 7 for VOL. Again, these do not say anything about causal relationships; but at the least it suggests that controlling for product offerings is important empirically.[26]

Product offerings also become more prevalent over time. Figure 3 shows the shares of credit unions offering each financial service product in the first and last years of the sample: 1992 and 2005. Every product (with the exception of agricultural loans) becomes more prevalent. While we do not show the corresponding data, it appears that this is primarily due to changes in sample composition stemming from exit and outsourcing; in simple regressions that condition on IT system and credit union size, the firm-level mean number of product offerings does not change between 1992 and 2005.

[24]In 1998 NCUA began collecting detailed information about credit unions' web sites and internet banking products. Borzekowski (2004) examines the relationship between internet banking and outsourcing and finds (somewhat surprisingly) that IT outsourcing does not drive internet banking.

[25]While we do not show the figures, conditional on offering a particular product the percentages of customers using that product is roughly equal for credit unions using different IT systems.

[26]See Bernard, Redding and Schott (2006a, 2006b) for discussions of product choice and switching, and the relationship between those things and productivity.

The data in Table 2 form the basis for our measures of credit union output. We first construct a set of dummy variables $D\left(y_{ijt}>0\right)_{it}^{j}$ for the set of financial services listed in Figure 2, indicating whether the credit union offers the product. We also construct a vector of financial service product quantities, where the quantity is the number of accounts for each product, y_j. Finally, we measure new originations of both real estate and non-real estate loans.

In the context of methodological work on financial service output, our measure has two useful features. First, it captures the multi-dimensional nature of retail financial services. This is important because having a wide range of services clearly makes a credit union attractive to customers; a large portfolio of services allows "one-stop shopping" for complements and provides variety in substitutes.[27] It is also important because offering a wide range of sophisticated financial services may require very different technology than offering a few simple services, all else equal. Indeed, many IT vendors claim that their technology allows credit unions to expand their financial service offerings in a cost-effective manner, either relative to doing IT in-house or to using competitors' systems.

A second useful feature of our output measure is that it measures service flows using the number of accounts rather than dollar levels of account balances.[28] This is advantageous because service flows on deposit accounts and loans are often relatively independent of the dollar values associated with those accounts.[29] Wang (2003a), for example, states when discussing loans that "the real quantity of bank value added should just be the number of loans certified, regardless of the loans' face value." A similar logic applies to deposit accounts. Such an account-based output measure is not as useful for comparing bank service output in the cross-section because we do not observe per-account fees. But as long as per-account fees and service flows remain constant within a credit union, a 10% increase in the number of loans or savings accounts held by credit union A will exactly represents a 10% increase in its service flow; it is that source of variation that provides identification in the empirical model. Because service flows for loans often have a significant fixed component when the account is first set up, we also assume that loan service flows are proportional to new

[27] The trade press views product-level measures of service flows as appropriate as well. Callahan and Associates (www.callahan.com) measures credit union-level "member service usage" using the numbers of checking, auto loan and credit card accounts per member, and also using total savings and loan accounts per member.

[28] The analogous "call reports" for commercial banks contain only the total dollar value of balances, and not the number of accounts in each deposit/loan category. Thus, most banking productivity research uses dollar values of balances rather than number of accounts.

[29] This is true only to a point, of course. We would argue that it is more true for credit unions than banks, because credit union customers are more homogeneous than retail bank customers; in particular, credit unions serve no commercial clients apart from small business owners.

loan originations in each period.

A constraint imposed by our choice to use a multi-dimensional output measure is that it precludes using a production function to measure productivity; we therefore use cost functions. We now discuss measures of credit union costs and present some summary data on the relationship between observed costs and IT system choices.

2.3 Summary Data on IT Choices and Costs

The cost data collected by NCUA are quite good. Credit unions must report not only overall operating costs, but costs by category of operations. The summary measure of costs that we use is non-interest operating expenses.[30] This is includes all of the variable costs of bank operations, as well as the explicit and recurring component of fixed costs. Table 4 shows summary data for costs, again stratified by IT system. The top row echoes the pattern in Figure 1: larger CUs, and therefore those with the greatest level costs, are more likely to outsource. The next three rows show cost shares for labor, office operations and professional/outside services. In-house IT expenses are included in office operations expense, while outsourced (VIH/VOL) expenses count are included in professional service expense.[31] The pattern in these data are not surprising; credit unions who outsource most completely have the highest share of professional service expense.[32]

The next rows show three measures of costs per unit of output, where output is defined unidimensionally. The first row shows operating costs per dollar of deposits. This ratio is roughly constant across IT system. The second and third cost measures yield less intuitive patterns. When costs are measured relative to either members (customers) or accounts, they are highest for credit unions who outsource and lowest for those with manual IT systems.[33] This seems contradictory: why, given the revealed preference for outsourcing by nearly every credit union in the sample, would

[30] For credit unions, this is closest to the cost measure advocated by Wang (2003a).

[31] Office operation expense includes expenditures for "expenses related to the operation of an office including communications, stationery and supplies, liability insurance, furniture and equipment rental and/or maintenance and depreciation, bank charges, in-house EDP cost, etc." The latter is expenses associated with a CU-developed IT system. Professional/outside service expense includes "legal fees, audit fees, accounting services, consulting fees, and outside EDP servicing."

[32] In principle, it is possible to pin down the size of EDP costs in these variables by looking at how they change within-firm when a credit union switches its IT system. Those estimates suggest that between one-third and one-half of these costs are associated with the type of IT system. We do not place much weight on these figures, however, clouded as they are by selection and measurement issues.

[33] The accounts measure is calculated at the credit union level by adding the number of accounts in each financial service category from Figure 2.

outsourcing be more expensive? A natural explanation, of course, is that these measures of output omit information. One possibility is that service flows per member or per account are greater for larger credit unions and/or those who outsource. Another is reverse causality: high-cost credit unions may be more likely to outsource. These summary data are unable to distinguish among the possible explanations, but we return to this issue later in the paper.

The second pane of the table shows our measures of input costs, which are controls in the cost functions we estimate below. These input costs are derived from our wage data, data on the number of full-time equivalent (FTE) employees at each credit union, and the other itemized components of operating costs: travel/conference expense, office occupancy expense, advertising expense, and insurance.[34] The data on wages and FTEs allows us to calculate the average wage. We also measure insurance costs per member, loan servicing costs per loan, office occupancy expenses per member and loan losses per loan.

Again, there are some substantial differences in these costs across credit unions with different IT systems. One thing that seems to be clear is that users of manual IT systems are fundamentally different from other credit unions. For example, the median wage at manual-IT credit unions is $8062, less than one quarter the median wage of $38,839 at credit unions using VOL IT systems. This may reflect true wage differences, or measurement error. Among those with computerized systems, the pattern is again that credit unions who outsource—and are the largest, by and large—have the highest input costs by these measures. This pattern holds for wages, loan servicing expenses, office occupancy expenses, and loan loss expenses. The one exception is insurance, which seems to be cheaper for larger credit unions.

We do not place too much emphasis on understanding the sources of these cross-sectional differences, because our empirical model identifies the effects of outsourcing on productivity via within-firm variation. But this does illustrate that cross-sectional comparisons probably embed too much unobserved heterogeneity to be useful. And, the cross-sectional patterns seem inconsistent with simple intuitions about the productivity benefits of outsourcing.

[34] NCUA requires credit unions to report both full-time and part-time employees. We assume that one part-time employee equals 0.65 full-time employees and calculate full-time equivalent (FTE) employee for each credit union.

3 Empirical Specification

3.1 Cost Functions

From a methodological standpoint the object of interest is the causal link between IT/outsourcing and productivity. Because we use a multi-dimensional measure of output, we estimate a cost function rather than a production function. We model the natural log of costs as follows:

$$\ln C_{it} = f\left(y_1, ..., y_M, w_1, ..., w_N\right) + \omega_{IT} + \omega_{it} + \varepsilon_{it}$$

where $f(\cdot)$ is a function of outputs (y_m) and input costs (w_n) and has some known functional form, ω_{IT} is the productivity effect of the credit union's IT system, ω_{it} is the firm-specific productivity and ε_{it} is either measurement error or shocks to productivity that are unknown to the firm at the time of input and output decisions.

The unit of observation is the credit union/year: due to missing values for some observations, the number of usable observations is roughly 137,000-139,000 depending on the specification.[35] The dependent variable is the log of operating expenses, as summarized in Table 4. The output measures include a set of dummies for each of the M product offerings, as in the first pane of Table 3, and the log number of accounts for each of the M products, as summarized in the second pane of Table 3.[36] The other right-hand side variables include the N input costs described in Table 4.

We measure the effects of computerization and outsourcing using a vector of IT system indicator variables, ω_{IT}. Manual IT is the omitted category, so the productivity effect of computerization is measured via the coefficient on CU-developed IT. The benefits of outsourcing are measured via dummy variables for each of the two outsourced systems (VOL or VIH); the difference between the outsourcing coefficient and the CU-developed coefficient measures the productivity benefit of IT outsourcing. One limitation of this specification is that it abstracts from dynamic issues, including either the increasing benefits of organizational change over time (found to be important in Brynolfsson and Hitt (1995), or transition/adjustment costs associated with implementing IT (discussed in Basu, Fernald, Oulton and Srinivasan [2003]). Our approach measures an average effect; if IT switching has greater effects over time, or imposes adjustment costs it is likely that our approach will understate the true ex post productivity benefits of outsourcing.

[35]Most of these missing observations are driven by non-reporting of an input cost such as wages.

[36]In order to enable the log transformation we replace zero values in accounts with one. This is less of a functional form concern given our inclusion of extensive margin dummies.

While our specification imposes the restriction that outsourcing has only a level effect on costs, we have also experimented with specifications that allow outsourcing to have more flexible effects via interactions with other independent variables. While there is some evidence that outsourcing has these more complex effects, the difficulty with this approach is that it increases the number of endogenous RHS variables, makes treating IT system choice as endogenous infeasible. It also makes interpreting the results difficult, given that the output and input cost variables may themselves be endogenous. We prefer using the level shifters because it is more likely to cleanly identify the mean effect, and gives the IT system variables a simpler interpretation.

We show results below for a translog cost function; we have also estimated Cobb-Douglas models and discuss those results below. In addition to the IT system variables, Our full translog model includes the vector of product offering dummies $D\left(y_{ijt}>0\right)_{it}^{j}$, the vector of product offering quantities $\ln y_{ijt}$, input costs $\ln w_{ikt}$ and a full set of interactions:

$$\begin{aligned}
\ln C_{it} \quad = \quad & \alpha_0 + \sum_{j=1}^{M} \alpha_j \ln y_{ijt} + \sum_{j=1}^{N} \beta_i \ln w_{ijt} + \frac{1}{2}\sum_{j=1}^{M}\sum_{k=1}^{M} \alpha_{jk} \ln y_{ijt} \ln y_{ikt} + \frac{1}{2}\sum_{j=1}^{N}\sum_{k=1}^{N} \beta_{jk} \ln w_{ijt} \ln w_{ikt} \\
& + \frac{1}{2}\sum_{j=1}^{M}\sum_{k=1}^{N} \alpha_{jk} \ln y_{ijt} \ln w_{ikt} + \frac{1}{2}\sum_{j=1}^{M}\sum_{k=1}^{N} \alpha_{jk} \ln y_{ijt} \ln w_{ikt} \\
& + \sum_{j=1}^{M} \rho_j D\left(y_{ijt}>0\right) + \omega_{OS} + \omega_i + \omega_t + \varepsilon_{it}
\end{aligned}$$

where M equals 13 and N is five. There are 13 year effects and roughly 13,000 fixed firm effects.

The model is therefore quite heavily parameterized.

3.2 Econometric Issues

The presence of ω_{it} in the model can generate two biases: simultaneity bias and selection bias.[37] In our case, it is likely that both outsourcing and output could be correlated with firm-specific productivity shocks, leading to simultaneity bias on those coefficients. It is also likely that firm-specific productivity shocks are correlated with firm survival, leading to selection bias. We now discuss our approach to these issues.

[37] See Griliches and Mairesse (1995) for an excellent exposition of the difficulties in identifying production and cost frontiers.

3.2.1 Simultaneity Bias

The literature has dealt with simultaneity bias in several ways. Olley and Pakes (1995) specify a behavioral model that allows them to account for simultaneity when there exists a monotonic relationship between one of the firm's decisions, such as investment, and ω_{it}. Monotonicity allows Olley and Pakes to invert the relationship allowing them to model the unobserved portion of productivity as a non-parametric function of investment. Such a monotonic relationship is unlikely to exit in our setting. Olley and Pakes apply their model to telecommunications equipment industry where a monotonic relationship between capital and unobserved productivity is plausible; no such input, as far as are aware, exists in the credit union industry.

We therefore address simultaneity in two ways. For one, we include fixed-firm and time effects, modeling ω_{it} as $\omega_i + \omega_t$. This accounts for unobserved firm-level productivity differences that are constant over time and industry-specific productivity changes across time. Second, we instrument for a credit union's IT system choice in each of the specifications.

IT System Instruments: Because we include fixed year and credit union effects, the coefficients on the independent variables, including the IT system categories, are identified by within-credit union variation over time. The goal of our instruments is finding a set of plausibly exogenous, time-varying variables that might affect IT system choice but are unaffected by idiosyncratic productivity shocks. Fortunately our data provide a number of such instruments for outsourcing choices. The first set of instruments is derived from information about credit unions' institutional affiliation. Nearly all credit unions are chartered to serve individuals affiliated with an institution such as a school, firm or governmental entity. NCUA requires credit unions to report both the type of institution (using some 50 categories) and also asks the credit union to report its number of "potential members" based on its affiliation. The set of potential members is generally based on the size of the organization with which the credit union is affiliated, and the number of potential members varies over time within credit union. Changes in this variable could certainly induce credit unions to switch IT system; the most common reason cited in the trade press for switches is credit union growth, which would be affected in part by growth in the number of potential members. However, the number of potential members should itself be exogenous to credit-union-specific productivity shocks. A second set of instruments is based on the "field of membership" of the credit union. This is a categorical variable taking on distinct values based on the institutional affiliation mentioned above. Because field of membership is generally time-invariant, we interact field of membership with time dummies. Our final set of instruments is geographical. Because credit unions operate in local markets we use the share of *other* credit unions choosing each IT system in the credit union's home state as instruments. These vary across credit unions and over time; other work has shown that IT choices are geographically correlated.[38] Overall, the instruments do well in explaining within-firm variation in IT system choices. To gauge the strength of the instruments, we estimate separate fixed-effect linear probability models for CU-Developed, VIH and VOL. In each case the F-statistic is above 50.

Output Instruments: Endogeneity of the output variables is also a potential concern since productivity may affect the decision to offer products, and may also affect output quantities. In our primary specifications we do not correct for the simultaneity of product offerings and quantities; we have too few instruments for this to be viable, given the number of interactions in the model. But we discuss some simpler Cobb-Douglas results below in which we do instrument for product offerings. In those models, we use the credit union's field of membership interacted with time dummies and the share of *other* credit unions in each state offering a given product as instruments.

3.2.2 Selection Bias

Olley and Pakes (1996) account for exit by explicitly modeling the exit rule, which, again assuming that investment and productivity are monotonically related, implies a threshold decision rule; firms exit if their productivity draw falls below a threshold that is a function of current capacity. We adopt their strategy assuming that there exists an exit threshold that is a function of the difference between a credit union's potential membership size and its current number of members. Similar to Olley and Pakes (1996), we estimate both a probit and linear exit probability model and include a fourth-order polynomial of the fitted values of these models in specifications.[39]

4 Results

Table 5 presents the results of the translog cost function estimates. We suppress the coefficients on most of the (roughly 240) right-hand side variables, as they are not of primary interest and are difficult to interpret given the number of interactions in the model. The table reports the coefficients on the IT system variables, and also the year effects. The omitted category is a manual system in the first year. The fit of the models is quite high; even the simple OLS model has an r-squared of 0.98.

[38] See Borzekowski and Cohen (2005).

[39] The fit of the models is no better with higher order terms. The correlation between the fitted probit probability and exit is 0.15, between the fitted linear probability and exit is 0.16, and between the two fitted probabilities is 0.92.

The first column reports OLS coefficients without any correction for selection on exit, while the second column reports OLS coefficients for the model that includes the selection correction. Both models show a pattern that echoes that in the summary data from Table 4: computerized and outsourced IT systems are associated with higher costs. The estimated effects are large; VOL systems are associated with costs roughly 16% higher than manual systems, and roughly 6% higher than CU-developed systems. The next column includes fixed firm effects, which dramatically reduces the coefficients. This suggests that the relationship between outsourcing and higher costs is being driven by the cross-section.

The last three columns show instrumental variable specifications that treat outsourcing as endogenous. The first column includes all years in the sample period and includes fixed effects for each year. The results suggest substantial benefits from computerization, but little difference between in-house and outsourced IT systems. The coefficient on the CU-developed indicator suggests that switching from manual to an in-house computerized systems reduces costs by roughly 29%. The coefficients on the VIH and VOL categories are nearly identical (32% and 30%), and not statistically different from that on the CU-developed system. The year dummies show a general pattern of increasing costs (falling productivity) over time, though the coefficients are relatively small compared to those on the IT system variables.

The next two columns split the sample into two periods: 1992-1997 and 1998-2005.[40] In the early period, the results are quite similar to those in the specification that pools both periods. In the later period, the coefficients suggest that it is outsourcing rather than computerization that confers productivity benefits. There is no statistically significant cost difference between manual and CU-developed systems. But relative to either in-house system, either outsourced system is over 30% cheaper.[41] While these results may seem large, they are consistent with the simple fact that both computerization and outsourcing have become the norm for 98% of all credit unions.

The results are also quite robust. Using a Cobb-Douglas cost function the estimated outsourcing effects are even larger, and there is a similar pattern across the two time periods. We have also estimated the model using dollar-based measures of output, with similar results. Aggregating our quantity variables into simply "total loans" and "total deposits" yields slightly smaller coefficients (but still above 20% on the outsourcing variables). We have also estimated the model dropping all

[40]We have also estimated the split sample using other cutoff years; the split we show here seems to capture the break in the data most effectively.

[41]These results may help to reconcile our results with those in Borzekowski (2004). Borzekowski finds that outsourcing does not appear to be correlated with adoption of web/internet technology; but he groups CU-developed and VIH systems together and labels them "in-house."

of the input costs except wages, and their interactions. Doing so leaves the full 1992-2005 results largely unchanged, but raises the estimated effects in the 1998-2005 subsample to 40% for VIH and 44% for VOL.

Given the size differences across the IT choices, we also estimate two models using information on the propensity score. We estimate a probit model aggregating the two outsourced IT systems into a single "treatment" and condition on all of the translog right hand side variables; the fitted probability defines the propensity score. We estimate one model where we condition on the propensity score and a second set of models that restricts our sample to only those observations where the probability of outsourcing is greater than 0.75, 0.85 and 0.9. In each model, we define two treatment groups as VIH and VOL and combine the Manual and CU-Developed credit unions as the control groups and focus on the later period. We continue to instrument for the two outsourcing variables to account for selection on unobservables. We find similar patterns to the models shown in Table 5. These result suggest that our baseline results are not driven by selection on observables.

Finally, given that endogeneity of outputs is a concern, we have estimated a Cobb-Douglas cost function in which we instrument for all of the product dummies and quantities (we have too few instruments to IV for outputs in the translog cost function). The results of these specification show little difference in the outsourcing coefficients.

In all, the results suggest two things. One is that relative to manual data processing, both computerization and outsourcing offer substantial advantages. The other is that the relative benefits of the two have changed over time. Outsourcing now carries clear advantages relative to in-house computerized IT, but that is a relatively recent development that occurs long after outsourcing became the predominant IT system choice for credit unions.

4.1 Firm-Level Productivity and Outsourcing

In addition to estimating the productivity benefits of IT outsourcing, the model also yields firm-level productivity estimates via the fixed effects in the translog cost model. These are informative for a number of reasons. First, they allow us to correlate firm-level productivity with IT system choice in the cross-section, asking how "outsourcing-independent" productivity is correlated with IT system switching. We can also examine how the industry distribution of productivity changes over time; this is of particular interest given that the composition of the sample changes so dramatically.

Table 6 provides some initial evidence on productivity and IT choices in the cross-section, for the early years of our sample (during which there is still substantial cross-sectional variation in

IT system choice). The table shows coefficients from a set of year-by-year regressions for 1992-1997 with firm-level fixed effects ($\hat{\omega}_i$) as the dependent variable, and size and IT system choice as regressors. Positive values for the dependent variables reflect higher costs or lower productivity. Because there is no within-firm variation in ($\hat{\omega}_i$), the year-by-year differences reflect the influences of changes in sample composition (exit) and changes in the value of RHS variables within firms. The fit of these models is quite good; the size and outsourcing variables explain roughly 80% of variation in firm-level productivity.

The coefficients suggest that large credit unions and those who outsource have lower productivity. In every year, credit unions with computerized IT have productivity 40-50% lower (costs 40-50% higher) than those who are not computerized. Within those with computerized IT systems, there is a tendency by the end of the sample for the most complete form of outsourcing (VOL) to be correlated with lower productivity than is CU-developed IT; the difference is roughly 10% and statistically significant.

While this relationship seems surprising, it may simply reflect a greater tendency to perform IT-related activities in-house by more productive firms (given the likely transition costs). This is in fact consistent with other research on productivity and outsourcing/vertical integration.[42] It is also possible that these coefficients mis-measure true productivity; one might imagine, for example, that high costs indicate unobservably high service levels or quality. To address that concern, Figure 5 shows kernel densities of productivity that capture two effects: exit over time, and outsourcing. Again, higher values reflect higher costs or lower productivity. We show these densities by size quartile of firm, to condition somewhat on the size-productivity relationship. Within each figure we show three productivity distributions. The first is the distribution of firm fixed effects in 1992. The second is the distribution of firm effects in 2005. Because the firm effects do not change over time, the differences in the two densities reflect the effects of exit within each size quartile. For every quartile except the smallest, there is a clear leftward shift. By this measure, the least productive (highest-cost) firms exit the sample; this is inconsistent with an interpretation that our measure of productivity measures omitted quality (in which case the relationship between observed productivity and exit would be positive). This is corroborated by regressions of exit (a dummy variable equal to one if the credit union exits in that year) on size (log members, log members squared), estimated firm-level productivity and year effects. The coefficient associated with $\hat{\omega}_i$ suggests that a one-standard deviation increase in $\hat{\omega}_i$ is correlated with a 57% increase in the probability of exit.

[42] See Syverson (2004) for evidence on this point. Gorg and Hanley (2004) find this result as well, and note that other work has found that greater use of purchased inputs (i.e. outsourcing) is often associated with lower productivity.

The third distribution shows the overall effect of exit and outsourcing (OS), by adding each firm's IT system coefficient to its costs; for the vast majority of firms in 2005, these are the VIH/VOL coefficients. Clearly, these serve to shift the cost distribution to the left; the difference in each size quartile between the 1992 and 2005 "with OS effects" distributions therefore shows how industry productivity has been affected by exit and outsourcing. The dominant influence is by far that of outsourcing, but both have together worked to increase overall productivity. And taken in concert with the evidence on productivity and outsourcing in the cross-section, it seems most likely that the results in the cross-section reflect a relationship between productivity and reliance on internal production.

Finally, it is worth placing our results on overall productivity in context of other work on banking productivity. The year effects in our cost functions grow more positive over time, suggesting falling productivity absent changes in IT systems. But the size of the year effects is only one-third the size of the outsourcing dummies; our results suggest a general increase in industry productivity, largely due to outsourcing and also due to exit of less productive firms.

4.2 Other Evidence: Products and Prices

We have also conducted two complementary analyses to broaden the picture of how IT affects what firms do and how they do it. One piece of this analysis is estimating whether outsourcing is correlated with changes in product mix.[43] We run a series of models in which a measure of product offerings is the dependent variable, and the RHS variables include size, IT system, fixed firm and year effects; the IT system choice is treated as endogenous using the instruments we use in the translog cost models above. The results of these models are mixed. When the dependent variable is the sum total of the number of financial service products offered by the firm, we estimate that outsourcing is correlated with offering more products (roughly 0.5 on the mean of 5 overall). However, when we conduct a product-by-product analysis (with the dependent variable being a dummy indicating that the firm offers that product), we do not find any significant effect of outsourcing. It is possible that there is not enough variation within-firm in offerings of individual products to identify an effect, so we interpret this overall as just weak evidence of a product/outsourcing effect.

Second, we have estimated a series of models with product prices as dependent variables.[44] We

[43]For work discussing the relationship between products and productivity, see Bernard et al. (2006a, 2006b).

[44]It is difficult to use a revenue-based output measure such as that suggested by Wang (2003). That measure is identified in large part by the reference rates used to benchmark deposit and loan terms; in our data, those rates are volatile and in fact yield negative output for many credit unions (making including output in a translog model impossible).

have prices (interest rates) for checking accounts, savings accounts, CDs, MMDAs, and each loan product: mortgages, personal loans, new car, used car and credit card. Specifications for these models include the level of the interest rate as the dependent variable, with either input costs or the full set of translog cost variables as the RHS variables; we also treat IT system choice as endogenous. Again, the results are fairly mixed. There seem to be differences between manual IT and the other types in terms of prices, but these are difficult to interpret given how few manual-IT credit unions offer these products. And among the other three IT systems, there are essentially no statistically significant differences in product prices.

5 Discussion and Conclusion

Our main empirical finding is that IT outsourcing has significant productivity benefits—benefits that change in character over the sample period. At the outset, outsourcing is not much more productive than CU-developed computerized IT. But by the end of the sample, outsourcing either via a VOL or VIH system is much more productive than CU-developed IT.

Once again, the productivity differences across these two systems reflect the gains associated with reorganizing production, conditional on available technology. We can not identify precisely why these gains exist—whether they reflect scale, specialization, or possibly something related to transaction costs. Nor can we say whether the changes in the relative attractiveness of outsourcing reflect lags in attaining efficiency by IT vendors, or changes in maximal efficiency by those vendors. But in either event, it is clear both that reorganizing production in this way has value, and that its value is itself changing over time.

It is also important to note that we only estimate large benefits associated with outsourcing when we treat it as endogenous, and examine within-firm switching. In the cross-section the relationship is reversed, which our firm-level results suggest is due to the fact that low-productivity firms are more likely to outsource. This suggests that in other industries, and particularly in the aggregate it may be extremely difficult to identify the productivity benefits of IT outsourcing; other firm-level data sets may not have panel data or useful instruments for outsourcing, and aggregate data almost certainly lack those things. This implies that results from these other settings should be interpreted cautiously.

We see the results as suggesting numerous avenues for future work. Exploring the role of outsourcing in firm survival is a natural extension of this work; we have preliminary findings suggesting that IT outsourcing reduces exit rates, conditional on other observables. Given that so many firms view IT outsourcing as a "business necessity," this is perhaps not surprising, but documenting its empirical importance should prove useful. It is likely to be particularly important in our setting, given that nearly one-third of firms exit during the sample period.

We also plan to further explore the implications of IT outsourcing for more aggregate productivity measurement. Its benefits may be measured, particularly if IT vendors are examined; for them, we would expect to see massive productivity increases over the sample period. Whether these would look like IT capital deepening or TFP increases is an open question—certainly, because we see relative productivity shifts across in-house and outsourced IT, we would expect to see TFP growth to some extent. But having a better view of whether and how the productivity benefits of IT outsourcing manifest in aggregate productivity seems to be a useful endeavor.

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Table 1. Credit Unions, IT and Outsourcing, 1992-2005

	Number of CUs with System:					Share:	
Year	Total	Manual	CU-Dev.	Vendor IH	Vendor OL	Computerized	Outsourced
1992	12,040	1,843	3,683	4,240	2,274	0.85	0.54
1993	11,468	1,461	1,994	4,563	3,450	0.87	0.70
1994	11,906	1,064	2,367	5,196	3,279	0.91	0.71
1995	11,651	772	2,026	5,732	3,121	0.93	0.76
1996	11,231	571	1,077	6,787	2,796	0.95	0.85
1997	11,028	506	702	7,125	2,695	0.95	0.89
1998	10,841	394	539	7,238	2,670	0.96	0.91
1999	10,533	369	481	7,090	2,593	0.96	0.92
2000	10,173	353	467	6,822	2,531	0.97	0.92
2001	9,848	299	396	6,706	2,447	0.97	0.93
2002	9,539	254	144	6,792	2,349	0.97	0.96
2003	9,234	217	103	6,602	2,312	0.98	0.97
2004	8,925	188	83	6,374	2,280	0.98	0.97
2005	8,615	155	81	6,143	2,236	0.98	0.97
Observations	147032	8446	14143	87410	37033	0.94	0.85

Source: NCUA Call Reports. Data above exclude observations where the credit union reports "other" as its IT system.

Table 2. IT System Switches and Credit Union Size

	Manual (t)	CU-Dev (t)	Vendor IH (t)	Vendor OL (t)	Total
Manual (t-1)	9.39	10.36	10.37	11.15	9.62
	5996	462	1013	165	7636
CU-Dev (t-1)	10.24	11.95	11.97	12.92	12.17
	171	6499	4039	3432	14141
Vendor IH (t-1)	10.56	11.64	12.69	12.88	12.64
	342	3031	74036	1737	79146
Vendor OL (t-1)	11.38	12.72	13.44	13.42	13.41
	76	464	4066	29423	34029
Total	9.50	11.82	12.66	13.33	12.61
	6585	10456	83154	34757	134952

Notes: Top row in each cell shows mean of ln(deposits) in (t-1). Bottom row shows number of observations. Data are from 1993-2005, because we do not observe lagged IT system choice in 1992.

Table 3. Financial Service Offerings, by IT System

Year	Manual	CU-dev.	Vendor IH	Vendor OL
		Share of CUs offering:		
Checking	0.03	0.44	0.56	0.83
MMDA	0.01	0.14	0.26	0.36
CD	0.07	0.48	0.62	0.79
IRA	0.04	0.45	0.53	0.76
Personal loan	0.04	0.30	0.44	0.63
New car loan	0.79	0.92	0.96	0.97
Used car loan	0.51	0.91	0.94	0.98
Fixed rate mortgage	0.59	0.90	0.93	0.97
Var. rate mortgage	0.08	0.33	0.43	0.57
Credit card	0.01	0.12	0.19	0.24
HELOC	0.01	0.18	0.31	0.45
Ag. Loan	0.01	0.03	0.02	0.03
Bus. Loan	0.02	0.09	0.14	0.17
Web site	0.00	0.01	0.16	0.19
		Accounts:		
Checking	227	669	1160	1173
MMDA	28	207	373	235
CD	20	96	210	240
IRA	24	125	169	174
Personal loan	30	213	235	424
New car loan	8	74	96	177
Used car loan	18	88	146	274
Fixed rate mortgage	4	23	39	40
Var. rate mortgage	7	28	26	22
Credit card	48	535	819	713
HELOC	14	40	73	48
Ag. Loan	5	5	5	8
Bus. Loan	2	5	5	5
Total members	223	1203	1616	3454
Total accounts	240	1563	2270	5469

Notes: First pane shows share of credit unions with each IT system offering each product. Second pane shows median number of accounts, conditional on offering that product. Data are for all years.

Table 4. Operating Costs and Input Costs, by IT System

	Manual	CU-dev.	Vendor IH	Vendor OL
Operating Costs:				
Ln(operating expenses)	9.64	12.02	12.38	13.40
Wage share	0.31	0.44	0.45	0.44
Office operations share	0.13	0.16	0.19	0.16
Professional expense share	0.01	0.04	0.03	0.12
Operating expenses/deposits	0.04	0.04	0.04	0.04
Operating expenses/account ($)	76.18	140.47	156.15	189.93
Operating expenses/member ($)	69.62	105.22	108.16	120.33
Input costs:				
Average wage ($)	8062	30913	34813	38839
Insurance ($/mem.)	8.90	7.06	3.45	2.51
Loan servicing ($/loan)	n/a	10.53	17.82	27.88
Office occupancy ($/FTE)	49.61	320.01	415.43	452.15
Loan losses ($/$1000)	n/a	43.89	46.11	47.77

Notes: All figures are sample medians. Dollar figures are inflation-adjusted. Operating expenses include wages and benefits, travel/conference expense, office occupancy expense, office operations expense, educational/promotional expenses, loan servicing expenses, professional/outside service expense, and insurance. Internal IT expenses are in office operations expense; outsourced IT expenses are in professional/outside services. Insurance input costs are measured per member, loan servicing is measured per loan, office occupancy is measured per FTE, and loan losses are measured per $1000 of loans. ‘‘n/a’’ for loan-related input costs indicates that the median firm has no loans.

Table 5. Translog cost function estimates.

	OLS	OLS w/ Selection Correction	FEs, Selection	FE, Selection and IV	Col. E., 1992-1997 Subsample	Col. E., 1998-2005 Subsample
CU Developed	0.106***	0.107***	0.001	-0.292***	-0.341***	0.158
	(0.005)	(0.005)	(0.004)	(0.020)	(0.022)	(0.128)
Vendor In-house	0.092***	0.094***	-0.005	-0.322***	-0.306***	-0.347***
	(0.005)	(0.005)	(0.004)	(0.020)	(0.023)	(0.115)
Vendor Online	0.165***	0.166***	0.013***	-0.301***	-0.335***	-0.368***
	(0.005)	(0.005)	(0.004)	(0.020)	(0.023)	(0.120)
year=1993	-0.023***	-0.027***	-0.002	0.007***	0.012***	
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	
year=1994	-0.041***	-0.047***	0.002	0.019***	0.035***	
	(0.004)	(0.004)	(0.002)	(0.003)	(0.003)	
year=1995	-0.057***	-0.063***	0.001	0.024***	0.042***	
	(0.004)	(0.004)	(0.002)	(0.003)	(0.003)	
year=1996	-0.061***	-0.067***	0.003	0.032***	0.045***	
	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)	
year=1997	-0.046***	-0.055***	0.021***	0.053***	0.066***	
	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)	
year=1998	-0.036***	-0.039***	0.035***	0.071***		-0.049***
	(0.004)	(0.004)	(0.002)	(0.004)		(0.006)
year=1999	-0.117***	-0.118***	-0.043***	-0.007		-0.127***
	(0.004)	(0.004)	(0.002)	(0.004)		(0.006)
year=2000	-0.131***	-0.131***	-0.047***	-0.010**		-0.132***
	(0.004)	(0.004)	(0.003)	(0.004)		(0.006)
year=2001	-0.117***	-0.117***	-0.024***	0.014***		-0.104***
	(0.004)	(0.004)	(0.003)	(0.004)		(0.006)
year=2002	-0.107***	-0.108***	0.001	0.042***		-0.070***
	(0.004)	(0.004)	(0.003)	(0.005)		(0.006)
year=2003	-0.091***	-0.096***	0.034***	0.075***		-0.035***
	(0.004)	(0.005)	(0.003)	(0.005)		(0.005)
year=2004	-0.089***	-0.102***	0.057***	0.097***		-0.010***
	(0.005)	(0.005)	(0.004)	(0.005)		(0.003)
year=2005	-0.112***	-0.133***	0.068***	0.108***		
	(0.005)	(0.006)	(0.005)	(0.006)		
r2	0.98	0.98	0.66			
N	132680	131846	131846	131846	63170	68676

Notes: All models include output dummies, output quantities, and input costs.
Asterisks indicate significance at 1% or better

Table 6. Productivity and IT/Outsourcing in the Cross-section.

Variable	1992	1993	1994	1995	1996	1997
CU-developed	0.52	0.44	0.43	0.46	0.46	0.37
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Vendor IH	0.39	0.46	0.46	0.48	0.48	0.40
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Vendor OL	0.46	0.56	0.53	0.56	0.57	0.50
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
ln(members)	0.40	0.40	0.42	0.42	0.42	0.41
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-3.48	-3.53	-3.68	-3.71	-3.70	-3.61
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
r-squared	0.79	0.78	0.86	0.86	0.85	0.85

Notes: coefficients are from a cross-sectional regression in each year, with firm-level productivity (the fixed effects from the translog cost function) as the dependent variable. Coefficients therefore measure log-differences in costs across IT system choices.

Table A1. IT System Choices in the Cross-section, 1992, 1998 and 2005

Size Decile:	Manual	Cu Dev.	VIH	VOL
		1992		
1	0.64	0.06	0.28	0.01
2	0.28	0.13	0.57	0.02
3	0.12	0.20	0.65	0.04
4	0.05	0.29	0.59	0.07
5	0.03	0.37	0.46	0.14
6	0.02	0.48	0.29	0.21
7	0.01	0.54	0.20	0.25
8	0.01	0.54	0.09	0.36
9	0.01	0.42	0.06	0.52
10	0.01	0.22	0.02	0.76
		1998		
1	0.24	0.07	0.66	0.02
2	0.05	0.09	0.80	0.06
3	0.02	0.09	0.80	0.10
4	0.01	0.06	0.76	0.17
5	0.00	0.04	0.68	0.27
6	0.00	0.05	0.60	0.35
7	0.00	0.02	0.52	0.46
8	0.00	0.02	0.50	0.48
9	0.00	0.02	0.57	0.41
10	0.00	0.03	0.81	0.16
		2005		
1	0.17	0.04	0.74	0.04
2	0.04	0.02	0.90	0.05
3	0.02	0.02	0.86	0.11
4	0.00	0.01	0.84	0.15
5	0.00	0.01	0.77	0.22
6	0.00	0.01	0.72	0.27
7	0.00	0.00	0.60	0.40
8	0.00	0.00	0.54	0.46
9	0.00	0.00	0.56	0.44
10	0.00	0.01	0.80	0.20

Notes: Cells show share of CUs within size deciles using each IT system type. Size deciles are constant across years, by real deposit balances.

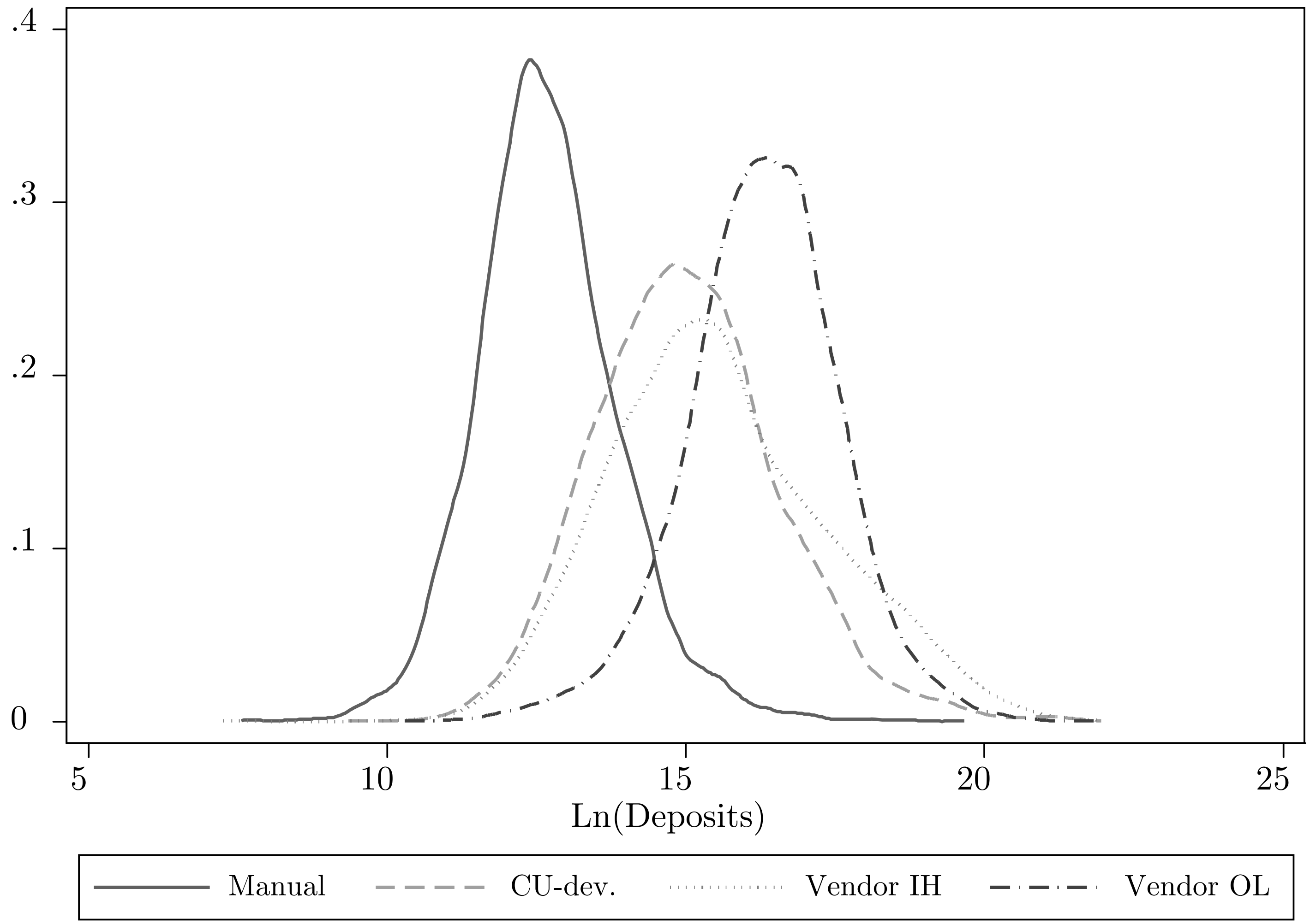


Figure 1. Kernel densities of credit union size by IT system, all years.

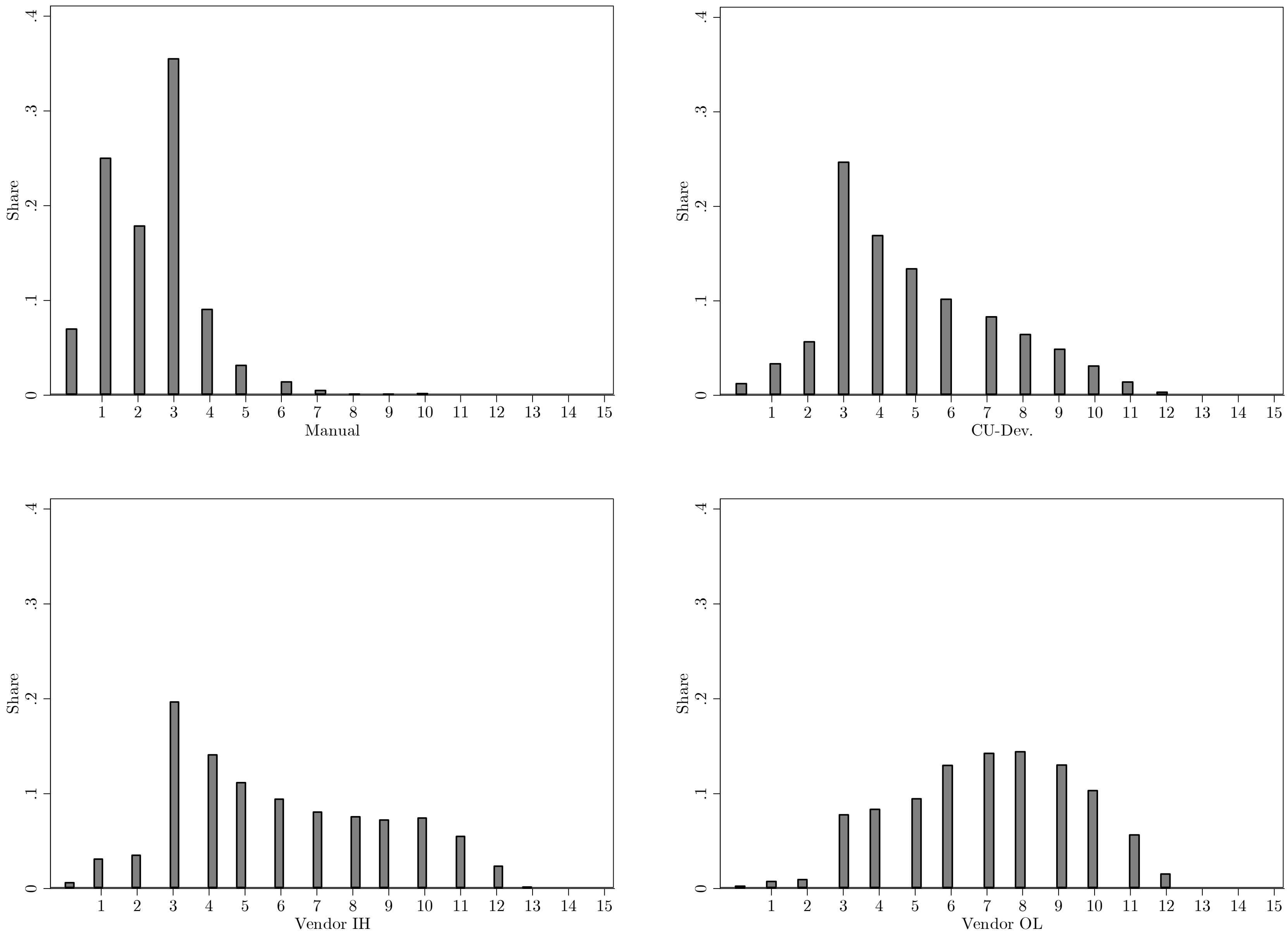


Figure 2. Financial service products offered at credit unions, by IT system.

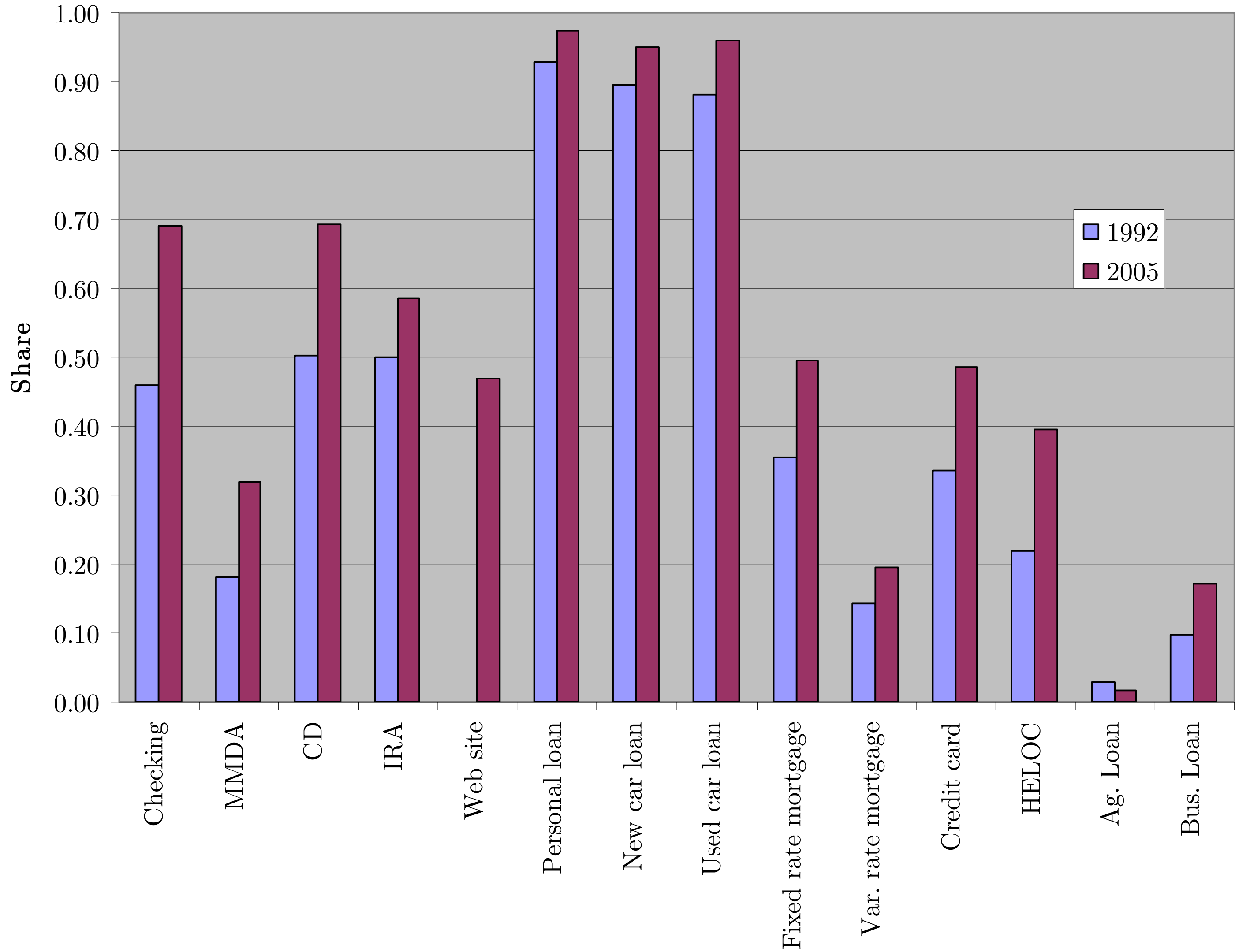
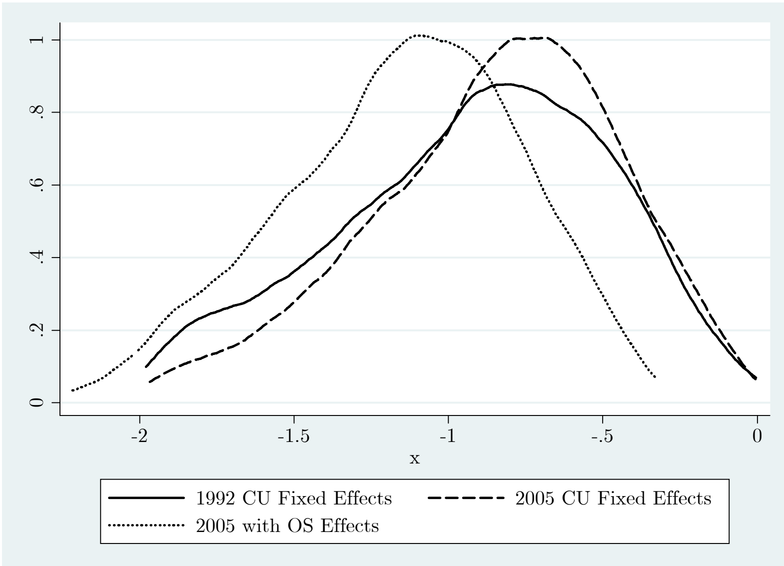
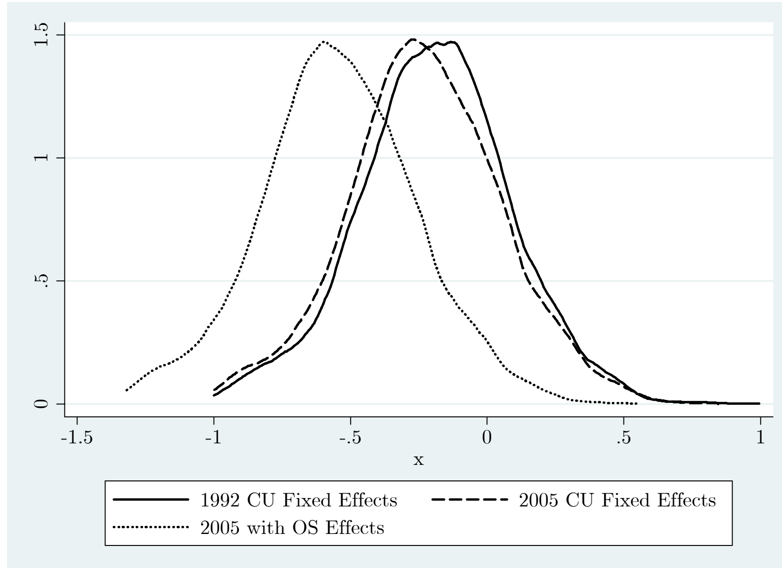


Figure 3. Share of Credit Unions Offering Financial Service Products, 1992 and 2005.



Size Quartile 1



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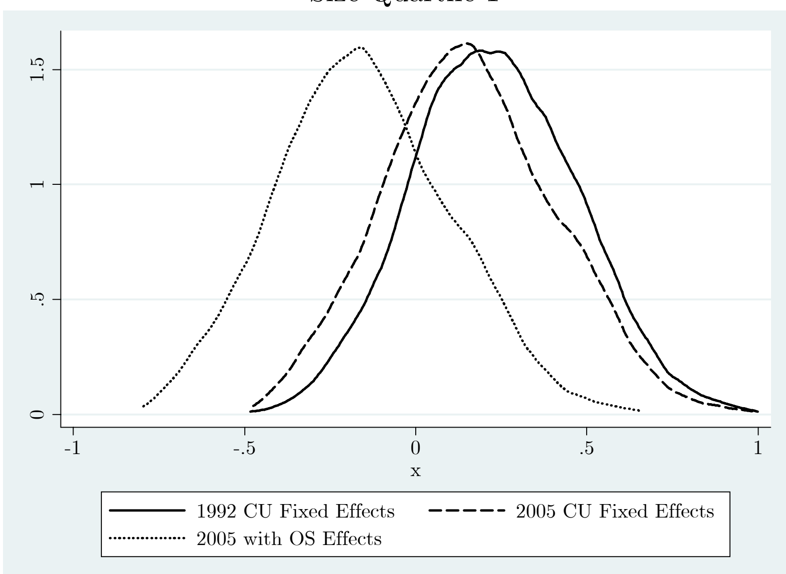

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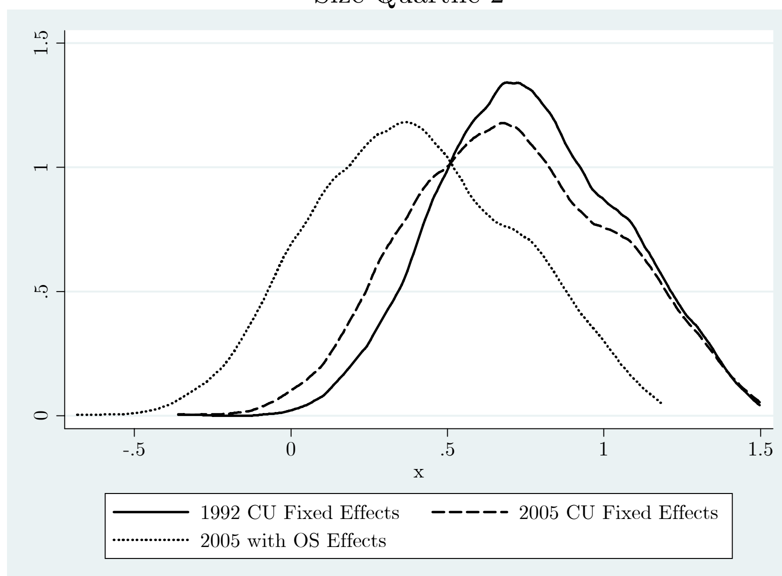

Size Quartile 4

Figure 4. Kernel densities of firm-level productivity, 1992, 2005 and 2005 including IT system effects
(firm fixed effect and IT system coefficients from Table 5). Higher numbers reflect higher costs (lower productivity).

PROGRESS SOFTWARE

Press Releases

Credit Union Banks on Progress-Based Application to Save Time and Money and Enhance Customer Service

Sharetec from Progress Partner Bradford-Scott Data Corp. Helps Wisconsin-Based Credit Union Triple Assets through Increased Services and Responsiveness

BEDFORD, Mass.--(BUSINESS WIRE)--Sept. 14, 2004--Progress Software, a leading supplier of technology for building the world's best business applications, and an operating company of Progress Software Corporation (Nasdaq: PRGS), today announced that the Marinette County Employees Credit Union in Marinette, Wis., is streamlining operations through Progress(R)-based Sharetec, an integrated credit union core software system distributed by Progress Application Partner (AP) Bradford-Scott Data Corp., a leading data processing systems vendor, to reduce its monthly costs by 25 percent over its former online application.

Based on the Progress OpenEdge(TM) platform, Sharetec from Sharetec Systems, Inc. is an efficient, in-house data processing system that uses the business logic scripting capabilities of the 4GL and the Progress RDBMS, the leading embedded database, to tightly integrate critical business tasks running against today's leading embedded database technology. By automating virtually every repetitive task, Sharetec enables employees to focus on managing member relationships. As a result, the asset size of the Marinette County Employees Credit Union has tripled since Sharetec was implemented.

Prior to Sharetec, the Marinette County Employees Credit Union utilized an online system that required a dedicated telephone line and charged fees on top of its monthly service contract to run reports. "We had no capability to do the things we wanted without being nickeled and dimed," said Sheila Kessel, manager of the Marinette County Employees Credit Union, which offers checking and savings accounts, debit cards, loans, mortgages, and online and telephone banking services. "To make matters worse, we had to wait hours for a call back when we had technical problems. In addition to creating a backlog of work for us, those kinds of delays caused even more anxiety for members waiting to hear about loans, mortgages and other services."

After learning about a nearby credit union's positive experiences with Sharetec, the Marinette County Employees Credit Union agreed to the conversion. Kessel said she knew she made the right decision when an IT team from Bradford-Scott Data Corp. remained onsite for a week after the overnight installation to ensure fluid operations.

"We chose Sharetec because of its ease of use and support, and it has exceeded our expectations," Kessel said. Rather than typing everything by hand, documents such as credit reports, cashier checks, forms and letters are now laser generated and printed. Account overdrafts and fees are automatically tallied each morning, and loan payments and other account transfers can be scheduled for a recurring date.

As a result of the time savings of at least two hours per day, Kessel said her focus has shifted to marketing endeavors, in-house training and added member benefits such as a Junior Savers Club and workshops teaching students how to balance a checkbook. "We wouldn't have had time to consider doing these things before Sharetec," she added.

"Extracting and analyzing data is extremely important to our customers, and it's hard to imagine anyone makes it any easier than Progress does," said Kevin Kolar, vice-president of Bradford-Scott Data Corp., which supports more than 150 Sharetec credit union clients. "The open architecture design of Progress allows our customers to use industry standard products like Word, Excel and Access to massage data, write reports and create marketing campaigns. Our developers also really enjoy Progress because it allows them to write software in a fraction of the time it would otherwise take with competitive programming languages. Progress definitely helps us to stay one step ahead of the competition."

About Bradford-Scott Data Corp.

Bradford-Scott Data Corp. is a leading provider of core data processing systems for credit unions. Bradford-Scott distributes the Sharetec System from Sharetec Systems, Inc. There are currently more than 300 credit unions using the Sharetec System with the largest credit union serving more than 31,000 members. To complement the Sharetec System, Bradford-Scott offers Courtesy Pay, e-Forms, Cross Selling, Member Rewards, Relationship Pricing, Online Home Banking, Bill Pay, Imaging, Online Credit Cards, Online ATM's, Investments, Marketing, Shared Branching, Indirect Lending and many other products through its strategic alliances. Bradford-Scott's headquarters are located at 9449 Priority Way West Drive, Indianapolis, IN 46240. Telephone: (800) 430-5120. Web Site: www.bradfordscott.com.

About Progress Software

Progress Software is an operating company of Progress Software Corporation (Nasdaq: PRGS), a $300+ million global software industry leader. Progress Software simplifies the development, deployment, integration, and management of the world's best business applications. Progress and its 2,000 Application Partners offer more than 5,000 Progress-based business applications that precisely fit customer needs and deliver competitive advantage. Customers purchase more than $5 billion annually in cost-effective software and services from Progress and its partners.

The Progress(R) OpenEdge(TM) platform enables its partners to rapidly build and deliver lowest cost-of-ownership applications. Progress Software Corporation also conducts business through its other operating companies: Sonic Software, DataDirect Technologies, ObjectStore and PeerDirect. Headquartered in Bedford, Mass., Progress Software can be reached on the Web at http://www.progress.com or by phone at +1-781-280-4000.

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