Accounting Software Adoption Through the Lens of Directed Technological Change*

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Abstract

Accounting software and associated technological tools are becoming ubiquitous, but we have little evidence on why firms voluntarily adopt them. To address this, we study how accounting software adoption responds to accounting labor market conditions. We first show that adoption is increasing in accounting wages and decreasing in the number of accounting workers in a given market. We confirm this finding in a Bartik estimation that exploits the passage of the Sarbanes-Oxley Act and states' pre-Act differences in labor market slack. Accounting software adoption frees up accounting employees to focus on operational and strategic tasks, and enables the implementation of management accounting practices such as variance analysis. Our results illustrate how labor market scarcity can induce accounting technology adoption, consistent with models of directed technological change.

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1. Introduction

Technological advances are transforming accounting—the tools available to firms, the mix of labor and capital employed in accounting processes, and the nature of accounting education. These developments have raised questions from both researchers and practitioners around the drivers of technology adoption, as well as the outlook for accounting labor and students amidst continued technological advances (Friedman, Sutherland, and Vetter 2024). One body of work focuses on regulation as an important adoption driver, as firms implement software and other tools to comply with new accounting standards (Kim, Kim, Kleymenova, and Li 2023) or internal control requirements (Charoenwong et al. 2024), and monitor employee behavior for industry violations (Heese and Pacelli 2024).

However, much accounting technology adoption is voluntary, and voluntary adoption determinants are not well understood. In this paper, we explore one theory of voluntary adoption—directed technological change—for its potential to explain accounting software adoption. In directed technological change models (e.g., Acemoglu 2002, 2010), input factor scarcity spurs innovations that reduce reliance on that given factor, leading to adoption and reduced reliance on that factor subsequently. The theory has its roots in Habbakkuk's hypothesis from the economic history literature (Habbakkuk 1962) and Hicks' (1932) theory of wages. The theory is used to explain, among other developments, countries' differential growth during the industrial revolution and the creation, initial adoption, and propagation of the spinning jenny, water frame, and carding machine in the eighteenth century. To illustrate using an example from accounting that is the focus of this paper, when firms encounter labor scarcity, such as when regulation increases demand for accounting workers, the theory would predict that firms search for labor-saving tools, such as accounting software.

To test this, we examine accounting software adoption (e.g., QuickBooks and similar products) among private industrial firms (i.e., not public accounting firms) in the early 2000s. We identify firms and software adoption based on task descriptions provided in a large set of resumes contained in the Revelio database. Our sample contains 34 million job descriptions from 24 million resumes describing employees' work at 2 million private firms. We develop a dictionary of terms indicating an employee's involvement with their employer's adoption (e.g., an employee mentioning "install QuickBooks" or "accounting system implementation" on their resume during a specific employment spell), similar to Fedyk et al. (2022) and Babina et al. (2024). We then aggregate our resume-based measures to the state-year level, and examine how adoption patterns (i.e., the number of firms first adopting technology that year) vary with labor market conditions.[1]

Our analysis of survey evidence and software reviews from our sample window indicates that prior to adopting accounting software, the private firms we study typically dealt with financial information production in one of two ways (AICPA 2004; Kawamoto 2004; Bertolucci 2005). First, an employee—sometimes an accounting manager, other times a financial manager or owner—would use a combination of spreadsheets and paper records. Second, the firm would instead rely on an external accountant to compile financial statements. In both cases, the firm relied on the accounting labor market, and the adoption of accounting software could reduce this reliance.

Our first tests examine software adoption as a function of wages for accountants and the number of accountants in a given state the previous year, and state and year fixed effects. Our results provide initial support for the directed technological change hypothesis. Adoptions correlate with measures of accounting labor scarcity: adoption increases with (lagged) accounting wages, and decreases with the (lagged) number of accountants. Economically, a one-dollar

[1] Throughout the paper, we refer to labor market scarcity and slack interchangeably to refer to markets with relatively tighter (looser) labor supply conditions.

increase in accounting hourly wages is associated with a 1.8% increase in the number of firms adopting accounting software.

Of course, these first tests are not designed to address omitted factors that might be correlated with wages or employment and their association with adoption, such as latent changes in economic conditions or strategic considerations. Therefore, our main empirical strategy employs a Bartik-type estimation (e.g., Breuer 2022), with several amenable features for testing our hypothesis. First, we exploit the labor demand shock resulting from the passage of the Sarbanes-Oxley Act ("SOX"). By significantly enhancing reporting and audit standards for *public* firms, the regulation generated large spillovers to *private* firms not subject to the rule but relying upon the common, rather inelastic accountant labor pool.[2] The second feature of our empirical strategy leverages pre-SOX differences in accounting labor market scarcity, measured based on the ratio of the number of accounting employees to the number of public firms. Intuitively, our empirical strategy leverages 1) a large shock to the inelastic accounting labor supply available to private firms, and 2) pre-shock differences in states' degree of accounting labor market slack. Validating our strategy, we find that post-SOX accounting wages rise more in states with less labor slack.

Results from the Bartik estimation reinforce our initial findings: following SOX, software adoption increases more in states with less labor market slack. This inference is not sensitive to alternative approaches to gleaning software adoption information from resumes. Moreover, placebo tests indicate that we are not merely picking up a common investment trend unrelated to the labor market slack construct: anti-virus software investment does not vary with our accounting labor market measures in the post-SOX period.

[2] Supporting this, Ettredge, Sherwood, and Sun (2018) find audit fee increases exceeding 40% for non-accelerated filers not subject to SOX, and Duguay, Minnis, and Sutherland (2020) find a roughly one-eighth decline in the propensity for private firms to provide attested financial statements to their banks.

Next, we examine the consequences of voluntary accounting software adoption, beginning with reallocation of accounting employee time. Intuitively, automation technology displaces labor from routine tasks (Acemoglu and Restrepo 2018), and those employees remaining with their firm can be assigned to other, less automatable tasks. Indeed, QuickBooks advertisements state "accounting software should be such that it automates your accounting process *so that you get time on your side for core business activities*" (emphasis added).[3]

To test this, we track accounting employees' operations and strategy tasks over time using position descriptions on their resumes and our Bartik regression framework. Some of the most common operations and strategy tasks we identify involve inventory management, purchasing/procurement, and strategic planning. Our instrumental variables analysis finds an increase in accounting employees' operations and strategy tasks that is happening through the software adoption documented in our main results.

The second software adoption consequence we study is the implementation of management accounting practices. This investigation is motivated by the idea that accounting software enhances the information environment of the firm through improved organization, standardization, and digitization. Additionally, many accounting software programs embed linkages to banking, credit card, payroll, tax, and shipping vendors, enabling new decision and control capabilities even for firms that previously had an external accountant compile their financial statements (Kawamoto 2004). Some programs include specific modules for inventory management and forecasting. We once again rely on employee resumes to identify management accounting practices (common ones include cash flow management, variance analysis, and cost accounting), and track them using our Bartik regression framework. Our instrumental variable tests find a significant increase in management accounting practice implementation happening through a software adoption channel.

[3] https://quickbooks.intuit.com/global/resources/accounting-and-bookkeeping/cloud-accounting-software/

Subsequent tests find that take up of profitability analysis and inventory/demand planning drive this finding.

Overall, our consequences tests indicate that accounting software adoption enables firms to redeploy those involved in the accounting function to operational tasks, and foster information environment improvements that render management accounting practices more feasible and worthwhile.

At this stage, we are unable to draw strong conclusions about whether firms are better off having adopted accounting software. We can, however, offer two interpretations rooted in related work. On one hand, adopting firms' first-best preparation choice may well have been labor-based, and only when faced with labor shortages do they resort to software adoption. Then, the gains from task reallocation and management accounting practice implementation merely serve to subsidize the greater adoption costs that the firm would have preferred avoiding (e.g., Charoenwong et al. 2024). On the other hand, managers at private firms often lack sophistication around basic accounting choices (e.g., Gassen and Muhn 2024). They may not fully grasp the gains from adopting accounting software, especially during the early 2000s era we study when such tools were rather new. Directed technological change models point to a related, more dynamic possibility, whereby there is an interaction between new firm adoption and vendors' investments in new features and customer experience improvements.

We make three contributions. First, our paper belongs in the burgeoning literature studying technology adoption in accounting (e.g., Fedyk et al. 2022; Law and Shen 2024; Charoenwong et al. 2024) and the economy more broadly (Bloom et al. 2024). We add to this literature by documenting one specific mechanism behind voluntary technology adoption, which we hope provides some helpful context for understanding the consequences of this adoption. Analyses of technology adoption consequences inevitably raise questions about why and when firms adopt in

the first place. Our results indicate that accounting labor market conditions are an important adoption driver. Although we focus on software, the directed technological change framework we draw upon has applications to other tools (e.g., generative AI), as labor market scarcity can spur other forms of technology adoption.

Second, we provide large sample evidence on the role of software in private firms' financial statement *preparation* (i.e., distinct from verification or disclosure). The limited empirical work on preparation tends to condition on banking relationships rather than study preparation more generally (Allee and Yohn 2009; Cassar, Ittner, and Cavalluzzo 2015) or analyze the choice to follow accrual accounting (Lisowsky and Minnis 2020). An AICPA survey conducted in 2004 explored the extent to which preparation depends on internal versus external accounting labor (AICPA 2004). In the ensuing two decades, software has emerged as a leading preparation approach, and our analyses shed some light on how and why this transition occurred.

Finally, we add to the work linking financial and managerial accounting (Hemmer and Labro 2008; Shroff 2017). Existing work focuses on public firms facing significant regulation around their information production, and therefore having inherently distinct information environments. Our specific contribution is to document how the adoption of accounting software enables private firms to implement management accounting practices such as variance analysis. This result is notable because smaller firms tend to be less sophisticated, and while there is evidence that such practices can improve productivity and profitability (Drexler, Fischer, and Schoar 2014; Bruhn, Karlan, and Schoar 2018), voluntary adoption has proven challenging to study (Bloom and Van Reenan 2007).

2. Theoretical Foundations

Technology adoption at firms has been traced to several motives, including compliance (Kim et al. 2023; Charoenwong et al. 2024; Heese and Pacelli 2024), strategic considerations (Liberti, Sturgess, and Sutherland 2022), and risk management (Kim 2024). The motive we focus on relates to factor market conditions for the firm's production inputs. Specifically, directed technological change models posit that technological innovation and adoption can often be traced to factor scarcity, labor in particular. As Acemoglu (2010) explains, "if a factor becomes more expensive, the demand for it should decrease, and we may expect some of this adjustment to take place by technology substituting for tasks previously performed by that factor" (p. 1039) (see also Hicks 1932).

Directed technological change models build upon the Habbukuk hypothesis in economic history (Habbukuk 1962). Habbukuk posited that labor scarcity was an important driver of the across-country differences in industrial development during the nineteenth century: "It seems obvious—it certainly seemed so to contemporaries—that that the dearness and inelasticity of American, compared to British, labour gave the American entrepreneur with a given capital a greater inducement that his British counterpart to replace labour by machines" (p. 17). The Habbakuk hypothesis has been used by Allen (2009) and Elvin (1972) to explain the link between wage levels and adoption of the spinning jenny, water frame, carding machine, and spinning wheel.

The directed technological change framework is useful for understanding firms' choice to adopt accounting software in the early 2000s period we study. Many accounting processes around this time were labor-driven, with firms relying on accounting labor to help with financial statement compilation, verification, analysis, and reporting. This labor could take the form of services from an independent CPA firm, or help from the firm's own employees or part-time help.[4] During this

[4] Offshoring was far less common in the early 2000s than today, and we expect offshoring to be used exceedingly rarely for the small private firms dominating our sample.

same period, the accounting labor market was subject to multiple forces that contributed to labor scarcity, including the passage of the SOX as described in the next section. Compounding this, much accounting work is performed by Certified Public Accountants (CPAs), who face significant licensing requirements that inhibit the responsiveness of the labor supply to demand shocks such as SOX.[5]

Turning to the consequences of technology adoption, Acemoglu and Autor (2011) and Acemoglu and Restrepo (2018) show how novel technologies—which expand the degree to which capital (e.g., information technology investments) can substitute for labor—affect the *tasks* performed by professionals. On the one hand, technology can displace tasks. For example, basic accounting tasks such as invoicing or report generation can be automated. On the other hand, technology can also create or enable new higher-productivity tasks, which Acemoglu and Restrepo label as a reinstatement effect. As an extension of the reinstatement effect relevant to our tests, the automation of basic accounting tasks enables time-constrained managers to turn their attention to more operations-oriented tasks which are difficult to automate, such as production planning or operations management.

3. Setting, Sarbanes-Oxley Act, and Data

a. Setting

We study accounting software adoption in the U.S. private firm setting. Private firms maintain relatively unsophisticated accounting systems—most do not undergo audits, and many do not even use GAAP (Allee and Yohn 2009; Lisowsky and Minnis 2020). In the early 2000s era of our sample, reliance on internal and external accounting labor for compilation and assurance

[5] For example, the Uniform Accounting Act "reserves the issuance of reports in standard form on audited, reviewed and compiled financial statements and other attest information to licensees who have demonstrated qualifications to perform attest and compilation services" (UAA 2018).

services was common. For example, a 2004 AICPA survey of private firms indicates that over 80% of participants prepare financial statements, and that preparation is most commonly handled by internal financial managers, followed by outside accountants (AICPA 2004). This reliance was ripe for disruption, as computers became widely adopted and business software was increasingly capable of taking over tasks that employees typically handled.

One particularly noteworthy development around this time was the growth in QuickBooks accounting software, produced by Intuit. Intuit was started in 1983 by Scott Cook and Tom Proulx as a personal finance software company (HMS 2023). By the late 1980s, their product Quicken was among the best-selling tools in the personal finance software category, and they began entering the commercial market with QuickPay, a payroll processing tool. In 1992, Intuit launched QuickBooks, an accounting software application aimed at small business owners with little or no formal accounting knowledge.

Subsequent versions of the software included expanded functionality, double-entry bookkeeping, full audit trail capabilities, and industry-specific licenses. During our sample period, QuickBooks became widely adopted by small and medium sized businesses, and to a more modest extent, professional accountants and consultants. A 2005 Businessweek article estimated that QuickBooks had a 74% market share of the retail (i.e., SME) market, and three million customers (Lacy and Greene 2005). Its SimpleSmart edition was popular with business owners lacking expertise in accounting, and priced competitively at $99. “Premier” and “Enterprise” editions priced at $499 and $3,500, respectively. One business owner stated that the software saved her 10 hours per week, explaining “I needed something I could just let do the work for me.” QuickBooks’ success attracted competitors to the accounting software market, and we include these vendors in our adoption analysis described in the next section.

While adopting accounting software can help a firm by reducing their preparation time and effort, there are costs that factor into the decision beyond the price of a software license.[6] Adopting first requires having a personal computer, and, depending on the particular software product, an internet connection. The direct costs of these requirements may be modest. However, the indirect costs can be significant. In the early 2000s period preceding the regulatory change we study, adopting accounting software required a "leap of faith" for many business owners lacking training or experience in business software applications.[7] This is particularly true for the private firms that QuickBooks and other vendors were targeting. These firms tend to be small, led by an owner without a university degree, and disproportionately involve construction and related services. Moreover, it seems natural that in these years of emerging software growth, some business owners would remain leery of sharing sensitive financial information, particularly if they perceived a risk of their information being hacked, lost, shared on the web, or reported to the Internal Revenue Service. Overall, although accounting software licenses per se were not particularly expensive, there existed meaningful financial, educational, and psychological barriers to adoption.

b. Sarbanes-Oxley Act

In 2002, U.S. Congress passed the Sarbanes-Oxley Act in the wake of multiple major accounting scandals. Section 404 of SOX requires a public firm's management and auditors to report on the adequacy of the internal controls over financial reporting (Iliev 2010; Ge, Koester, and McVay 2017). Accelerated filers were required to comply with these internal control reporting provisions beginning in fiscal years ending on or after November 15, 2004. This represented one of the most consequential changes in securities regulation in the past half century, and resulted in

[6] Lacy and Greene (2005) discussed how the cost of a QuickBooks license ranged from $99 to $3,500 depending on the version.

[7] To illustrate, in 2003 only 63% of U.S. households reported having a computer, and the figure is only 39% for individuals with just a high school education or lower (BLS 2010).

a significant demand shock for accounting labor to help with developing, documenting, and testing controls.

These developments are relevant to the private firms in our sample because the market for CPA services and accountants more broadly is a common one: private firms and public companies regularly access a similar pool of CPAs and accountants. So, when new securities regulation introduces a substantial accounting labor demand shock for public firms, accounting labor becomes scarcer for private firms and other nonpublic entities. The responsiveness of the labor supply to these demand shocks is shaped by licensing restrictions: CPAs comprise much of the accounting labor pool, and due to licensing restrictions (Barrios 2022; Sutherland, Uckert, and Vetter 2024), their supply is rather inelastic (Cascino, Tamayo, and Vetter 2021).[8]

Therefore, accounting labor demand shocks can propagate across different segments of the market. As one example, Duguay, Minnis, and Sutherland (2020) find that private firms' propensity to provide an attested financial statement to their bank declined by 6.3% following the passage of SOX. As another, Ettredge, Sherwood, and Sun (2018) find that non-accelerated filers *not subject to the Act* experienced audit fee increases exceeding 40%. Those subject to the Act experienced increases exceeding 80%. This evidence illustrates the inelasticity of the accounting labor supply, and the resulting exposure of private firms to major securities reforms targeted at public firms.

c. Data

We identify accounting software adoption using the employee resume dataset from Revelio Labs. Revelio is a workforce intelligence company that collects unstructured employment records

[8] Nevertheless, we study accounting wages and employment for the accounting occupation generically, because the directed technology adoption hypothesis applies to both licensed CPAs and other accountants, and we cannot separate the two types of workers in our data.

from professional networking websites and other sources, structures the records, and sells them to consulting firms, investors, academics and governments. As part of their data structuring, they extract, clean, and tabulate each employee's job title, start and end date, employer, qualifications, and tasks as the employee describes in their position description. According to Revelio's website[9], their resume dataset contains "hundreds of millions of publicly available employment records." Given our focus on private firms and our use of Sarbanes-Oxley as an exogenous shock to these firms, we eliminate public firm employers and accounting firms from the sample, but note that this choice does not affect our inferences.

The "description" field and employment dates are key to our adoption identification. Specifically, we rely on employees describing key work activities during each employment spell to identify whether and when their firm adopted accounting technology. We developed a data dictionary of adoption terms based on our research of the accounting software market. Given QuickBooks' dominant share of this market, "QuickBooks" is the most commonly triggered term (over 60% of identified adoptions); however, there are other brands (e.g., "Peachtree" or "Sage 50") and terms ("accounting software" or "financial reporting package") that we rely upon (our criteria are not case sensitive). We employ a broad, generic measure because incorporating different software editions or comparing brands introduces complexity and does little to inform our main analyses. We exclude accounting software that is part of broader ERP software (e.g., "NetSuite") as well as software names that may also refer to other concepts (e.g., "Sunrise" or "Tally"). The full keyword list is presented in Appendix B, and Figure 1 details how frequently individual keywords appear.

We estimate when the firm adopted accounting software using two steps. First, we classify firms as using accounting software in a given year if they have an employee whose job description

[9] https://www.reveliolabs.com/

for that year includes our dictionary terms. Second, we identify the earliest of these years under the classification scheme as the adoption year. Our approach to using resumes from professional networking websites to detect technology adoption is standard in the literature (e.g., Fedyk et al. 2022; Babina et al. 2024; Charoenwong et al. 2024; Heese and Pacelli 2024). Figure 2 provides example resumes that are representative of the type we identify as demonstrating accounting software use.

For accounting wage and employment data, we access the Occupational Employment and Wage Statistics table from the Bureau of Labor Statistics (BLS). We identify individuals working in accounting based on the 13-2011 occupation code ("accountants and auditors"). The BLS is also the source for our macroeconomic control variables. We obtain data on state-year industry composition and the proportion of small firms from the Statistics of U.S. Businesses (SUSB). Last, we measure average firm age in the state-year using the "year started" field from Dun & Bradstreet (D&B).

d. Summary Statistics

Table 1 presents summary statistics for the state-year level variables used in our main tests.[10] Our sample spans 1999-2008. The median (average) state-year has 32 (62) incidents of accounting software adoption. In terms of our accounting labor variables, the median (average) hourly wage is $24.68 ($24.92) and there are 11,360 (19,375) accounting employees. To assess accounting labor scarcity, we scale the number of accounting workers by the number of Compustat firms in the state-year. The median (mean) of this scaled variable is 239 (327). Half of our observations are from the post-SOX period beginning in 2004.

[10] We use state-level measurement because Revelio's more granular geographic variables (e.g., MSA) are unstandardized.

4. Research Design and Results

a. Accounting software adoption

Our initial tests model accounting software adoption using the following Poisson specification (Cohn, Liu, and Wardlaw 2022):

$$y_{s,t+1} = AcctWage_{s,t} + AccEmp_{s,t} + GDP_{s,t} + Unemp_{s,t} + \alpha_s + \alpha_t + \varepsilon_{s,t}. \quad (1)$$

The unit of observation is state-year, where *s* indexes states and *t* indexes years. The sample spans 1999-2008. The dependent variable is $AcctSW_{s,t+1}$, the number of firms adopting accounting software the following year. We measure the dependent variable in year t+1 to avoid issues related to reverse causality. *AcctWage* and *AccEmp* are the average hourly accountant wage and scaled number of accounting workers in the state-year. We control for log GDP and the unemployment rate in the state-year. We also control for state fixed effects (α_s) to account for time-invariant state-level firm composition and labor market characteristics, and year fixed effects (α_t) to account for the overall state of the economy and its effect on accounting software adoption. We cluster standard errors by state.

As an initial step, we include the accounting wage and employment variables separately. Table 2 presents the results. Column 1 shows that accounting wages in a given year predict accounting software adoption in the following year. Column 2 studies accounting employment, and finds that having more accounting workers per Compustat firm in the state-year is negatively associated with software adoption in the following year. Column 3 includes both the wage and employment variables in the same regression, and column 4 adds controls for the macroeconomic environment in the state (log GDP and unemployment). In both columns, our findings are similar: accounting software adoption follows periods of high accounting wages and fewer accounting workers in the state-year. Economically, the 0.018 $AcctWage_t$ coefficient implies that a one-dollar increase in accounting hourly wages is associated with a 1.8% increase in the number of firms

adopting accounting software.[11] The -0.094 coefficient on *AcctEmp* implies that a one standard deviation increase in the pooled sample (within-state) accounting employment is associated with 5.7% (2.9%) less adoption.

b. Bartik

Our next analyses employ a Bartik-type estimation to examine the drivers of accounting software adoption, using the following Poisson estimation:

$$y_{s,t} = EmpShortage_{s,pre} \times SOX_t + GDP_{s,t} + Unemp_{s,t} + \alpha_s + \alpha_t + \varepsilon_{s,t}. \quad (2)$$

The unit of observation is state-year, where *s* indexes states and *t* indexes years. The sample spans 1999-2008, such that there are five pre-SOX years and five post-SOX years in the sample. As before, the dependent variable is *AcctSW*, the number of firms adopting accounting software that year. *EmpShortage* is an indicator variable equal to one for states in the lowest tercile for the average ratio of accounting employees to Compustat firms, *measured in the pre-SOX period* (1999-2003) (i.e., before regulatory change to avoid mechanical issues, hence the *pre* subscript). *SOX* is an indicator variable equal to one starting in 2004, the first year of compliance with Section 404 provisions for accelerated filers. Similar to equation (1), we control for log *GDP* and the unemployment rate in the state, as well as state fixed effects (α_s) to account for time-invariant state-level firm composition and labor market characteristics, and year fixed effects (α_t) to account for the overall state of the economy and its effect on accounting software adoption. We cluster standard errors by state.

Intuitively, our estimation compares how states with more versus less accounting labor scarcity before SOX differ in their post-SOX accounting software adoption patterns. Under a

[11] A one standard deviation increase in the pooled sample (within-state) accounting hourly wages is associated with a 7.0% (5.4%) increase in the number of firms adopting accounting software.

directed technology adoption hypothesis, the $EmpShortage_{s,t} \times SOX_t$ interaction term should be positive and significant—states with less labor market slack should see more adoption when faced with a labor demand increase.

To validate our approach, Column 1 of Table 3 first examines the link between accounting wages and our *EmpShortage* measure. We find that in the post-SOX period, accounting wages increase more in states with greater scarcity, thus supporting our assumption that SOX generated a meaningful shift in the cost of accounting labor to private firms. Economically, states in the top scarcity tercile experience a $1.11 greater increase in accounting wages compared to states in the bottom tercile, and this difference represents 37% of the within-state standard deviation in accounting wages.

Column 2 then presents our results of estimating Equation (2). In the post-SOX period, we find more accounting software adoption in states that had greater accounting labor scarcity in the pre-SOX period, reinforcing our Table 2 inference that labor scarcity drives technology adoption. Column 3 examines a complementary specification based on indicator variables for terciles of *EmpShortage*, and finds the greatest adoption for the most labor-constrained states.

We then conduct several analyses to strengthen our inferences. First, Figure 3 presents an event-time version of Equation (2). In the pre-SOX period (i.e., before 2003), there is no statistical software adoption difference across high and low *EmpShortage* states. Then in 2004, states with a greater shortage during the pre-period see a jump in adoption, consistent with SOX inducing a major shift toward software- from labor-based accounting work. The coefficients for 2005-2008 are generally positive but nowhere near as pronounced as the 2004 increase. This evidence supports a causal interpretation of our Table 3 results, as opposed to an interpretation based on pre-existing trends or concurrent events uncorrelated with accounting labor shortages.

Second, Table 4 assesses the sensitivity of our results to alternative specifications. One concern is that measurement error related to our attempt to identify software adoption using resumes somehow biases the results in our favor. We therefore repeat our tests using an adoption variable based only on resumes including references to "QuickBooks," which unambiguously captures the use of accounting software. Panel A shows that our results are similar.

Then, we address a broader concern that our results are simply picking up a technology adoption trend that has little to do with accounting labor market conditions or demand for accounting software. For example, our early 2000s sample period coincided with widespread growth in the number of firms adding computers, software, and websites; this adoption may be difficult to model and could correlate with our labor market variables of interest. Therefore, we conduct a placebo test where the dependent variable measures anti-virus software adoption (as identified from employee resumes) rather than accounting software adoption. Under a trend explanation, we should find greater post-SOX adoption for states with more accounting labor scarcity. However, Panel B reports an insignificant coefficient on *EmpShortage* x *SOX*.

Overall, our evidence in this section is most consistent with accounting software adoption following from labor scarcity induced by the enactment of the Sarbanes-Oxley Act.

5. Cross-Sectional Evidence

Does adoption occur uniformly across firms, or are some firms more responsive than others to accounting labor scarcity? To shed light on this, we review analyst reports, industry white papers, and Intuit 10-Ks from the early 2000s to understand how software vendors targeted consumers and which segments were most inclined to adopt accounting software. Several recurring themes emerge. A Morgan Stanley report highlights the popularity of software among smaller firms ("currently, 90% of Intuit customers have fewer than 20 employees" and that "most of the customer acquisition from QuickBooks was from businesses later in their lifecycles" (Meeker,

Pitz, and Fitzgerald 2004). QuickBooks website also advertised a construction accounting software product that simplified invoicing and helped contractors get paid faster.

These discussions motivate exploratory cross-sectional tests using Equation (2). Column 1 of Panel A of Table 5 shows that post-SOX, adoption is greater in states with a greater share of construction firms. Column 2 and 3 study interactions with firm size and age, respectively, and find no statistical relation with adoption in the post-SOX period. Panel B adds controls for the moderating variables (e.g., the column 1 test of construction firm share adds controls for average firm size and age in the state) and arrives at similar inferences: construction share meaningfully predicts adoption, while firm size and age do not.

6. Accounting Software Adoption Consequences

In our next set of tests, we investigate how accounting software adoption affects the task allocation of employees involved in the accounting function, and the implementation of management accounting practices. For task allocation, we examine the non-accounting tasks listed on accounting employees' resumes, as recorded by Revelio. Specifically, we examine the same sample of companies we use to identify accounting software adoption in our main tests, and see whether employees add tasks related to operations and strategy. To do so, we create a dictionary of operations and strategy keywords that are included in the following three Revelio skill groups: 1) budget management / reporting / reporting & analysis; 2) operations management / inventory management / logistics; and 3) strategic planning / team leadership / negotiation. Our measure then counts the number of accounting employees in the state-year with job descriptions containing at least one of these keywords. Appendix B contains the full list of keywords in these Revelio skill groups; the most common examples in our sample include "inventory," "purchasing," "strategic planning," and "logistics." We use these keywords to explore our hypothesis that accounting

software frees up accounting employees to work on "core business activities" as described in QuickBooks advertisements shown in Figure 4, Panel A.

We follow a similar approach to identify and study the implementation of management accounting practices. Using the resume dataset, we develop a keyword dictionary referencing common management accounting practices including cash flow management, variance analysis, and cost accounting (Appendix B contains the full set of keywords). Our measure counts the number of accounting employees in the state-year whose job descriptions contain at least one of these keywords. We then use this count measure to explore our hypothesis that adopting new management accounting practices is more feasible and desirable when the firm has 1) a more structured system of recording and analyzing financial information, and 2) accounting employees with freed up time as a result of the software adoption. Management accounting practice-embedded tools in many software programs support this hypothesis: Figure 4 Panels B and C show budgeting, forecasting, and inventory management modules within popular accounting software programs.

As a first step, Table 6 models task uptake using equation (2). Column 1 finds more operations and strategy tasks among accounting employees in the post-SOX period in states with greater labor scarcity. In terms of economic magnitude, compared to the lowest scarcity tercile the highest scarcity tercile has a 3.4 percentage point greater increase in accounting jobs mentioning operations and strategy tasks. This pattern aligns with our Table 3 results showing that such states see significantly more accounting software adoption.

However, an alternative explanation for these results is that they stem from increased hiring of accounting employees, which then enables an expansion of employee tasks and management

practices. To address this, we control for the number of accounting employees in column 2.[12] Our results remain.

To more directly trace task reallocation to accounting software adoption, column 3 uses an instrumental variables approach. Specifically, we predict *AcctSW* using OLS regressions based on our Equation (2).[13] Then, we regress our task measure on the predicted value of the number of accounting software adopting firms. Our inference is the same as in the reduced form estimation: there is a reallocation towards operations and strategy tasks, and it is happening through accounting software adoption. Column 4 controls for the number of accounting employees, and arrives at the same conclusion. We also repeat our tests on a more focused set of operations and strategy keywords, as the "off-the-shelf" Revelio set is broad and contains several terms not directly related to our construct of interest. Columns 5-8 show a similar pattern to our original results: more task uptake, and this is happening through accounting software adoption.

Table 7 examines management accounting practices using a similar empirical approach. Columns 1 and 2 find greater adoption of management accounting practices post-SOX in high pre-SOX scarcity states. Economically, column 1 shows that the states with the most scarcity experience about a 4.8% greater expansion in management accounting practices than the lowest scarcity states. The instrumental variables analyses in columns 3 and 4 link this expansion to accounting software adoption.

These results provide support for the hypothesis that accounting software adoption facilitates the implementation of management accounting practices. However, such a result could derive from the task reallocation documented in Table 6 (i.e., accounting employees having freed up time), the more structured system of recording and analyzing financial information, or both. To

[12] Doing so requires us to omit our GDP control, which is nearly collinear with the number of accounting employees in the state.
[13] In all of our instrumental variable estimations, the first-stage F-statistic exceeds 10 and the p-value is <0.01.

help narrow down the channel, we repeat our tests on a firm sample where there was *no* increase in the operations and strategy tasks of accounting employees from the pre-SOX period (1999-2003) to the post-SOX period (2004-2008). For this subsample, the task reallocation channel is less likely to be at play. Columns 5-8 find that our inferences are similar, indicating that reallocation alone is unlikely to be producing the increased implementation in management accounting practices.

Finally, Table 8 explores which types of management accounting practices are being adopted. We assign our management accounting practice keywords into three categories based on the nature of the practice: profitability analysis, inventory/demand planning, and cash flow/risk management (see Appendix B for the full set of keywords for each category). We then model practice adoption for each of the three categories using equation (2). At this stage we view these analyses as exploratory and descriptive—we do not have an ex-ante hypothesis for which practice types see the greatest take up.

Columns 1 and 2 show that profitability-related management accounting practices increase more in high-scarcity states after SOX, amounting to an 8.4% greater expansion in the highest scarcity states versus the lowest. We observe a similarly large, statistically significant increase in inventory/demand planning practices (roughly 12% based on column 3). By contrast, we do not find a significant increase in cash flow/risk management practices (columns 5 and 6).[14] Our inferences across these columns are qualitatively similar under the IV approach used earlier. Overall, it appears that the link between software adoption and management accounting practices is driven by profitability analysis and inventory/demand planning.

7. Conclusion

[14] However, when we replace the continuous *EmpShortage* variable with indicator variables for middle and high scarcity terciles (similar to Table 3, column 3), both terciles experience a statistically significant increase in cash flow and risk related management accounting practices compared to the lowest tercile.

Accounting software and associated technological tools are becoming ubiquitous. These advances are transforming the field of accounting, reshaping the tools firms utilize, the composition of labor and capital in accounting processes, and the skills required of accounting professionals. Yet, we have little evidence on why firms voluntarily adopt them.

This study examines how labor market conditions drive voluntary adoption of accounting software, drawing on theories of directed technological change. These theories suggest that firms respond to input factor scarcity by adopting labor-saving technologies, thereby reducing reliance on the constrained resource.

Our analysis reveals that accounting software adoption positively responds to accounting labor market scarcity—firms are more likely to adopt such tools in environments with rising accounting wages or limited accounting labor supply. We employ a Bartik-style estimation approach, using SOX as a significant labor demand shock that amplified scarcity in certain regions. Consistent with the theory, regions experiencing greater labor scarcity exhibit higher adoption rates, highlighting the role of labor market constraints in shaping technological adoption patterns.

Beyond the drivers of adoption, we explore the impact of software adoption on the tasks performed by accountants. Adoption appears to displace routine accounting tasks, allowing professionals to focus on more strategic and operational activities, in line with accounting software advertisements. This shift facilitates the implementation of managerial accounting practices. Overall, our findings suggest that labor scarcity not only accelerates technological adoption but also prompts changes in the tasks performed by accountants.

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Appendix A: Variable Descriptions

Variable	Definition	Source
AcctSW	The number of new accounting software adopting firms in the state-year. Accounting software adoption is measured as the first mention of accounting software keywords in resume descriptions. Refer to Appendix B for keywords.	Revelio
$AcctSW^{QB}$	The number of new accounting software adopting firms in the state-year. Accounting software adoption is measured as the first mention of 'quickbooks' in resume descriptions. Refer to Appendix B for keywords.	Revelio
AcctWage	The mean wage of accountants (BLS occupation code 13-2011) in the state-year.	U.S. Bureau of Labor Statistics (BLS)
AcctEmp	The total number of accountants (BLS occupation code 13-2011) scaled by the total number of Compustat firms in the state-year, log transformed.	BLS & Compustat
SOX	An indicator variable for years beginning in 2004.	Public
EmpShortage	Three minus the tercile ranking of mean *AcctEmp* from 1999 to 2003 for each state-year. High *Empshortage* corresponds to low *AcctEmp*.	BLS & Compustat
$EmpShortage_{mid}$	The middle tercile ranking of mean *AcctEmp* from 1999 to 2003 for each state-year.	BLS & Compustat
$EmpShortage_{high}$	The lowest tercile ranking of mean *AcctEmp* from 1999 to 2003 for each state-year.	BLS & Compustat
TotalFirms	The total number of firms in the state-year according to the Revelio resume dataset.	Revelio
GDP	GDP in the state-year, log transformed.	BLS
Unemp	The unemployment rate in the state-year	BLS
AntiVirus	The number of new antivirus software adopters in the state-year. Antivirus software adoption is measured as the first mention of either ‘antivirus’ or ‘anti-virus’ in resume descriptions.	Revelio
ConstFirm	The ratio of firms in the construction industry (two-digit NAICS 23) to total firms in the state, measured in 2003.	SUSB

SmallFirm	The ratio of firms with less than 20 employees to total firms in the state, measured in 2003.	SUSB
FirmAge	The average age of firms in the state, measured in 2003.	D&B
OtherTasks (*OtherTasks*^{core})	The number of accounting employees (role_k50= "Accountant") with job descriptions including operating or strategy keywords (streamlined keywords) in the state-year. Refer to Appendix B for keywords.	Revelio
MgAcct (*MgAcct*^{NoTask})	The number of accounting employees (role_k50= "Accountant") with job descriptions including management accounting practice keywords (excluding firms that experienced an increase in *OtherTasks*^{core} from the pre-SOX period to the post-SOX period). Refer to Appendix B for keywords.	Revelio
AllAcct	The log of number of accounting employees (role_k50="Accountant") in the state-year.	Revelio

Appendix B: Keywords

Variable	Keywords
AcctSW	QuickBooks, accounting software, Peachtree, accounting program, financial reporting package, accounting application, accounting package, accounting platform, accounting solution, financial reporting software, ledger software, Sage 50, financial reporting tool, financial reporting application, ledger application, accounting tool, record keeping software, financial reporting platform, FreshBooks, AccountEdge, ledger package, record keeping platform, record keeping program, ledger program, financial reporting solution, ledger platform, financial reporting program, record keeping application, ledger solution, bookkeeping software
$AcctSW^{QB}$	QuickBooks
AntiVirus	Antivirus, Anti-virus
OtherTasks	KPI reports, order management, complaint management, budget forecasts, purchasing negotiation, invoice processing, reporting & analysis, reporting, supervising, budget monitoring, capital budgeting, schedules, stock control, capacity planning, budget process, supervision, budget management, business operations, purchasing processes, staff management, operating budgets, supplier negotiation, purchase orders, cross-functional team building, department budgeting, purchase management, staff supervision, supervisory experience, cross-functional coordination, Contract management, LTL, logistics management, logistics, warehousing, EDI, global sourcing, demand planning, WMS, warehouse operations, distribution center operations, warehouse management, truckload, transportation, international logistics, steel, spend analysis, supply chain optimization, supply chain management, supplier quality, inventory management, supplier evaluation, inventory control, supplier development, inventory analysis, inventory, supply management, international shipping, customs regulations, shipping, import, IBM iSeries, production planning, forklift operator, strategic sourcing, reverse logistics, building materials, demand forecasting, supply chain, freight forwarding, cement, freight, container, purchasing, DOT regulations, air freight, procurement, AS400 system, billing systems, operations management, dispatching, transportation management, ocean, JD Edwards,

	3PL, e-procurement, export, trucking, collections, materials management, materials, MRP, product marketing, mobile internet, innovation, strategic negotiations, mobile, customer insight, product development, commercialization, start-ups, international project management, strategy, market research, consumer insight, mobile communications, business strategy, negotiation, global business development, product lifecycle management, brand equity, segmentation, international business, strategic consulting, competitive intelligence, strategic planning, internet of things, team leadership, virtual teams, consumer electronics, messaging, business planning, mobile applications, contract negotiation, mobile devices, benchmarking, mobile technology, entrepreneurship, organizational change, cloud applications, product launch, global marketing, product management, agriculture, product strategy, innovation management, small business, competitive analysis, strategic alliances, international marketing, strategic leadership, budgets, strategic partnerships, international trade, strategic thinking, consulting, strategy development, management consulting, technical leadership, thought leadership, market intelligence, advertising research, agribusiness, balanced scorecard, business modeling, consumer behaviour, market development, technology management
OtherTasks^{core}	order management, complaint management, purchasing negotiation, stock control, capacity planning, business operations, purchasing processes, staff management, supplier negotiation, purchase orders, purchase management, contract management, logistics management, logistics, warehousing, global sourcing, warehouse operations, distribution center operations, warehouse management, truckload, transportation, international logistics, supply chain optimization, supply chain management, supplier quality, inventory management, supplier evaluation, inventory control, supplier development, inventory analysis, inventory, supply management, international shipping, customs regulations, shipping, import, production planning, strategic sourcing, reverse logistics, building materials, supply chain, freight forwarding, freight, container, purchasing, air freight, procurement, operations management, dispatching, transportation management, e-procurement, export, trucking, materials management, product marketing, innovation, strategic negotiations, customer insight, product development, commercialization, international project

	management, strategy, market research, consumer insight, business strategy, global business development, product lifecycle management, brand equity, segmentation, international business, strategic consulting, competitive intelligence, strategic planning, business planning, contract negotiation, product launch, global marketing, product management, product strategy, innovation management, competitive analysis, strategic alliances, international marketing, strategic leadership, strategic partnerships, international trade, strategic thinking, strategy development, market intelligence, advertising research, business modeling, consumer behaviour, market development
MgAcct	cash flow forecasting, managerial finance, cost accounting, variance analysis, management accounting, financial forecasting, enterprise risk management, risk, cash flow, financial management, working capital management, contract management, supply chain optimization, supply chain management, inventory management, inventory analysis, production planning, strategic sourcing, demand forecasting, supply chain, operations management, KPI reports, budget forecasts, budget monitoring, capital budgeting, budget process, budget management, operating budgets, department budgeting, demand planning, spend analysis, demand forecasting, benchmarking, balanced scorecard
$MgAcct^{profitability}$	cost accounting, variance analysis, management accounting, KPI reports, budget forecasts, budget monitoring, capital budgeting, budget process, budget management, operating budgets, department budgeting, spend analysis, benchmarking, balanced scorecard
$MgAcct^{cashflow}$	cash flow forecasting, managerial finance, financial forecasting, enterprise risk management, risk, cash flow, financial management, working capital management
$MgAcct^{inventory}$	contract management, supply chain optimization, supply chain management, inventory management, inventory analysis, production planning, strategic sourcing, demand forecasting, supply chain, operations management, demand planning, demand forecasting

Figure 1: Measuring Accounting Software Adoption

This figure presents the keywords we use to identify accounting software adoption. Count is the number of resume descriptions containing each keyword in our sample.

Keywords	Count
quickbooks	64,783
accounting software	20,572
peachtree	8,144
accounting program	1,947
financial reporting package	1,318
accounting application	770
accounting package	756
accounting platform	435
accounting solution	329
financial reporting software	268
ledger software	256
sage 50	244
financial reporting tool	147
financial reporting application	104
ledger application	102
accounting tool	95
record keeping software	70
financial reporting platform	59
freshbooks	57
accountedge	49
ledger package	47
record keeping platform	39
record keeping program	37
ledger program	28
financial reporting solution	26
ledger platform	24
financial reporting program	23
record keeping application	15
ledger solution	14
book keeping software	9

Figure 2: Example Resumes

This figure presents examples of resumes that we identify as indicating the use of accounting software at the firm. To preserve anonymity, we have redacted the employer and firm names.



Accountant
[redacted]
Aug 2000 - May 2001 · 10 mos
Napa, CA

Responsible for all accounting functions through financial statement preparation for two locations. Implemented conversion to Quickbooks which gave management daily control over financial information to make business decisions. Prior financials were prepared by an outside bookkeeping service. Implemented weekly reports to assist management and executive chef in controlling food and labor costs which resulted in cost savings to the corporation.

Accounting Manager
[redacted]
Sep 2007 - Mar 2008 · 7 mos

Assisted in researching, implementing and starting up a family business.
Set up Quickbooks software and managed all accounting responsibilities.
Responsible for all banking transactions including payments, deposits and transfers.
Managed all payroll processed through ADP.
Managed 6 temporary employees.
Supervised children while in the play arena.

Accounting Coordinator
[redacted]
Aug 2008 - Dec 2009 · 1 yr 5 mos
Toledo, OH

Implemented QuickBooks to integrate accounting processes, provide subledger to general ledger reconciliations, and improve financial reporting.

Maintained A/R and A/P representing over 100 customers, 15 suppliers, and 20 employees.

Managed bank reconciliations, cash deposits/disbursements, and cash flow analysis.

Figure 3: Accounting Labor Costs around SOX
This figure plots the coefficients and 90% confidence intervals from the event-time regressions as in Equation (2). The dotted line denotes the start of SOX compliance. The holdout year is 2003.

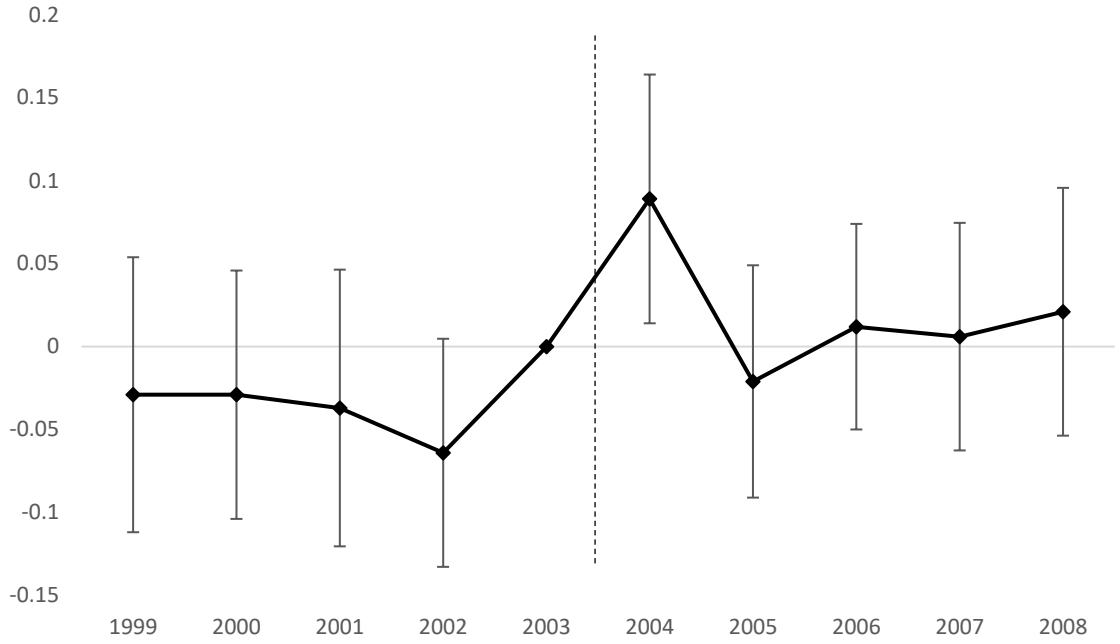
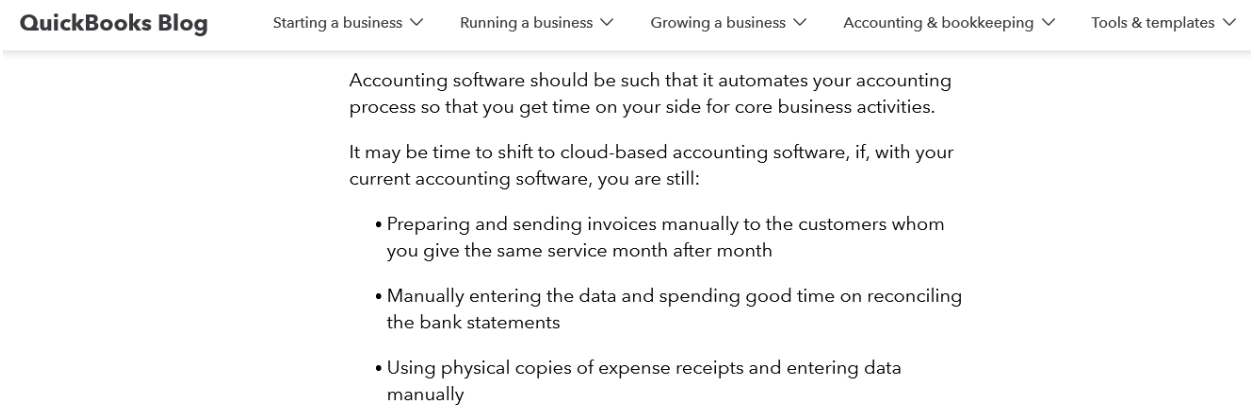


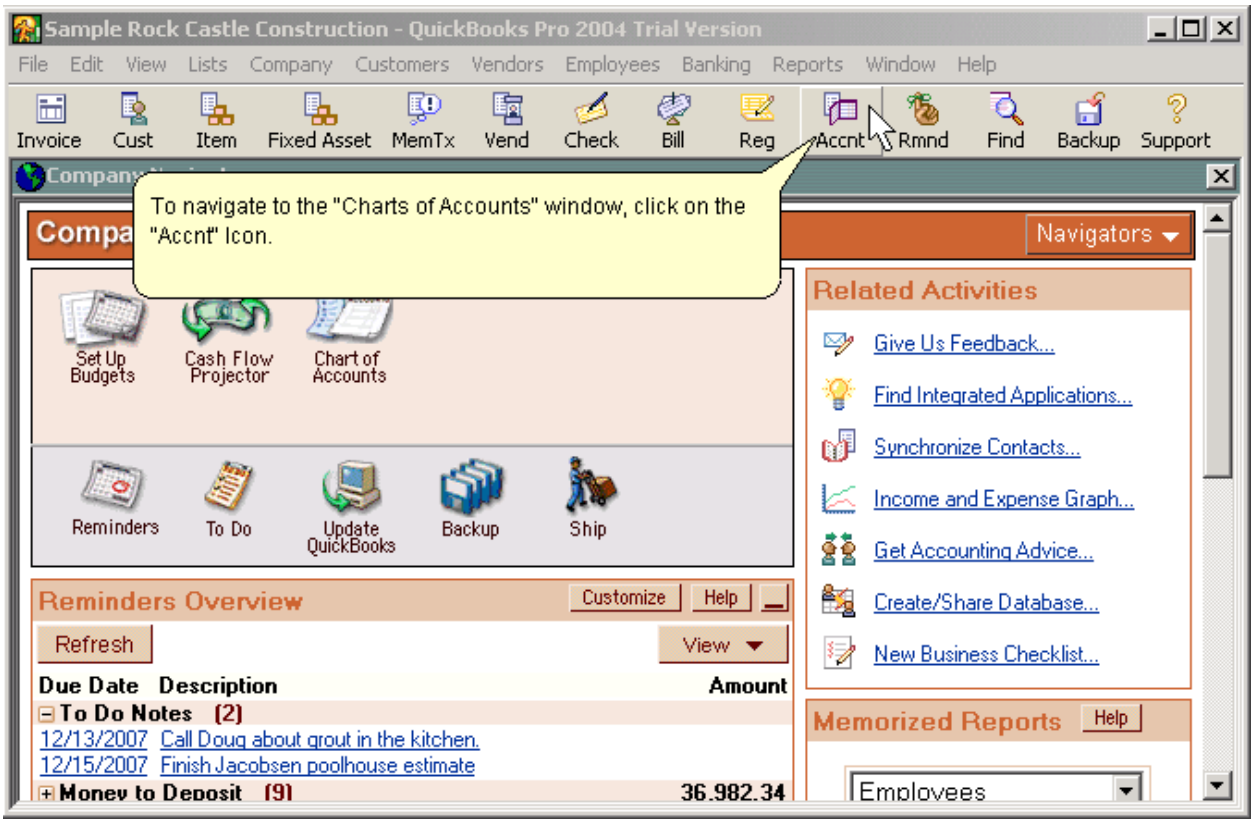
Figure 4: Accounting Software Advertisements
This figure compiles software advertisements and software screenshots describing program features and adoption benefits. Sources are provided under the advertisements.

Panel A: Automation and Time Reallocation



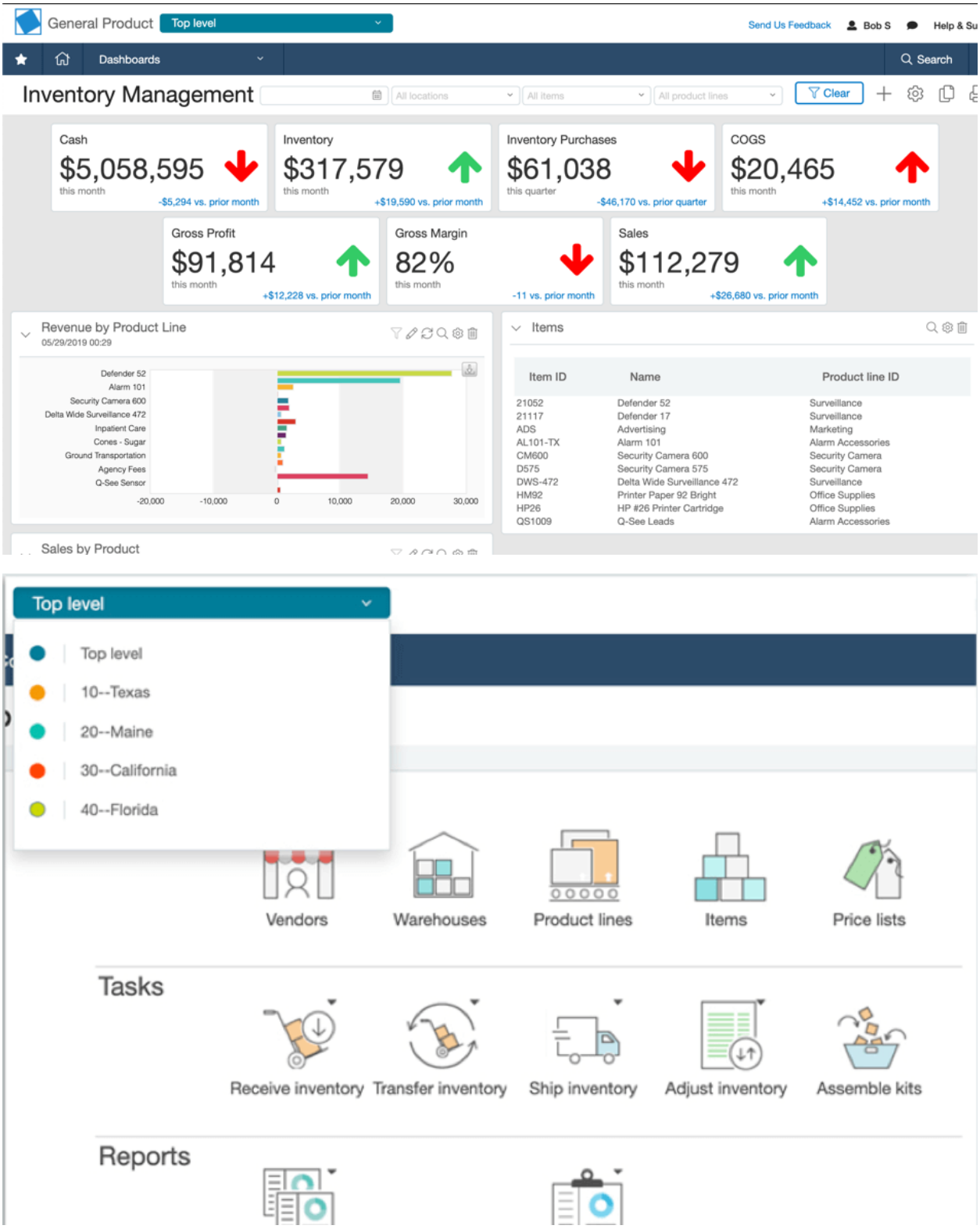
Source: https://quickbooks.intuit.com/global/resources/accounting-and-bookkeeping/cloud-accounting-software/

Panel B: Budgeting and Cash Flow Projection Tools



Source: https://www.conficio.com/plan-b/examples/quickbooks/create_account/credit_card/flat_excerpt.html

Panel C: Inventory Management Tools



Source: https://www.sage.com/en-ca/sage-business-cloud/intacct/additional-financial-management-modules/cloud-inventory-management-system/

Table 1: Summary Statistics

This table provides summary statistics for the variables used in our analyses. The sample spans 1999-2008 for 50 states in the U.S. Variables logged transformed in the regressions are reported both in raw and logged values. Refer to Appendix A for variable descriptions.

Variable	N	Mean	SD	Q1	Median	Q3
AcctSW	500	61.78	92.01	10	32	77
$AcctSW^{QB}$	500	38.3	64.68	5	17	46
AcctWage	500	24.92	3.86	22.03	24.68	27.41
$AcctEmp_{unscaled}$	500	19,375	22,502	4,435	11,360	23,585
AcctEmp	500	5.55	0.61	5.15	5.47	5.89
SOX	500	0.50	0.50	0	1	1
GDP_{raw}	500	302,245	355,879	71,422	186,061	386,939
GDP	500	12.09	1.05	11.18	12.13	12.87
Unemp	500	4.75	1.14	3.90	4.70	5.50
AntiVirus	500	20.65	26.78	4	10	28
ConstFirm	500	0.13	0.02	0.11	0.13	0.15
SmallFirm	500	0.86	0.02	0.85	0.86	0.87
FirmAge	500	13.75	2.85	11.76	13.68	15.72
OtherTasks	500	2,549	3,387	408	1,224	3,363
$OtherTasks^{core}$	500	959	1,276	153	471	1,277
MgAcct	500	888	1,230	130	379	1,194
$MgAcct^{NoTask}$	500	698	926	115	336	929
$MgAcct^{profitability}$	500	280	376	41	128	382
$MgAcct^{cashflow}$	500	600	854	84	246	779
$MgAcct^{inventory}$	500	102	140	15	47	130
$AllAcct_{raw}$	500	10,796	13,632	2,027	5,602	14,201

Table 2: Accounting Software Adoption and Accounting Labor Scarcity
This table studies accounting software adoption using Equation (1). The unit of observation is state-year. *AcctSW* is the number of new accounting software adopters. *AcctWage* is the mean accountant wage. *AcctEmp* is the number of total accountants scaled by the number of Compustat firms, log transformed. *GDP* is the log GDP. *Unemp* is the unemployment rate. Standard errors are clustered at the state level. *, **, *** indicate significance at the two-tailed 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	$AcctSW_{t+1}$	$AcctSW_{t+1}$	$AcctSW_{t+1}$	$AcctSW_{t+1}$
AcctWage	0.014*		0.015**	0.018***
	(1.94)		(2.07)	(2.90)
AcctEmp		-0.089*	-0.094*	-0.094*
		(-1.80)	(-1.87)	(-1.90)
GDP				0.385*
				(1.95)
Unemp				-0.031**
				(-2.33)
Observations	500	500	500	500
FE	state, year	state, year	state, year	state, year
Cluster	state	state	state	state
Adjusted R-squared	0.935	0.935	0.935	0.935

Table 3: Bartik Estimation

This table studies accounting wages and accounting software adoption using Equation (2). *AcctWage* is the mean accountant wage. *AcctSW* is the number of new accounting software adopters. *SOX* is an indicator equal to one starting in 2004. *EmpShortage* is three minus the tercile ranking of mean *AcctEmp* in the pre-SOX period for each state. $EmpShortage_{high(mid)}$ is an indicator variable equal to one for states with the highest (middle) tercile of *EmpShortage*, and zero otherwise. *GDP* is the log transformed GDP. *Unemp* is the unemployment rate. Standard errors are clustered at the state level. *, **, *** indicate significance at the two-tailed 10%, 5%, and 1% levels, respectively.

	(1) *AcctWage*	(2) *AcctSW*	(3) *AcctSW*
EmpShortage×*SOX*	0.554***	0.049**	
	(3.02)	(2.27)	
$EmpShortage_{mid}$×*SOX*			0.042
			(0.75)
$EmpShortage_{high}$×*SOX*			0.095*
			(1.71)
GDP	-3.923	0.675***	0.675***
	(-1.47)	(3.04)	(3.05)
Unemp	0.133	-0.026**	-0.026**
	(1.02)	(-2.21)	(-2.21)
Observations	500	500	500
FE	state, year	state, year	state, year
Cluster	state	state	state
Adjusted R-squared	0.934	0.932	0.932

Table 4: Robustness

This table studies accounting software adoption using variations of Equation (2). *AcctSW* is the number of new accounting software adopters. *AcctEmp* is the number of total accountants scaled by the number of Compustat firms, log transformed. *EmpShortage* is three minus the tercile ranking of mean *AcctEmp* in the pre-SOX period for each state. *SOX* is an indicator equal to one starting in 2004. Panel A studies a software adoption measure based only on "QuickBooks" as a resume keyword. Panel B tabulates our placebo analysis, where the dependent variable measures the number of new antivirus software adopters. Standard errors are clustered at the state level. *, **, *** indicate significance at the two-tailed 10%, 5%, and 1% levels, respectively.

Panel A. Alternative Measure of Accounting Software Adoption

	(1) $AcctSW^{QB}_{t+1}$	(2) $AcctSW^{QB}$
AcctWage	0.020**	
	(2.25)	
AcctEmp	-0.112*	
	(-1.66)	
EmpShortage×*SOX*		0.059*
		(1.83)
Controls	Yes	Yes
Observations	500	500
FE	state, year	state, year
Cluster	state	state
Adjusted R-squared	0.918	0.912

Panel B. Placebo Tests on AntiVirus

	(1) $AntiVirus_{t+1}$	(2) *AntiVirus*
AcctWage	-0.006	
	(-0.53)	
AcctEmp	-0.025	
	(-0.27)	
EmpShortage×*SOX*		-0.048
		(-1.37)
Controls	Yes	Yes
Observations	500	500
FE	state, year	state, year
Cluster	state	state
Adjusted R-squared	0.834	0.834

Table 5: Cross-Sectional Tests

This table studies accounting software adoption using a variation of Equation (2). $AcctSW^{QB}$ is the number of new QuickBooks adopters. *SOX* is an indicator equal to one starting in 2004. *EmpShortage* is three minus the tercile ranking of mean *AcctEmp* in the pre-SOX period for each state. *Moderator* refers to one of three cross sectional variables, as follows. *ConstFirm* is the ratio of construction firms to total firms in each state in 2003. *SmallFirm* is the ratio of firms with fewer than 20 employees to total firms in each state in 2003. *FirmAge* is the average firm age in each state in 2003. Control variables in Panel A include log GDP and the unemployment rate. Panel B adds controls for the other moderating variables. Standard errors are clustered at the state level. *, **, *** indicate significance at the two-tailed 10%, 5%, and 1% levels, respectively.

Panel A. Baseline

Moderator	(1) *ConstFirm*	(2) *SmallFirm*	(3) *FirmAge*
	$AcctSW^{QB}$	$AcctSW^{QB}$	$AcctSW^{QB}$
EmpShortage×SOX×Moderator	4.636*	1.598	0.003
	(1.83)	(0.72)	(0.24)
EmpShortage×SOX	-0.508	-1.297	0.017
	(-1.55)	(-0.67)	(0.08)
SOX×Moderator	-6.050	-3.691	-0.010
	(-1.59)	(-0.93)	(-0.44)
Controls	Yes	Yes	Yes
Observations	500	500	500
FE	state, year	state, year	state, year
Cluster	state	state	state
Adjusted R-squared	0.912	0.912	0.912

Panel B. With Controls

Moderator	(1) *ConstFirm*	(2) *SmallFirm*	(3) *FirmAge*
	$AcctSW^{QB}$	$AcctSW^{QB}$	$AcctSW^{QB}$
EmpShortage×SOX×Moderator	5.231*	1.504	0.010
	(1.94)	(0.65)	(0.77)
EmpShortage×SOX	-0.623*	-1.225	-0.092
	(-1.72)	(-0.61)	(-0.45)
SOX×Moderator	-7.488*	-2.627	-0.004
	(-1.78)	(-0.60)	(-0.19)
Controls	Yes	Yes	Yes
Moderating Variable Controls	Yes	Yes	Yes
Observations	500	500	500
FE	state, year	state, year	state, year
Cluster	state	state	state
Adjusted R-squared	0.913	0.912	0.913

Table 6: Accounting Software Adoption and Accountant Tasks

This table studies accountants working on operations or strategy tasks. *OtherTask* is the number of accounting employees with job descriptions including operations or strategy keywords according to Revelio. *OtherTask*^{core} is an alternative measure based on a more focused set of keywords. Appendix B contains the keyword lists. *EmpShortage* is three minus the tercile ranking of mean *AcctEmp* in the pre-SOX period for each state. *SOX* is an indicator equal to one starting in 2004. $\widehat{AcctSW}$ is the predicted value of *AcctSW* from the first-stage OLS regression using Equation (2). The coefficients for $\widehat{AcctSW}$ are multiplied by 100 to aid interpretability. *AllAcct* is the log number of accounting employees according to Revelio. Columns 1, 2, 5, and 6 (3, 4, 7, and 8) present results based on Equation (2) (instrumental variables analyses). Control variables include *GDP* and *Unemp* for odd columns and *Unemp* for even columns. For models using predicted values, we report first-stage F-statistics and their corresponding p-values. Standard errors are clustered at the state level. *, **, *** indicate significance at the two-tailed 10%, 5%, and 1% levels, respectively.

	(1) *OtherTask*	(2) *OtherTask*	(3) *OtherTask*	(4) *OtherTask*	(5) *OtherTask*^{core}	(6) *OtherTask*^{core}	(7) *OtherTask*^{core}	(8) *OtherTask*^{core}
EmpShortage×*SOX*	0.017**	0.010***			0.017**	0.011**		
	(2.16)	(2.84)			(2.14)	(2.23)		
$\widehat{AcctSW}$			0.044**	0.027***			0.045**	0.029**
			(2.16)	(2.84)			(2.14)	(2.23)
AllAcct		0.969***		0.938***		0.885***		0.852***
		(14.80)		(13.49)		(9.72)		(8.97)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	500	500	500	500	500	500	500	500
FE	state, year	state, year	state, year	state, year	state, year	state, year	state, year	state, year
Cluster	State	state	state	state	state	state	state	state
Adjusted R-squared	0.997	0.997	0.997	0.997	0.993	0.993	0.993	0.993
First-stage F-statistic			12.51	12.75			12.51	12.75
			(0.00)	(0.00)			(0.00)	(0.00)

Table 7: Accounting Software Adoption and Management Accounting Practices

This table studies adoption of management accounting practices. *MgAcct* is the number of accounting employees with job descriptions including management accounting practice keywords. $MgAcct^{notask}$ is the number of accounting employees with job descriptions including management accounting practice keywords but not operations or strategy keywords. Panel B reports regression results using subcategories of management accounting keywords. Appendix B contains the keyword lists. *EmpShortage* is three minus the tercile ranking of mean *AcctEmp* in the pre-SOX period for each state. *SOX* is an indicator equal to one starting in 2004. $\widehat{AcctSW}$ is the predicted value of *AcctSW* from the first-stage OLS regression using Equation (2). The coefficients for $\widehat{AcctSW}$ are multiplied by 100 to aid interpretability. *AllAcct* is the log number of accounting employees according to Revelio. Columns 1, 2, 5, and 6 (3, 4, 7, and 8) in both panels present results based on Equation (2) (instrumental variables analyses). Control variables include *GDP* and *Unemp* for odd columns and *Unemp* for even columns. For models using predicted values, we report first-stage F-statistics and their corresponding p-values. Standard errors are clustered at the state level. *, **, *** indicate significance at the two-tailed 10%, 5%, and 1% levels, respectively.

	(1) *MgAcct*	(2) *MgAcct*	(3) *MgAcct*	(4) *MgAcct*	(5) $MgAcct^{notask}$	(6) $MgAcct^{notask}$	(7) $MgAcct^{notask}$	(8) $MgAcct^{notask}$
EmpShortage×*SOX*	0.024***	0.018***			0.022**	0.016*		
	(2.83)	(2.94)			(2.09)	(1.95)		
$\widehat{AcctSW}$			0.063***	0.046***			0.059***	0.042*
			(2.83)	(2.94)			(2.09)	(1.95)
AllAcct		0.957***		0.904***		1.010***		0.962***
		(9.59)		(8.43)		(8.18)		(7.92)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	500	500	500	500	500	500	500	500
FE	state, year	state, year	state, year	state, year	state, year	state, year	state, year	state, year
Cluster	state	state	state	state	state	state	state	state
Adjusted R-squared	0.993	0.993	0.993	0.993	0.991	0.991	0.991	0.991
F-statistic			12.51	12.75			12.51	12.75
			(0.00)	(0.00)			(0.00)	(0.00)

Table 8: Accounting Software Adoption and Management Accounting Practices by Type

This table studies adoption of different types of management accounting practices. $MgAcct^{profitability}$ ($MgAcct^{inventory}$; $MgAcct^{cash\ flow}$) is the number of accounting employees with job descriptions including profitability analysis (inventory / demand planning; cash flow / risk management) keywords. Appendix B contains the keyword lists. *EmpShortage* is three minus the tercile ranking of mean *AcctEmp* in the pre-SOX period for each state. *SOX* is an indicator equal to one starting in 2004. Control variables include *GDP* and *Unemp* for odd columns and *Unemp* for even columns. Standard errors are clustered at the state level. *, **, *** indicate significance at the two-tailed 10%, 5%, and 1% levels, respectively.

	(1) $MgAcct^{profitability}$	(2) $MgAcct^{profitability}$	(3) $MgAcct^{inventory}$	(4) $MgAcct^{inventory}$	(5) $MgAcct^{cashflow}$	(6) $MgAcct^{cashflow}$
EmpShortage×*SOX*	0.042***	0.034***	0.060***	0.059***	0.011	0.005
	(2.85)	(2.75)	(3.17)	(3.03)	(1.27)	(0.71)
$EmpShortage_{mid}$×*SOX*						
$EmpShortage_{high}$×*SOX*						
AllAcct		1.141***		0.664***		0.828***
		(5.99)		(2.78)		(7.47)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	500	500	500	500	500	500
FE	state, year	state, year	state, year	state, year	state, year	state, year
Cluster	state	state	state	state	state	state
Adjusted R-squared	0.980	0.981	0.957	0.957	0.991	0.991