Revenue recognition timing and attributes of reported revenue: The case of software industry's adoption of SOP 91-1 ☆

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Abstract

I examine how revenue recognition timing affects attributes of reported revenue, using a sample of software firms that adopted Statement of Position 91-1 in the early 1990s. I find early recognition yields more timely revenue information, as evidenced by higher contemporaneous correlation with information impounded in stock returns. However, such early recognition diminishes the extent to which accounts receivable accruals map into future cash flow realizations and lowers the time-series predictability of reported revenue. Overall,

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the results suggest early revenue recognition makes reported revenue more timely and more relevant, but at the cost of lower reliability and lower time-series predictability.

Keywords: Revenue recognition; Relevance; Timeliness; Reliability; Time-series predictability

1. Introduction

Revenue is almost always the single largest item reported in a company's income statement. As with bottom-line income, top-line revenue is significant not only in monetary terms but also in its importance to investors' decision-making process; trends and growth in a company's revenue are barometers of the company's past performance and future prospects (Turner, 2001). Consequently, revenue recognition has been one of the most important issues confronting standard setters and accountants.

One of the critical issues with respect to revenue recognition is timing, i.e., the appropriate point in the sales cycle when revenue should be recognized. U.S. GAAP broadly stipulates that revenue should be recognized when it is realized/realizable and earned (i.e., the "revenue recognition principle," Financial Accounting Standards Board, 1984, para. 83). However, in practice, the timing of revenue recognition is complicated because of the complexity and diversity in the underlying revenue-generating transactions. Companies frequently have opportunities to accelerate revenue through early recognition—for example, by recognizing revenue before transfer of title and/or shipment of product, or at a time when the customer still has the option to terminate, void, or delay the sale.

Recently, early revenue recognition has drawn the attention of standard setters. For example, former Securities and Exchange Commission (SEC) Chairman Arthur Levitt listed premature recognition of revenue as one of the five major areas of earnings management (Levitt, 1998). The Financial Accounting Standards Board (FASB) has released a series of Emerging Issues Task Force Bulletins (e.g., FASB, 2000) and the SEC has released Staff Accounting Bulletin (SAB) 101 (SEC, 1999), providing more guidelines for the appropriate timing of revenue recognition.

Despite the importance of revenue recognition in financial reporting and the recent attention devoted by standard setters, there is surprisingly little empirical research examining revenue recognition in general and revenue recognition timing in particular. One reason for the paucity of research in this area is the difficulty in obtaining data related to revenue recognition policies. In this study, I exploit a unique situation around the promulgation of Statement of Position (SOP) 91-1 on Software Revenue Recognition (American Institute of Certified Public Accountants, 1991) in the early 1990s to empirically test the effects of early revenue recognition relative to the Statement on the attributes of reported revenue.

Before SOP 91-1, a number of software firms recognized revenue prior to product delivery or service performance. This practice deviated from the revenue recognition principle and concerned standard setters. Consequently, the American Institute of Certified Public Accountants (AICPA) released SOP 91-1 in December 1991, which stipulated that if collectibility is probable, license revenue should be recognized upon delivery and service revenue should be recognized ratably over the service arrangement. In particular, the SOP's requirement of retroactive application permits identification of early revenue recognition, which is critical to my empirical tests.[1]

I hypothesize that early revenue recognition increases the timeliness of reported revenue in reflecting the economics underlying the firm's revenue-generating transactions. However, I also expect that such practice decreases the extent to which accounts receivable accruals map into cash flow realizations ex post. Finally, I hypothesize that the time-series predictability of revenue is lower under early revenue recognition.

I test my hypotheses with a sample of 122 software firms over the period of 1987–1997. Twenty-nine of the sample firms employed some form of early revenue recognition prior to SOP 91-1. To isolate the effects of early revenue recognition, I employ a 2×2 design that controls for the effects of both inherent cross-sectional differences and time-series changes in macro- or industry-wide factors.

I find that early recognition yields more timely revenue information, as evidenced by higher contemporaneous correlation with economic information impounded in stock returns. However, I also find that such early recognition diminishes the extent to which accounts receivable accruals map into future cash flows from the receivables and lowers the time-series predictability of reported revenue.

This study contributes to the literature in the following ways. First, it contributes to the literature on revenue recognition. Until recently, this literature has largely focused on the issues of gross versus net revenue for internet firms (e.g., Davis, 2001; Bowen et al., 2002). Along with Altamuro et al. (2002), my study attempts to investigate the issues related to revenue recognition timing. Altamuro et al. use the adoption of SAB 101 to study the managerial motivations for early revenue recognition. They find that for a sub-sample of firms affected by the SAB, early revenue recognition was used to manage earnings to meet important benchmarks and reduce contracting costs. In contrast, I examine the consequences of early revenue recognition on different attributes of reported revenue for a sample of software firms that adopted SOP 91-1.

Second, to the extent that timeliness and low estimation error are important ingredients of relevance and reliability, my study documents the trade-off between relevance and reliability in financial accounting. Many studies examine the value-relevance of specific accounting topics (e.g., Lev and Sougiannis, 1996; Venkatachalam, 1996). Other studies examine the reliability issues (e.g., Barth, 1991; Kothari

[1]Although it is possible that some software firms intentionally chose to defer, rather than accelerate, recognition of revenue, this practice was not a particular target in SOP 91-1. Accordingly, in this paper I focus on early revenue recognition only and do not differentiate firms that deferred revenue recognition from other firms that were not affected by adopting SOP 91-1.

et al., 2002). My study is one of the few that examine both relevance and reliability (e.g., Barth and Clinch, 1998) and the underlying tension between these two objectives of financial accounting.

This study also adds to Kasznik (2001) who focuses on the setting of SOP 91-1 as well and finds that managers use their discretion in the pre-SOP period to convey private information about their firms' underlying economics. While my results on timeliness are consistent with Kasznik's results, my study also suggests that the higher relevance under early revenue recognition comes at the cost of lower reliability.

The paper proceeds as follows. Section 2 provides institutional background on software revenue recognition and Section 3 discusses the sample. Section 4 examines the timeliness of reported revenue, Section 5 investigates the extent to which accounts receivable accruals map into future cash flow realizations, and Section 6 focuses on the time-series predictability of reported revenue. Section 7 concludes.

2. Software revenue recognition

The Statement of Financial Accounting Concepts (SFAC) No. 5 outlines that revenue should be recognized when it is realized/realizable and earned (FASB, 1984, para. 83). However, prior to SOP 91-1, the authoritative accounting literature provided no specific guidance on the appropriate timing for recognizing revenue from licensing, selling, leasing, or otherwise marketing computer software (Morris, 1992). Consequently, there was considerable diversity in revenue recognition practices within the software industry.[2] While some of these practices reflected the variety in the nature of sales transactions, others are driven by differences in firms' propensity for aggressive or conservative revenue recognition. Particularly, some software firms recognized revenue before delivery, which potentially violated one or both of the conditions of the revenue recognition principle. The inconsistent application of the revenue recognition principle as well as the aggressive revenue recognition practices concerned standard setters and eventually resulted in the issuance of SOP 91-1 in December 1991 by the AICPA.

One of the key issues in software revenue recognition is the point at which software license revenue should be recognized. Some believed that revenue should be recognized at contract signing. They argued that delivery of software is incidental to the earnings process because most of the significant costs related to the transaction have been incurred and expensed prior to contract signing (Morris, 1992) and because in the software industry, transfer of rights to software is achieved by license, rather than outright sale or delivery, in order to protect vendors from unauthorized duplication of their products (Carmicheal, 1998).

[2]For example, a 1984 survey by the Association of Data Processing Service Organizations indicated that 45% of the software companies in the survey recognized some revenue at contract signing, 51% at installation, 44% at customer acceptance, and 15% at other times.

Others, however, argued that all parties treat the transaction as a transfer of the title to the software since the customer has full and free use of the software. Thus, this point of view believed licensing of software is, in substance, a sale of a product, and that the revenue should be recognized upon delivery, as in the case of sale of other products (Carmicheal, 1998).

SOP 91-1 agreed with the second point of view and stipulated that revenue for licensing software should be recognized upon delivery if collectibility is probable and if the vendor has no significant obligation remaining under the licensing agreement after delivery (para. 32–33).

In addition to licensing software, providing post-contract customer support (PCS) is another major source of revenue for many software firms. Those who favored immediate recognition of PCS revenue argued that such practice is easier to apply. Others felt that the PCS revenue should be recognized over time, because an obligation to perform service is incurred at contract signing and is discharged gradually over time. SOP 91-1 took the second view and concluded that PCS revenue should be recognized ratably over the period of the PCS arrangement if collectibility is probable (para. 114). The SOP also stated that although PCS and software may be sold together, they are considered to be separate items that should be accounted for separately (para. 117).

The rules governing software revenue recognition have been in a continual state of development. In 1997, SOP 91-1 was superseded by SOP 97-2 (AICPA, 1997) which was amended by SOP 98-4 and SOP 98-9 (AICPA, 1998a, b) in 1998.[3] While consistent with SOP 91-1 in principle, these later SOPs clarified certain aspects of SOP 91-1 and provided additional procedural/interpretative guidance. I focus my empirical tests on SOP 91-1, as opposed to these later SOPs, because SOP 91-1 marked standard setters' initial attempt to codify software revenue recognition issues and had relatively more significant and pervasive impacts. In addition, among all these SOPs, only SOP 91-1 required retroactive application, which allows me to ex post differentiate firms that employed early revenue recognition prior to SOP 91-1 from those that did not. As discussed in Section 3, such differentiation is critical for my empirical tests.

3. Sample and descriptive statistics

SOP 91-1 was effective for financial statements issued after March 15, 1992. Accordingly, I obtain an initial sample of 240 firms from the software industry (SIC 7370–7374) for which 1991 quarterly revenue information is available in Compustat and daily stock price and return information is available in CRSP. I next retrieve 1991–1993 annual reports or 10-K forms of these firms from Lexis-Nexis in order to

[3]The recently issued SAB 101 does not apply to software transactions to the extent that "the transaction is within the scope of specific authoritative literature that provides revenue recognition guidance" (SEC, 1999). Further, the provisions in SAB 101 are largely consistent with those in SOP 97-2 and its amendments.

identify the effects of adopting SOP 91-1. One hundred and thirty-seven distinct firms have at least one annual report or 10-K form available during this period. Five firms are deleted because they were not engaged in software business. Sixty of the remaining firms directly reported the time, nature, and/or effects of adopting the SOP. For the other 72 firms, I require that financial statements are available for each fiscal year during 1991–1993. This requirement ensures that no firm's revenue recognition policy is misclassified (discussed below) only because its financial statement disclosing the effects of adopting the SOP is not included in Lexis-Nexis.[4] Ten firms were deleted because of this requirement, yielding a smaller final sample of 122 firms.[5]

I classify the 122 firms into two groups—*EARLY* and *CONTROL*—depending on the cumulative adjustment, if any, made upon adopting SOP 91-1. Twenty-nine firms (24% of the sample), including *Group 1 Software* and *Oracle*, reported negative cumulative adjustment, indicating that they had previously applied early revenue recognition and had to change their revenue recognition policies upon adopting the SOP. Thus, these firms are assigned to the *EARLY* group. The remaining 93 firms, including *Microsoft* and *Adobe*, disclosed no material impact from adopting the SOP and are assigned to the *CONTROL* group. No firms in the sample reported positive cumulative effects.

Table 1 summarizes the time, nature, and cumulative effects of adopting the SOP for the 29 *EARLY* firms. Panel A indicates that nine firms adopted the SOP in fiscal 1991. Sixteen firms adopted it in fiscal 1992 and four in fiscal 1993. Panel B reports that upon adopting SOP 91-1, 13 firms had to defer part of the license revenue while 20 had to defer part of the PCS revenue.[6] Half of the 20 firms affected by the PCS provisions also disclosed that they had to "unbundle" PCS revenue from license revenue. The appendix reprints the SOP 91-1-related disclosures by three *EARLY* firms, demonstrating the nature of different types of effects. The magnitude of the cumulative adjustment to retained earnings, summarized in Panel C, ranges from \$70,000 to more than \$240 million, with a mean of more than \$18 million and a median of \$2.7 million. Expressed as a percentage of total assets at the end of the adoption year, the cumulative adjustment ranges from less than 1% to almost 28%, with a mean of about 7.5% and a median of 6%.[7]

[4]For example, if an *EARLY* firm disclosed the effects of adopting SOP 91-1 in its 1992 annual report but Lexis-Nexis did not cover the firm until 1993, without this requirement, one would erroneously classify this firm as a *CONTROL* firm.

[5]The primary reason of the drop in sample size is the limited coverage by Lexis-Nexis during my sample period. Further analysis reveals that firms that dropped out of my sample were generally smaller and less profitable than the firms in my sample. Thus, my sample is biased toward larger/profitable firms and the results should be interpreted accordingly.

[6]One firm did not disclose the nature of the accounting change. Five firms had to defer part of both license revenue and PCS revenue.

[7]Note that the cumulative effects in Panel C are in terms of earnings. SOP 91-1 did not require disclosure of cumulative effects on revenue, which are expected to be larger by an order-of-magnitude. With firm-specific gross margin ratios in the adoption year and an assumed marginal tax rate of 35%, the cumulative effects on revenue is estimated to range between \$0.18 million to \$1,390 million (1–64% of total assets), with a mean effect of \$83 million (18% of total assets).

Table 1
Description of the effects of adopting SOP 91-1: 29 *EARLY* firms

Panel A: year of adoption	
1991	9
1992	16
1993	4
Panel B: nature of the effects	
License revenue deferred	13
PCS revenue deferred	20
PCS revenue unbundled from license revenue	10

Panel C: magnitude of the effects[a]

	Magnitude of the cumulative effects of SOP 91-1 adoption	As a percentage of total assets at the end of adoption year (%)
Mean	$18.722 mill.	7.47
Std. dev.	48.025	6.55
Minimum	0.072	0.41
25 percentile	1.003	1.92
Median	2.679	5.97
75 percentile	10.928	10.45
Maximum	242.658	27.81

[a]The (negative) cumulative effects of adopting SOP 91-1 represent the cumulative effects of applying the provisions of SOP 91-1 on retained earnings.

The sample period is from 1987 to 1997. I start at 1987 because my analyses require information from the statements of cash flows, which became available in 1987 under the Statement of Financial Accounting Standards 95 (FASB, 1987). I stop at 1997 to ensure that, given the rule changes introduced by SOP 97-2 and its amendments, the post-SOP firm-quarters have consistent definition of revenues, thereby increasing the power of my tests.

For all *EARLY* firms, I am able to identify the specific quarter in which the firm first adopted SOP 91-1. I specify all quarters before that quarter as the ''pre-SOP'' period and all quarters after as the ''post-SOP'' period. The adoption quarter is excluded because accounting information for that quarter includes both operating results and the cumulative effects of the accounting change. For *CONTROL* firms, however, the information about adoption is limited. The 93 firms' disclosures about SOP 91-1 are of the following three types: (1) ''the effect of adopting SOP 91-1 in the fiscal year was not material;'' (2) ''our revenue recognition policy is in conformity with SOP 91-1;'' and (3) there is no specific reference to SOP 91-1. For type (1), I am able to identify the year of adoption. Since no adoption-year information is available for types (2) and (3), I use fiscal 1992 as the adoption year.[8] For the *CONTROL*

[8]Since SOP 91-1 had no material effect on *CONTROL* firms, exact identification of ''pre-SOP'' and ''post-SOP'' periods is not as critical as for the *EARLY* firms. Nonetheless, I conduct sensitivity analysis by excluding fiscal 1991 and 1992 observations of these firms. My inferences are not affected.

firms, I classify quarters prior to the adoption year as the "pre-SOP" period and quarters during and after the adoption year as the "post-SOP" period.

Other financial accounting information is obtained from Compustat unless otherwise indicated, and stock information is obtained from CRSP. I use quarterly data for my primary analyses because the effects of differences in revenue recognition timing are expected to be more salient over shorter reporting cycles. Using quarterly data, however, has some drawbacks. My sample firms are likely subject to seasonality.[9] In addition, prior research shows differences between accruals during the fourth quarter and the other three quarters (e.g., Hayn and Watts, 1997). I control for these effects in my empirical analyses.

To mitigate survival bias, I do not restrict my sample to only those firms with all 1987–1997 data. Panel A of Table 2 presents the number of firms in each of the sample years. Although the number of distinct firms changes over the sample period, the proportional composition of the two groups of firms remains relatively constant.

Panel B of Table 2 provides descriptive statistics of three sets of constructs that prior research suggests affect accounting choices: size, growth, and performance (e.g., Watts and Zimmerman, 1986).[10] I focus on these constructs because they are also expected to affect the attributes of reported revenue that I examine. To the extent that they differ systematically between the *EARLY* and *CONTROL* firms, appropriate control is warranted in my tests.

In terms of size, which I measure using both total assets and market capitalization, *EARLY* firms are generally smaller than *CONTROL* firms in the pre-SOP period, but they become larger than *CONTROL* firms post-SOP. This evidence suggests that *EARLY* firms are probably younger, growth firms. The mean of book-to-market ratio, a proxy for growth, however, is not significantly different between the two groups of firms in either period. Untabulated results also reveal that *EARLY* firms do not have significantly younger age, calculated as the number of years of the firm being listed on an exchange as of year 1992, or significantly higher compounded annual growth rate of sales than their counterparts.

To further investigate the reasons for the fast growth in size of the *EARLY* firms, I obtain information of all equity and debt issuance by the sample firms during my sample period from the SDC database. Although the difference is not statistically significant in either period, it suggests that post-SOP, *EARLY* firms are more likely to externally raise capital than *CONTROL* firms, vis-à-vis pre-SOP. This evidence implies that the larger size of *EARLY* firms post-SOP is more likely due to external financing than to internal growth.

Finally, among the performance measures, returns on assets and market returns generally do not differ significantly between the two groups of firms in either period. Sales deflated by total assets (i.e., assets turnover), however, is significantly smaller for *EARLY* firms than for *CONTROL* firms in both periods, suggesting the *EARLY*

[9]An analysis of variance (ANOVA) indicates that quarter is a significant effect in explaining revenue, after controlling for firm effect.

[10]To the extent that certain variables such as revenue are "contaminated" by early revenue recognition of the *EARLY* firms pre-SOP, the descriptive statistics should be interpreted with caution.

Table 2
Descriptive statistics of select variables of the sample during 1987–1997

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Panel A: number of sample firms by year[a]											
EARLY (%)	24 (24%)	26 (25%)	28 (24%)	29 (24%)	29 (24%)	28 (24%)	27 (23%)	26 (23%)	23 (23%)	21 (23%)	21 (24%)
CONTROL (%)	74 (76%)	79 (75%)	87 (76%)	93 (76%)	93 (76%)	89 (76%)	89 (77%)	88 (77%)	78 (77%)	71 (77%)	66 (76%)
TOTAL (100%)	98	105	115	122	122	117	116	114	101	92	87
Panel B: descriptive statistics[b,c,d]											
	Mean				Median						
	Pre-SOP		Post-SOP		Pre-SOP		Post-SOP				
	CONTROL	EARLY	CONTROL	EARLY	CONTROL	EARLY	CONTROL	EARLY			
SIZE											
TA($mill.)	276.851	125.498	444.842	441.198	53.879	41.817	90.763	116.975			
	(0.01)		(0.94)		(0.00)		(0.01)				
MV($mill.)	313.893	245.304	1389.670	1604.880	63.767	57.385	147.959	210.567			
	(0.05)		(0.43)		(0.36)		(0.02)				
GROWTH											
BM	0.633	0.603	0.373	0.388	0.507	0.474	0.337	0.286			
	(0.24)		(0.70)		(0.16)		(0.00)				
CAPRAISE	0.366	0.276	0.182	0.333	0	0	0	0			
	(0.38)		(0.15)		(0.38)		(0.15)				
PERFORMANCE											
ROA	0.013	0.013	0.004	0.004	0.017	0.016	0.018	0.015			
	(0.92)		(0.82)		(0.78)		(0.02)				
RAWRET	0.044	0.054	0.072	0.066	0.013	0.035	0.045	0.059			
	(0.53)		(0.63)		(0.30)		(0.68)				
AssetTurnover	0.355	0.289	0.369	0.279	0.312	0.268	0.329	0.264			
	(0.00)		(0.00)		(0.00)		(0.00)				

[a]Panel A presents number of distinct *EARLY* firms and *CONTROL* firms in each fiscal year during the sample period 1987–1997.

[b]Panel B presents descriptive statistics of the following variables. *TA* is total assets at the end of the fiscal quarter. *MV* is market value of equity at the end of the fiscal quarter. *BM* is book-to-market ratio, measured at the end of the fiscal quarter. *CAPRAISE* is an indicator variable that equals 1 if a firm issued equity or debt securities during the specific period (i.e., pre-SOP and post-SOP, respectively) and 0 otherwise. *ROA* is net income deflated by average total assets during the fiscal quarter. *RAWRET* is raw return during the fiscal quarter. *AssetTurnover* is sales revenue deflated by average total assets during the fiscal quarter.

[c]Numbers in parentheses are two-sided *p*-values. For means, the *p*-values are from *t*-tests; for medians, the *p*-values are from Wilcoxon tests.

[d]For *EARLY* firms, "pre-SOP" period includes quarters before the adoption quarter; "post-SOP" period includes quarters after the adoption quarter. For *CONTROL* firms, "pre-SOP" period includes quarters before the adoption year; "post-SOP" period includes quarters during and after the adoption year. If the adoption year is not disclosed (*CONTROL* firms only), I set it as 1992. There are 4,467 firm-quarters.

firms might have adopted early revenue recognition to boost their sales performances.

In summary, while *EARLY* firms do not seem to be significantly different from *CONTROL* firms for most of the variables examined, there is some evidence that *EARLY* firms are smaller and growth firms. Since size and growth are expected to affect some of the revenue attributes that I examine, I control for them in the corresponding tests. In addition, as discussed later, I also control for other variables that are expected to affect revenue attributes but may not have necessarily motivated the revenue recognition policies.

4. Timeliness of reported revenue

4.1. Hypothesis development and research design

SFAC No. 6 states that "the goal of accrual accounting is to account in the periods in which they occur for the effects on an entity of transactions and other events and circumstances, to the extent that those financial effects are recognizable and measurable" (FASB, 1985, para. 145). This statement indicates standard setters' emphasis on both relevance and reliability of accounting information. However, there is a trade-off between relevance and reliability. Relevance may suffer when an accounting method is changed to gain reliability, and vice versa (FASB, 1980, para. 90). In this paper, I examine different aspects of both relevance and reliability in the context of software revenue recognition and provide evidence of the trade-off between these two objectives of financial accounting. In this section, I investigate the effect of early revenue recognition on the timeliness, an important aspect of relevance, of reported revenue.

The FASB defines timeliness as "having information available to a decision maker before it loses its capacity to influence decisions" and considers timeliness critical for information to be relevant (FASB, 1980). In the software industry, since early revenue recognition has higher capacity to influence decisions by providing more timely information, it is expected to increase timeliness, and hence relevance, of reported revenue. Accordingly, my first hypothesis, in alternative form, is:

Hypothesis 1. Ceteris paribus, reported revenue under early revenue recognition is more timely in providing economic information than that under SOP 91-1.

I measure timeliness of revenue by the extent to which revenue contemporaneously captures economic events reflected in stock returns. Specifically, I employ the reverse regression methodology first proposed by Beaver et al. (1980) and applied extensively by others (e.g., Collins and Kothari, 1989). An efficient stock market impounds value-relevant information of economic transactions in a quick and unbiased fashion, thus changes in security prices reflect timely information. Financial accounting, however, often records value-relevant information in a delayed fashion due to emphasis on reliability and conservatism and therefore

reflects both timely and stale information (see, e.g., Ball et al., 2000). Thus, a reverse regression design (i.e., regressing accounting information on stock returns) offers an intuitive and direct way to test the timeliness of accounting information with respect to the information reflected in security prices (e.g., Basu, 1997; Ball et al., 2000).

To investigate the effects of early revenue recognition on the timeliness of reported revenue, I control for other factors that might also affect timeliness. The choice of revenue recognition policy in the pre-SOP period is possibly based on cross-sectional operational characteristics, and both the macro-economy and the software industry experienced significant changes over the two regimes (i.e., pre-SOP and post-SOP). Accordingly, I employ a 2×2 design as in the following pooled regression to control for both effects:

$$\begin{aligned} REV_{it}/P_{it-1} = {} & a + bRET_{it} + cRET_{it} \times EARLY_i + dRET_{it} \times POST_t \\ & + eRET_{it} \times EARLY_i \times POST_t + fEARLY_i \\ & + gPOST_t + \varepsilon_{it}. \end{aligned} \tag{1}$$

The dependent variable is quarterly revenue (*REV*) deflated by the beginning market value of equity (*P*). *RET* is market return adjusted for the CRSP equal-weighted index over the fiscal quarter. *EARLY* is a cross-sectional indicator variable that equals 1 if it is an *EARLY* firm and 0 otherwise. *POST* is a time-series indicator variable that equals 1 for the post-SOP period and 0 otherwise.

Let β_{it} be the reverse regression coefficient on returns for each of the four group-regimes, where *i* indicates *CONTROL* firm (*C*) or *EARLY* firm (*E*) and *t* indicates pre-SOP (*0*) or post-SOP (*1*). As illustrated in Fig. 1, β_{it} can be estimated using the coefficients in model (1). Thus, the two-way difference in β_{it}, which captures the effect of early revenue recognition, can be estimated using the coefficient *e* on the two-way interaction term in model (1). Specifically, the coefficient *e* measures

$$\begin{aligned} REV_{it}/P_{it-1} = {} & a + bRET_{it} + cRET_{it} \times EARLY_i + dRET_{it} \times POST_t \\ & + eRET_{it} \times EARLY_i \times POST_t + fEARLY_i + gPOST_t + \varepsilon_{it} \end{aligned} \tag{1}$$

	Pre-SOP	Post-SOP	Difference
CONTROL firms	$\hat{\beta}_{C0} = b$	$\hat{\beta}_{C1} = b + d$	$\hat{\beta}_{C1} - \hat{\beta}_{C0} = d$
EARLY firms	$\hat{\beta}_{E0} = b + c$	$\hat{\beta}_{E1} = b + c + d + e$	$\hat{\beta}_{E1} - \hat{\beta}_{E0} = d + e$
Difference	$\hat{\beta}_{E0} - \hat{\beta}_{C0} = c$	$\hat{\beta}_{E1} - \hat{\beta}_{C1} = c + e$	e

Fig. 1. Estimation of Reverse Regression Coefficients for *EARLY* and *CONTROL* Firms Before and After SOP 91-1. *Note*: β_{it} represents the reverse regression coefficient on return for each of the four group-regimes, where *i* indicates *CONTROL* firm (*C*) or *EARLY* firm (*E*) and *t* indicates pre-SOP (*0*) or post-SOP (*1*). The Figure shows how the coefficient estimates in model (1) relates to β_{it}. *REV* is sales revenue and *P* is market value of equity. *RET* is market-adjusted return during the quarter. *EARLY* equals 1 for *EARLY* firms and 0 for *CONTROL* firms. *POST* equals 1 if after adoption of SOP 91-1 and 0 if before.

the change from pre-SOP to post-SOP in the contemporaneous revenue-return correlation of the *EARLY* firms relative to the *CONTROL* firms. It is negatively related to the effect of early revenue recognition, and thus is the focus of the test.

A conceptual issue that arises in model (1) is that it relates returns to revenue. A return-revenue association is not readily derived from theory, unlike a return-earnings association. I do not investigate the return-earnings association because of my specific interest in revenue and also because of the improper matching between revenue and expenses (e.g., software development costs) in the software industry (Morris, 1992). It is possible, however, to specify a return-revenue relation from an underlying return-earnings relation, $RET = f(EARN)$, by noting that revenue (*REV*) and earnings (*EARN*) are linked by the profit margin ratio *PM*, i.e., $EARN = REV \times PM$. Thus, it follows that $RET = f(REV \times PM)$, and in a reverse regression, that $REV = f(RET \times 1/PM)$. Therefore, I control for the reciprocal of profit margin, *RPM* (i.e., $1/PM$) and interact it with the return variable.

Model (1) controls for purely cross-sectional differences between the two groups of firms and purely time-series changes over the two regimes. However, it is also important to control for factors that could affect the revenue-return association and that might change both cross-sectionally and over time. Prior studies show that the association between accounting information and stock returns is a function of firm-characteristics including risk, growth, persistence of accounting information, and size (e.g., Freeman, 1987; Collins and Kothari, 1989; Easton and Zmijewski, 1989). In addition, the results in Basu (1997) suggest that the association between earnings and stock returns varies with the nature of the news (i.e., ''good'' news or ''bad'' news) implicit in stock returns. These variables can change both cross-sectionally and over time. I explicitly control for these factors as in the following model:

$$\begin{aligned} REV_{it}/P_{it-1} = {} & a + bRET_{it} + cRET_{it} \times EARLY_i + dRET_{it} \times POST_t \\ & + eRET_{it} \times EARLY_i \times POST_t + fRET_{it} \times RPM_{it} \\ & + gRET_{it} \times BETA_{it} + hRET_{it} \times MB_{it} + iRET_{it} \\ & \times PERSIST_{it} + jRET_{it} \times SIZE_{it} + kRET_{it} \times NEGRET_{it} \\ & + lEARLY_i + mPOST_t + nRPM_{it} + oBETA_{it} + pMB_{it} \\ & + qPERSIST_{it} + rSIZE_{it} + sNEGRET_{it} + \varepsilon_{it}. \end{aligned} \tag{2}$$

Following Collins and Kothari (1989), I proxy for risk by systematic risk estimated through the market model over the year ending the day before the start of the relevant fiscal quarter (*BETA*), growth by market-to-book ratio at the beginning of quarter (*MB*), persistence by coefficient ϕ in the seasonal ARIMA (autoregressive integrated moving average) model $REV_t - REV_{t-4} = \phi(REV_{t-1} - REV_{t-5}) + \varepsilon_t - \theta\varepsilon_{t-4}$ (Brown and Rozeff, 1979) estimated for pre- and post-SOP periods separately at the firm level with at least 12 observations (*PERSIST*), and size by market capitalization at the beginning of the quarter (*SIZE*). Cready et al. (2001) suggest one should use binary variable interactions in such multivariate reverse regressions

as applied by Collins and Kothari (1989). Accordingly, I code each of these control variables as a binary variable that equals 1 if its value is above sample median of the fiscal quarter and 0 otherwise. Finally, as in Basu (1997), *NEGRET* equals 1 if *RET* is negative and 0 otherwise. All other variables are as defined in model (1). As discussed earlier, *e*, the coefficient of the two-way interaction, is of special interest in testing Hypothesis 1. If early revenue recognition leads to more timely revenue information, I predict $e < 0$.

4.2. Evidence

Panel A of Table 3 presents the OLS estimation of model (2) with and without control variables, respectively. I estimate each specification after deleting observations with absolute studentized residuals greater than 2 (SAS Institute, 1989, p. 418). Consistent with prediction, the estimates of *e*, at −0.193 and −0.159, are significantly negative at the 0.01 level or better. This result suggests that the *EARLY* firms experienced a significant drop in the contemporaneous revenue-return association vis-à-vis *CONTROL* firms after adopting SOP 91-1, which in turn suggests early revenue recognition increases the timeliness of reported revenue.[11]

Panel A also displays coefficient estimates for the control variables in model (2b). Consistent with expectations, *RPM* has a positive effect, and *MB*, *PERSIST*, and *SIZE* have negative effects, on the revenue-return association, although the effect of *SIZE* is insignificant. The coefficient on the interaction term of *BETA* with *RET* is insignificantly negative. In contrast to Basu (1997), the interaction term of *NEGRET* with *RET* is significantly negative.[12]

Panel B summarizes the reverse regression coefficients for each of the four group-regimes, calculated based on the OLS estimates of model (2) and the scheme in Fig. 1. After controlling for various factors, *CONTROL* firms had a reverse regression coefficient of 0.238 prior to the SOP, which increased to 0.299 in the post-SOP period. In contrast, *EARLY* firms' reverse regression coefficient dropped significantly from 0.321 to 0.223. On the other hand, pre-SOP, *EARLY* firms' reverse regression coefficient was significantly higher than that of *CONTROL* firms, while post-SOP, *EARLY* firms had a significantly lower reverse regression coefficient than *CONTROL* firms.

[11] I also examine the association between reported revenue and lagged returns RET_{t-1}. If SOP 91-1 decreases the contemporaneous revenue-returns association for *EARLY* firms, it is also expected to increase the lagged association for these firms. The result without the control variables is consistent with this expectation, providing additional support to Hypothesis 1. The result with the control variables, however, shows that while the two-way interaction term with concurrent returns remains significant, that with the lagged returns becomes insignificant.

[12] There could be several reasons for this result. First, the result in Basu (1997) may apply to earnings but not revenue. Second, the Basu result applies to a large pooled cross-sectional and time-series sample, while mine is a small sample of software companies, which could have systematic differences from Basu's sample. Finally, my model has several other variables in the regression. It is difficult to predict how this could affect the coefficient.

Table 3
Tests of the timeliness of reported revenue[a,b]

Panel A: regression estimation[c]

$$REV_{it}/P_{it-1} = a + bRET_{it} + cRET_{it} \times EARLY_i + dRET_{it} \times POST_t + eRET_{it} \times EARLY_i \times POST_t + fRET_{it} \times RPM_{it} + gRET_{it} \times BETA_{it} + hRET_{it} \times MB_{it} + iRET_{it} \times PERSIST_{it} + jRET_{it} \times SIZE_{it} + kRET_{it} \times NEGRET_{it} + lEARLY_i + mPOST_t + nRPM_{it} + oBETA_{it} + pMB_{it} + qPERSIST_{it} + rSIZE_{it} + sNEGRET_{it} + \varepsilon_{it}, \quad (2)$$

	Predicted sign	Model (2a)	Model (2b)
# Obs. (firm-quarter)		4,346	3,241
INTERCEPT		0.355	0.480
		(0.00)	(0.00)
RET	+	−0.003	0.238
		(0.90)	(0.00)
RET × EARLY	±	0.094	0.083
		(0.06)	(0.08)
RET × POST	±	0.166	0.061
		(0.00)	(0.05)
RET × EARLY × POST	−	**−0.193**	**−0.159**
		(0.01)	**(0.01)**
RET × RPM	+		0.001
			(0.00)
RET × BETA	+		−0.006
			(0.82)
RET × MB	−		−0.051
			(0.08)
RET × PERSIST	−		−0.096
			(0.00)
RET × SIZE	−		−0.003
			(0.92)
RET × NEGRET	+		−0.135
			(0.00)
EARLY	±	−0.097	−0.073
		(0.00)	(0.00)
POST	±	−0.060	−0.090
		(0.00)	(0.00)
RPM	±		0.000
			(0.00)
BETA	±		−0.046
			(0.00)
MB	±		−0.177
			(0.00)
PERSIST	±		0.019
			(0.01)
SIZE	±		−0.087
			(0.00)
NEGRET	±		0.031
			(0.00)
Adjusted R^2		5.44%	38.87%
F-test (p-value)		42.64 (0.00)	115.45 (0.00)

Table 3 (*continued*)

Panel B: summary of reverse regression coefficient estimates for the 2 × 2 matrix[d]

	Pre-SOP	Post-SOP	Difference
Model (2a)			
CONTROL firms	−0.003	0.163	0.166
	(0.90)	(0.00)	(0.00)
EARLY firms	0.091	0.064	−0.027
	(0.03)	(0.00)	(0.66)
Difference	0.094	−0.099	**−0.193**
	(0.06)	(0.04)	**(0.01)**
Model (2b)			
CONTROL firms	0.238	0.299	0.061
	(0.00)	(0.00)	(0.05)
EARLY firms	0.321	0.223	−0.098
	(0.00)	(0.00)	(0.07)
Difference	0.083	−0.075	**−0.159**
	(0.08)	(0.06)	**(0.01)**

[a]Variables definitions: *REV* is sales revenue and *P* is market value of equity. *RET* is market-adjusted return during the quarter. *EARLY* equals 1 for *EARLY* firms and 0 for *CONTROL* firms. *POST* equals 1 if after adoption of SOP 91-1 and 0 if before. *RPM* is the reciprocal of profit margin, where profit margin is calculated as the operating income deflated by sales revenue; *BETA* is the systematic risk of market model estimated over the year ending the day before the start of the relevant fiscal quarter; *MB* is the market to book value of equity ratio at the beginning of quarter; *PERSIST* is based on persistence coefficient ϕ in a seasonal ARIMA model $REV_t - REV_{t-4} = \phi(REV_{t-1} - REV_{t-5}) + \varepsilon_t - \theta\varepsilon_{t-4}$ (Brown and Rozeff, 1979) estimated for pre-SOP and post-SOP periods, respectively, at firm level; and *SIZE* is the market capitalization at the beginning of quarter. I code each of the control variables as a binary variable that equals 1 if its value is above sample median for the fiscal quarter and 0 otherwise. *NEGRET* equals 1 if *RET* is negative and 0 otherwise.

[b]Model (2a) is the full model without any controls. Model (2b) is the full model. Both regressions are estimated after deletion of observations with absolute studentized residual greater than 2. Sample period is 1987–1997. Numbers in parentheses are two-sided *p*-values.

[c]Panel A presents the OLS coefficient estimates for models (2a) and (2b), respectively.

[d]Panel B presents the 2 × 2 matrix of the reverse regression coefficient on RET_{it} based on the OLS estimates of model (2) and the scheme in Fig. 1. The *p*-values are calculated using the covariance matrix estimates from the corresponding model.

In summary, evidence in this section suggests that early revenue recognition increases the timeliness, and hence relevance, of reported revenue in capturing the underlying economic events. This result is robust to controlling for variables that prior research suggests affect the contemporaneous association between stock returns and accounting information.[13]

[13]The results are also robust to various alternative specifications of model (2) including using raw returns for *RET* or using continuous values for the control variables. I also re-estimate the model without *PERSIST* which limits the number of observations in the regression, and get qualitatively similar results. Finally, the inferences remain unchanged when I use a generalized method of moments as described in Newey and West (1987) to control for serially correlated and heteroskedastic errors.

5. Estimation error in accounts receivable accruals

5.1. Hypothesis development and research design

While timeliness is a desirable property of accounting information, increased relevance through greater timeliness may entail a trade-off of other objectives of accounting such as reliability. In the case of the software industry, while early revenue recognition increases the timeliness, it also increases uncertainty of reported revenue. For example, customers' acceptance, commitment to pay, and/or needs for customization may change before or upon delivery of the software or rendering of the service, but these changes may not be foreseen at the time of contract signing or otherwise earlier than as specified in SOP 91-1. Consequently, early revenue recognition results in higher uncertainty (at the time of revenue recognition) about the amount of the revenue that will be realized as cash flows in the future, which increases estimation errors in reported revenue and accounts receivable accruals. In this section, I focus on the estimation errors in accounts receivable accruals and specifically examine how the accounts receivable accruals map into future cash flow realizations. My second hypothesis, in alternative form, is:

Hypothesis 2. Ceteris paribus, the accounts receivable accruals under early revenue recognition map into cash flow realizations ex post to a lesser degree than those under SOP 91-1.

I test this hypothesis by focusing on the standard deviations of residuals from a regression of accounts receivable accruals on corresponding cash flow realizations, a method similar to that in Dechow and Dichev (2002). While revenue recognition can involve both accounts receivable accruals and unearned revenue accruals, I focus specifically on accounts receivable accruals for two reasons. First, early revenue recognition involving accounts receivable accruals were one of the major reasons that led to SOP 91-1. Standard setters were particularly concerned by software firms' premature recognition of revenues and accounts receivables at contract signing for licensing and/or PCS transactions. Indeed, for both types of transactions, SOP 91-1 emphasized that no revenue and hence accounts receivables can be recognized unless collectibility is probable (see also, Morris, 1992) and provided specific guidance on how accounts receivables may be reported. Second, while the Dechow and Dichev model detects estimation errors in accruals where opening accruals precede cash flows, it is not able to detect estimation errors in accruals such as unearned revenues where cash has been received in advance but the vendor subsequently fails to deliver the product or provide the service (see Appendix A of Dechow and Dichev, 2002, pp. 54–56, for a detailed discussion).

Accounts receivable accruals are expected to be realized in either the current or future periods. An important step in applying the Dechow and Dichev model is specifying the time lag between the accruals and the corresponding cash flow realizations. Generally, it is reasonable to assume that accounts receivable accruals are realized within one quarter. This assumption, however, is potentially invalid in the current context because the time lag between revenue recognition and

corresponding cash flow realizations is longer under early revenue recognition than it would otherwise be. This is also evidenced by the *EARLY* and *CONTROL* firms' respective average accounts receivable outstanding period of 110 and 80 days. To take this into account, in the following regression I include accounts-receivable-related cash flow realizations up to two quarters into the future (firm subscript suppressed):

$$\Delta AR_t = a + bCASHREV_t^{t-1} + cCASHREV_{t+1}^{t} + dCASHREV_{t+2}^{t} + \varepsilon_t, \qquad (3)$$

where ΔAR_t is change in net accounts receivables in period t and $CASHREV_t^{t'}$ is sales cash collected in period t but recognized as revenue in period t'. As explained in Dechow and Dichev (2002), b is expected to be negative while c and d are expected to be positive.

The operationalization of model (3) is as follows (firm subscript suppressed):

$$\begin{aligned}\Delta AR_t = {} & a + bCASHREV_t + cCASHREV_{t+1} \\ & + dCASHREV_{t+2} + \sum_q e_q QTR_{qt} \times CASHREV_t \\ & + \sum_q f_q QTR_{qt} \times CASHREV_{t+1} \\ & + \sum_q g_q QTR_{qt} \times CASHREV_{t+2} + \varepsilon_t. \end{aligned} \qquad (4)$$

Following Dechow and Dichev (2002), I use $CASHREV_t$, i.e., sales cash collected during period t (that is not associated with unearned revenue), as a proxy for $CASHREV_t^{t'}$, since $CASHREV_t^{t'}$ is not directly observable. I calculate $CASHREV_t$ as sales minus increases in net accounts receivables excluding provisions as reported in the statement of cash flows (Collins and Hribar, 2002).[14] QTR_q's are indicator variables for quarters 2–4. I allow different coefficients for each of the four quarters in a fiscal year to account for seasonality and the different accrual patterns in fourth quarters (Hayn and Watts, 1997). As in Dechow and Dichev (2002), I deflate the accruals and cash flow variables by average total assets of quarter t. To allow sufficient degree of freedom, I estimate model (4) for each group-regime.

Following Dechow and Dichev, I measure the estimation errors in accounts receivable accruals using $sresid_{it}$, the firm-regime-specific standard deviation of the residuals from estimating model (4). The higher *sresid* is, the less reliable the accounts receivable accruals are in estimating future cash flows from the receivables.[15]

[14]Some firms do not show provisions separately in the statement of cash flows, which introduces measurement error in my estimate of $CASHREV_t$. I rerun the analyses with only the firm-quarters that disclose this information separately. The results are qualitatively similar to those reported.

[15]The ability of the residuals to capture the true estimation errors in accounts receivable accruals depends on the appropriateness of model specifications, such as number of lags included or potential omitted correlated variables, and on the validity of certain assumptions, such as parameter stability within each group-regime or the independence between estimation errors and the cash flow variables.

The residuals from the regression capture the part in accounts receivable accruals that is unrelated to cash flow realizations. Dechow and Dichev (2002) assume the estimation errors in accounting accruals are independent of each other and of the cash flow realizations. McNichols (2002) suggests that the assumption is plausible when the focus is total (as opposed to discretionary) accruals, but less likely for estimation errors caused by management discretion. To the extent that early revenue recognition is due to management discretion, the assumption of independence is potentially violated for *EARLY* firms in the pre-SOP period. This effect, however, would lead to underestimated *sresid* for those firm-regimes, which works against finding the expected results.

To formally test Hypothesis 2, I use the 2×2 research design as in the case of timeliness and estimate the following model:

$$sresid_{it} = b + cEARLY_i + dPOST_t + eEARLY_i \times POST_t + fSIZE_i + gSTDAR_{it} + \varepsilon_{it}. \quad (5)$$

EARLY and *POST* are as defined in Section 4 and *sresid* is defined above. *SIZE* is an indicator variable that equals 1 if the firm's market capitalization at the end of 1991 is higher than the sample median and 0 otherwise. I control for size because larger firms have more stable and predictable operations and therefore smaller estimation errors in accruals (Dechow and Dichev, 2002) and the analyses in Table 2 show that size is different between the *EARLY* and *CONTROL* firms. *STDAR* is the standard deviation of ΔAR deflated by average total assets for pre- and post-SOP, respectively. I include this variable because *sresid*, the standard deviation of the residuals from model (4), depends on the standard deviation of the corresponding dependent variable. Hypothesis 2 implies that early revenue recognition increases *sresid*, which predicts $e < 0$.

5.2. Evidence

Panel A of Table 4 provides descriptive statistics of the firm-regime-specific *sresid* estimated from model (4). In general, *sresid* is higher for *EARLY* firms than for *CONTROL* firms prior to SOP 91-1. This pattern reverses post-SOP, with the *EARLY* firms' *sresid* showing a considerable decrease and the *CONTROL* firms' *sresid* showing an increase.

As in the timeliness test, I estimate model (5) after deleting observations with absolute studentized residuals greater than 2. Results of the OLS regression estimations, with and without control variables, are presented in Panel B of Table 4, with the 2×2 matrix in Panel C. The coefficients of the two-way interaction term, at -0.010 and -0.005, are significant at the 0.05 level or better, indicating that *sresid* dropped for *EARLY* firms after SOP 91-1 relative to for *CONTROL* firms. This in turn suggests that early revenue recognition decreases the extent to which accounts receivable accruals map into cash flow realizations ex post. The magnitude of the

coefficient on the interaction term also suggests that on average, early revenue recognition increases the estimation errors in accounts receivable accruals by about 0.5–1% of total assets, depending on the model specification. Regarding the control

Table 4
Tests of the estimation error in accounts receivable accruals

Panel A: estimation of Model (4)[a]

$$\Delta AR_t = a + bCASHREV_t + cCASHREV_{t+1} + dCASHREV_{t+2} + \sum_q e_q QTR_{qt} \times CASHREV_t + \sum_q f_q QTR_{qt} \times CASHREV_{t+1} + \sum_q g_q QTR_{qt} \times CASHREV_{t+2} + \varepsilon_t, \quad (4)$$

	Pre-SOP		Post-SOP	
	CONTROL	*EARLY*	*CONTROL*	*EARLY*
Mean	0.031	0.033	0.036	0.027
Std. dev.	0.017	0.011	0.020	0.011
25%	0.018	0.025	0.022	0.019
Median	0.029	0.033	0.031	0.024
75%	0.040	0.041	0.046	0.032

Panel B: estimation of Model (5)[b,c]

$$sresid_{it} = b + cEARLY_i + dPOST_t + eEARLY_i \times POST_t + fSIZE_i + gSTDAR_{it} + \varepsilon_{it}, \quad (5)$$

	Predicted Sign	Model (5a)	Model (5b)
# Obs. (firm-regime)		173	172
INTERCEPT		0.028	0.008
		(0.00)	(0.00)
EARLY	±	0.005	0.002
		(0.12)	(0.21)
POST	±	0.004	0.001
		(0.08)	(0.35)
EARLY × POST	−	**−0.010**	**−0.005**
		(0.04)	**(0.05)**
SIZE	−		−0.002
			(0.11)
STDAR	+		0. 258
			(0.00)
Adjusted R^2		1.29%	80.38%
F-test (p-value)		1.75 (0.15)	141.08 (0.00)

Panel C: summary of sresid estimates for the 2 × 2 matrix[d]

	Pre-SOP	Post-SOP	Difference
Model (5a)			
CONTROL firms	0.028	0.032	0.004
	(0.00)	(0.00)	(0.08)
EARLY firms	0.033	0.027	−0.006
	(0.00)	(0.00)	(0.15)
Difference	0.005	−0.005	**−0.010**
	(0.12)	(0.16)	**(0.04)**
Model (5b)			
CONTROL firms	0.008	0.009	0.001
	(0.00)	(0.00)	(0.35)

Table 4 (*continued*)

EARLY firms	0.010	0.006	−0.004
	(0.00)	(0.00)	(0.08)
Difference	0.002	−0.003	**−0.005**
	(0.21)	(0.12)	**(0.05)**

[a]Panel A presents the descriptive statistics of *sresid* estimated from model (4). ΔAR is change in net accounts receivable in the quarter. *CASHREV* is calculated as revenue adjusted for change in net accounts receivable excluding provisions for doubtful accounts. Accrual and cash flow variables are deflated by average total assets in the quarter. QTR_q's are indicators for quarters 2, 3, and 4. The model is estimated for each group-regime. *sresid* is the firm-regime-specific standard deviation of the residuals calculated with at least eight observations.

[b]Model (5a) is the full model without any controls. Model (5b) is the full model. *SIZE* is an indicator variable that equals 1 if the firm's market capitalization at the end of 1991 is higher than the sample median and 0 otherwise. *STDAR* is the standard deviation of ΔAR deflated by average total assets for pre- and post-SOP, respectively. See notes to Table 3 for definitions of other variables. Both regressions are estimated after deletion of observations with absolute studentized residual greater than 2. Sample period is 1987–1997. Numbers in parentheses are two-sided *p*-values.

[c]Panel B presents the OLS coefficient estimates for models (5a) and (5b), respectively.

[d]Panel C presents the 2×2 matrix of *sresid* based on the OLS estimates of model (5) and the scheme in Fig. 1. The *p*-values are calculated using the covariance matrix estimates from the corresponding model.

variables in model (5b), *SIZE* has an insignificant coefficient, and *STDAR* has a significantly positive coefficient as expected.[16]

The 2×2 matrix in Panel C of Table 4 shows that based on model (5b) with the control variables, *sresid* of *EARLY* firms, but not that of *CONTROL* firms, dropped significantly after the SOP. The cross-sectional differences are not significantly different in either period.

Finally, further analyses show that pre-SOP, in comparison to *CONTROL* firms, *EARLY* firms had higher write-offs of accounts receivables, obtained in the "Valuation and Qualifying Accounts" schedule in the 10-K forms, deflated by sales, suggesting that accounts receivable accrual is an upward biased estimate of the cash eventually collected. A *t*-test of this difference is statistically significant at the 0.05 level. Post-SOP, however, the difference does not seem to attenuate rapidly, although the significance level is only at 0.10 level and the difference is on a steadily decreasing trend.

Overall, this section presents results consistent with the notion that early revenue recognition results in accounts receivable accruals that have higher estimation errors. This result suggests that early revenue recognition decreases the reliability of revenue-related accounting information.

[16]Using the Newey and West (1987) method to estimate model (5) yields qualitatively similar results to those reported in Table 4.

6. Time-series predictability of reported revenue

6.1. Hypothesis development and research design

In this section, I examine the time-series predictability of reported revenue, which represents an earnings quality construct according to Schipper and Vincent (2003). Section 5 presents evidence that early revenue recognition results in higher estimation errors in accounts receivable accruals and hence lower quality of reported revenue. The higher estimation error is expected to lower the time-series predictability of reported revenue for early revenue recognition. In addition, under SOP 91-1, PCS revenue is recognized ratably, which should "smooth" reported revenue. Such smoothing is also expected to increase the time-series predictability for *EARLY* firms post-SOP. Consequently, my third hypothesis, stated in alternative form, is:

Hypothesis 3. Ceteris paribus, the time-series predictability of reported revenue under early revenue recognition is lower than that under SOP 91-1.

To test Hypothesis 3, I focus on the absolute forecast error based on the Foster (1977) model, i.e., autoregressive model in seasonal differences (firm subscript suppressed):

$$REV_t - REV_{t-4} = a + b(REV_{t-1} - REV_{t-5}) + \varepsilon_t, \tag{6}$$

where *REV* is quarterly revenue. At least 12, but no more than 20 historical observations are required to estimate the model for each firm-quarter. To ensure that the change in revenue recognition policy does not contaminate the model estimation for the post-SOP period, I use revenue information in the post-SOP period only to estimate the model for post-SOP quarters. I then forecast revenue on a rolling basis using the estimated model (6). I measure predictability by deflated absolute forecast error *DAFE*, with the deflator being total assets at the beginning of the quarter (i.e., $DAFE_t = \left|REV_t - \hat{REV}_t\right| / TA_{t-1}$).

I formally test Hypothesis 3 as follows, using the 2×2 design discussed earlier:

$$\begin{aligned} DAFE_{it} = {} & b + cEARLY_i + dPOST_t + eEARLY_i \times POST_t \\ & + fSIZE_{it} + gREVVOL_{it} + \sum_y h_y YR_{yt} + \varepsilon_{it}. \end{aligned} \tag{7}$$

DAFE is defined above. *REVVOL* is firm-regime-specific volatility in revenue, measured as the standard deviation of revenue deflated by average total assets for pre- and post-SOP, respectively. *YR*'s are year indicators, which allow different predictability in different years. All other variables are as defined in Section 4. In light of the evidence shown in Table 2, I explicitly control for size because prior research suggests that larger firms exhibit more stable and less volatile growth patterns, and hence higher time-series predictability in their accounting information (Bathke et al., 1989). I control for revenue volatility because higher volatility is

expected to decrease the time-series predictability of revenue. Hypothesis 3 predicts that early revenue recognition decreases time-series predictability and increases forecast error, implying $e<0$ in model (7).

6.2. Evidence

Panel A of Table 5 presents descriptive statistics of the deflated absolute forecast errors, *DAFE*. Prior to SOP 91-1, *DAFE* are generally higher for *EARLY* firms than

Table 5
Tests of the time-series predictability of reported revenue

Panel A: descriptive statistics of deflated absolute forecast error (DAFE)[a]

	Pre-SOP		Post-SOP	
	CONTROL	EARLY	CONTROL	EARLY
Mean	0.035	0.040	0.055	0.030
Std. dev.	0.038	0.064	0.084	0.039
25%	0.009	0.012	0.011	0.008
Median	0.024	0.027	0.028	0.022
75%	0.046	0.048	0.060	0.038

Panel B: model estimation[b,c]

$$DAFE_{it} = b + cEARLY_i + dPOST_t + eEARLY_i \times POST_t + fSIZE_{it} + gREVVOL_{it} + \sum_y h_y YR_{yt} + \varepsilon_{it}, \quad (7)$$

	Predicted sign	Model (7a)	Model (7b)
# Obs. (firm-quarter)		2,006	1,991
INTERCEPT		0.032	0.024
		(0.00)	(0.00)
EARLY	±	0.000	0.002
		(0.83)	(0.32)
POST	±	0.005	−0.000
		(0.00)	(0.88)
EARLY × POST	−	**−0.011**	**−0.009**
		(0.00)	**(0.01)**
SIZE	−		−0.008
			(0.00)
REVVOL	+		0.259
			(0.00)
Adjusted R^2		0.71%	13.02%
F-test (*p*-value)		5.80 (0.00)	23.91 (0.00)

Panel C: summary of DAFE estimates in the 2 × 2 matrix[d]

	Pre-SOP	Post-SOP	Difference
Model (7a)			
CONTROL firms	0.032	0.037	0.005
	(0.00)	(0.00)	(0.00)

Table 5 (*continued*)

EARLY firms	0.032	0.027	−0.006
	(0.00)	(0.00)	(0.07)
Difference	0.000	−0.011	**−0.011**
	(0.83)	(0.00)	**(0.00)**
Model (7b)			
CONTROL firms	0.024	0.024	−0.000
	(0.00)	(0.00)	(0.88)
EARLY firms	0.026	0.017	−0.009
	(0.00)	(0.00)	(0.01)
Difference	0.002	−0.007	**−0.009**
	(0.32)	(0.02)	**(0.01)**

[a]Panel A presents the descriptive statistics of the deflated absolute forecast error *DAFE*, based on the Foster (1977) model, i.e., the autoregressive model in seasonal differences, $REV_t - REV_{t-4} = a + b(REV_{t-1} - REV_{t-5}) + \varepsilon_t$, where REV_t is sales revenue for period t. The model is estimated using firm-specific historical data for each firm-quarter. At least 12 (but no more than 20) historical time-series observations are required to estimate the model for each quarter. Only revenue information in the post-SOP period is used to obtain forecast for the post-SOP revenues. *DAFE* is calculated as the absolute difference between the actual value and the predicted value of revenue, deflated by the average total assets in the quarter.

[b]Model (7a) is the full model without any controls. Model (7b) is the full model. *REVVOL* is volatility in revenue, measured as the standard deviations of quarterly revenue deflated by average total assets for pre- and post-SOP, respectively. *YR*'s are year indicators. See notes to Table 3 for definitions of other variables. Both regressions are estimated after deletion of observations with absolute studentized residual greater than 2. Sample period is 1987–1997. Numbers in parentheses are two-sided *p*-values.

[c]Panel B presents the OLS coefficient estimates for models (7a) and (7b), respectively. For model (7b), the estimates for terms related to the year-indicators are suppressed.

[d]Panel C presents the 2×2 matrix of *DAFE* based on the OLS estimates of model (7) and the scheme in Fig. 1. The *p*-values are calculated using the covariance matrix estimates from the corresponding model.

for *CONTROL* firms. Post SOP, however, *CONTROL* firms experienced an increase in *DAFE*, suggesting that changes in macro-economic or industry-wide factors such as growth or economic volatility decreased the time-series predictability. Despite this, *EARLY* firms' average *DAFE* decreased from 0.040 to 0.030. This is consistent with the prediction that early revenue recognition decreases the time-series predictability of reported revenue.

Again, I estimate model (7) after deleting observations with absolute studentized residuals greater than 2. Panel B of Table 5 displays the OLS coefficient estimates for model (7) with and without control variables, respectively. The coefficients e of the two-way interaction term, at −0.011 and −0.009, are significantly negative at the 0.01 level or better, indicating that adoption of SOP 91-1 decreases *DAFE* and increases time-series predictability of the *EARLY* firms, in comparison to the *CONTROL* firms. The magnitude of the coefficient suggests that on average, early revenue recognition increases the time-series prediction errors in revenue by about 1% of total assets. As expected, *SIZE* has a significantly negative coefficient, and *REVVOL* has a significantly positive coefficient, suggesting larger firms and firms with lower sales volatility have higher time-series predictability of reported revenue.

Finally, the 2×2 matrix in Panel C of Table 5 shows that after controlling for other variables in model (7b), *EARLY* firms' *DAFE*, but not *CONTROL* firms', dropped significantly from the pre- to the post-SOP period.[17]

Overall, Table 5 provides empirical evidence that the adoption of SOP 91-1 increased the time-series predictability of *EARLY* firms' revenue. This result is robust to alternative specifications and controls for firm size and revenue volatility.

7. Concluding remarks

This study examines the effects of early revenue recognition on attributes of reported revenue, using a unique setting in the early 1990s from the promulgation of SOP 91-1 in the software industry. I find that early recognition yields more timely revenue information, as evidenced by higher contemporaneous correlation with information impounded in stock returns. However, such early revenue recognition decreases the extent to which accounts receivable accruals map into cash flow realizations ex post, suggesting greater uncertainty in reported revenue. Early revenue recognition also yields lower time-series predictability of reported revenue. Overall, the results suggest that early revenue recognition makes reported revenue more timely and hence more relevant, but at the cost of lower reliability and lower time-series predictability.

This study makes the following contributions. First, it documents the effects of early revenue recognition on important attributes of reported revenue. Second, it provides empirical evidence of the trade-off between different objectives in financial accounting, particularly relevance and reliability. The study is based on a specific event in a single industry, using a small sample of firms. To the extent that the nature of revenue-generating transactions differs across industries and over time, the results in this paper should be generalized with caution.

Appendix A. Sample disclosures of adoption of SOP 91-1 by *EARLY* firms

A.1. Maintenance/PCS revenue

Computer Associates International Inc. 1992.

On December 12, 1991, the American Institute of Certified Public Accountants issued an SOP on Software Revenue Recognition. As a result of the issuance of this SOP, the Company changed its accounting method effective January 1, 1992, to conform to the requirements therein. Consistent with the SOP, the Company has deferred all maintenance revenue, whether separately priced or bundled with license fee revenue and recognized this revenue ratably over the maintenance period. All

[17]The results are qualitatively similar when I use the Brown and Rozeff (1979) model to estimate *DAFE* or when I estimate model (7) using the Newey and West (1987) method.

periods have been restated to reflect this change. The retroactive application resulted in a decrease in net income of $27 million ($0.15 per share), $29 million ($0.16 per share), and $35 million ($0.19 per share) in 1992, 1991 and 1990, respectively.

A.2. License revenue and maintenance/PCS revenue

System Software Associates Inc. 1992.

In December 1991, the American Institute of Certified Public Accountants (AICPA) issued SOP 91-1 entitled "Software Revenue Recognition." SOP 91-1 mandates the deferral of software revenue until delivery of the underlying software has occurred, in addition to recognizing revenue from maintenance and support services, including such revenue that is contractually bundled with initial licensing fees, ratably over the term of the contract. Historically, the Company recognized software license fees when an agreement was signed and the customer had accepted the product, while revenues from maintenance and HelpLine agreements were recognized on contract anniversary dates. The Company elected early adoption, as allowed, in the first quarter of fiscal 1992, applying the provisions of SOP 91-1 retroactively as required. Accordingly, the consolidated financial statements of prior periods have been restated to reflect the required changes in revenue recognition policies. The restatement had the effect of deferring previously recorded revenues and associated costs to subsequent periods. Deferred periods ranged from typically less than 6 months for software products to twelve months for maintenance and HelpLine agreements. The impact of the restatement was to increase (decrease) net income by approximately $2.0 million, or $0.07 per share in 1992, ($1.3) million, or ($0.05) per share in 1991, and ($7.6) million, or ($.28) per share in 1990.

A.3. License revenue when other significant obligations remain after delivery

Cerner Corp. 1991.

In the fourth quarter of 1991, the Company adopted the provisions of SOP 91-1, "Software Revenue Recognition" for sales of clinical information systems. Pursuant to the provisions of SOP 91-1, financial statements for prior years have been restated to retroactively apply these new accounting principles. The Company recognizes revenue from sales of clinical information systems under SOP 91-1 using a percentage-of-completion method based on meeting key milestone events over the term of the contracts. The Company's revenue recognition from providing support and maintenance of installed clinical information systems was not impacted under the provisions of SOP 91-1. The application of SOP 91-1 resulted in an increase in net earnings of $589,000 ($ 0.17 per share) for 1991, an increase in net earnings of $1,081,000 ($ 0.31 per share) for 1990 and a decrease in net earnings of $1,087,000 ($ 0.29 per share) for 1989. The cumulative effect of applying the provisions of SOP 91-1 as of December 31, 1988, 1989 and 1990 was to decrease retained earnings by $1,381,000, $2,468,000 and $1,387,000, respectively.

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