Matching and the changing properties of accounting earnings over the last 40 years

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Abstract: We present a theory that poor matching manifests as noise in the economic relation of advancing expenses to earn revenues. As a result, poor matching decreases the correlation between contemporaneous revenues and expenses, increases earnings volatility, decreases earnings persistence, and induces a negative autocorrelation in earnings changes. The empirical tests document these effects in a sample of the 1,000 largest U.S. firms over the last 40 years. We find a clear and economically substantial trend of declining contemporaneous correlation between revenues and expenses, increased volatility of earnings, declining persistence of earnings, and increased negative autocorrelation in earnings changes. The combined evidence suggests that accounting matching has become worse over time and that this trend has a pronounced effect on the properties of the resulting earnings. This evidence also suggests that the standard setters' stated goal of moving away from matching and towards more fair-value accounting is likely to continue and deepen the identified trends in the properties of earnings.

Keywords: matching principle; fair-value accounting; earnings properties.

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I. Introduction

This study investigates the effects of poor matching on the properties of accounting earnings over the last 40 years. This topic is interesting for three reasons. First, earnings is the single most important output of the accounting system (Graham, Harvey, and Rajgopal 2005) and the matching of expenses to revenues has great impact on the determination of earnings. Therefore, an inquiry into matching could potentially provide valuable insights into the properties of accounting earnings. Second, since the late 1970's accounting standards have taken a deliberate and far-reaching turn away from matching as the fundamental concept in the determination of earnings and towards a more balance sheet-based model of the determination of income. It is important to document and assess the consequences of this evolution for the properties of earnings. Third, changes in the real economy towards more fixed costs and R&D-type activities also imply a temporal decline in matching success, with corresponding effects on the properties of earnings. The temporal confluence of economic and accounting factors suggests there could be substantial changes in the properties of earnings over time, and it is important to document the economic magnitude of these changes.

The main ideas of the paper are formalized in a simple model of matching, where accounting earnings are shaped by both economic factors and the degree of matching success. The essence of the model is that mismatched expenses act as noise in the economic relation of advancing expenses to earn revenues, and therefore poor matching decreases the contemporaneous correlation between revenues and expenses. As a result, the mismatch between revenues and expenses increases the volatility of earnings, decreases the persistence of earnings, and increases the negative autocorrelation in earnings changes. Since poor matching resolves over time, we expect that the identified effects of poor matching are less pronounced for longer-horizon definitions of earnings.

We examine these predictions in a time-series framework because the evolution of standard setting and the real economy provide strong reasons to believe that matching has become worse over time, and therefore we expect to see detectable effects in the time-series properties of revenues, expenses and earnings. We use a sample of the largest 1,000 firms over the last 40 years, and find that all predictions of the model are borne out in the data. The contemporaneous correlation between revenues and expenses has substantially decreased over time, while the correlation between current revenues and past and future expenses has increased. Earnings volatility has nearly doubled while the underlying volatilities of revenues and expenses have remained roughly the same. Earnings persistence has substantially declined from 0.91 to 0.65 during this period. The reversibility (or autocorrelation) of earnings changes is nearly zero at the beginning and reaches a surprisingly large -0.30 at the end of the period. We find more muted evidence that consideration of longer-horizon earnings attenuates the effects of poor matching, most probably because our longer-horizon specification is limited to two-year definitions of variables.

A battery of additional tests extends and solidifies the main results. First, we find that the same pattern of results exists after controlling for the well-known large temporal increase in the frequency of one-time items and losses. Second, we document that the same pattern of results obtains within industries that either increase or decrease in prominence over time, which suggests that industry composition and, more broadly, the changing characteristics of the sample firms and the real economy are unlikely to fully account for our findings. Third, in contrast to the pronounced temporal patterns in reported accrual-based measures, we find none of those temporal patterns in cash-based measures of revenues, expenses, and earnings. This evidence suggests that changing accounting has much to do with the identified trends in our main results.

These findings have a number of implications and can be a useful guide for further research. On the more immediate and obvious level, these results suggest that a consideration of matching generates useful insights into the properties of earnings, which can be helpful in pursuing topics such as the improved prediction of earnings and accounting-based valuation. For example, one can use historical patterns of correlations between revenues and expenses as a measure of matching success and as a predictor of earnings persistence to pursue quality of earnings investigations, possibly including earnings forecasting and equity valuation.

The results of this study can also be useful for more general and philosophical considerations. For example, if investors use reported earnings primarily to assess firms' long-run profitability, the temporal trends identified in this study suggest that earnings have become considerably less useful in that regard over the last 40 years. In addition, the prevailing philosophy and the specific current agenda of both the FASB and the IASB suggests that this trend is going to continue, and thus a future in which reported earnings have evolved into something which is divorced from their classic role as a gauge of long-term value looks highly probable in the next 30 to 50 years. Such an evolution would likely impose a considerable difficulty and cost on investors, and it is reasonable to suggest that standard setters should more explicitly consider this cost in their deliberations.

The remainder of the paper is organized as follows. Section II presents the theory of the paper. Section III presents the main empirical tests and results. Section IV presents robustness checks and additional results. Section V provides a discussion of the results and suggestions for future research. Section VI concludes.

II. Theory

We develop a simple model of matching that formalizes the link between poor matching and the properties of accounting earnings. It is important to clarify from the beginning that this paper takes a specific perspective on the determination of accounting earnings and that other perspectives are also possible and useful depending on the goals of the investigation. We view the firm as an entity that continually advances expenses hoping to reap revenues and earnings. Thus, firm success is naturally measured by the excess of revenues over the expenses advanced to earn it, and the goal of accounting matching is to explicitly recognize and measure this business reality. Poor matching is defined as the extent to which expenses are not matched against the resulting revenues, and is modeled as noise in the economic relation of advancing expenses to earn revenues.

Note that poor matching can arise for several reasons including unavoidable business factors (e.g., fixed costs, poor traceability of costs), managerial discretion (e.g., taking a big bath), and accounting rules (e.g., R&D is required to be expensed regardless of traceability). In addition, note that accounting practice differentiates between several degrees of matching success, i.e., “direct matching” for costs which are directly and specifically matched to associated revenue (cost of goods sold), "indirect matching" for costs which are matched indirectly by allocating them to periods (depreciation, taxes), and "no matching" or "expense as incurred" for costs where matching considerations are entirely absent (most R&D and advertising). At the theoretical level, we do not make a specific provision for the multitude of sources and manifestations of poor matching to keep things simple and because for our purposes all these aspects of poor matching have similar consequences on the properties of revenues, expenses, and especially earnings. In the empirical tests later in the paper, we provide some evidence on the relative importance of various sources and manifestations of poor matching.

Perfect matching

We start the development of the model with the consideration of a benchmark case of "perfect matching", which is later contrasted with the case of "poor matching". Perfect matching is defined as the situation where all relevant expenses are matched against the associated revenue. In practical terms, perfect matching can be viewed as a case where all costs are directly and specifically traceable to specific revenues, e.g., a firm where the only costs are cost of goods sold and sales commissions. For the purposes of this paper, revenue recognition is largely treated as fixed, and therefore the model treats the schedule of revenues as given and concentrates on the properties of matching and expense recognition. Accounting variables derived under perfect matching are denoted by asterisk (*) throughout the paper. The earnings relations for firms with perfect matching are assumed to be given by the following expressions:

$$E_t^* = Rev_t^* - Exp_t^* \tag{1}$$

$$E_t^* = E_{CC} + \beta_1^*(E_{t-1}^* - E_{CC}) + \varepsilon_t \tag{2}$$

Where E_t denotes earnings at time t, *Rev* and *Exp* denotes revenues and expenses, $0 < \beta_1^* < 1$, and E_{CC} is the earnings which is given by the firm's cost of equity capital, and can be also thought of as the firm's required rate of return and the long-run mean of its earnings. The model assumes that E_{CC} is constant; however, the main conclusions remain the same if E_{CC} is varying over time or across firms.

On one level, equation (1) is simply a statement of the income statement identity, that earnings is the residual of revenues minus all expenses. However, note that E_t^* in (1) captures a notion of economic performance because it summarizes the results of spending Exp_t^* to get Rev_t^*. Thus, E_t^* in (1) is our representation of "economic performance" or "economic earnings." The goal of Equation (2) is to provide a parsimonious representation of the essential time-series features of the economic earnings process. We choose a time-series specification because matching is essentially a time-series phenomenon, where all mismatching of expenses eventually resolves over time. Equation (2) incorporates several realistic and research-vetted time-series features of economic earnings. First, earnings arise in a competitive equilibrium, where long-run earnings tend to gravitate to the cost of equity capital. Second, recent deviations in earnings from the long-run mean tend to persist but gradually diminish over time (Freeman, Ohlson and Penman 1982), so the β_1^* coefficient is positive but less than 1. Third, each period there is an economic shock, which is modeled as a mean-zero white noise. The variance of ε, denoted as $var(\varepsilon)$, is a representation of the "economic volatility" in the firm's business environment.

Note that while the basic model in (2) is presented in a way that clarifies the economic properties of earnings, it can be re-written in a more familiar way as:

$$E_t^* = (1 - \beta_1^*)E_{CC} + \beta_1^* E_{t-1}^* + \varepsilon_t$$

Or, having in mind that E_{CC} and β_1^* are constants, and denoting $\beta_0^* = (1 - \beta_1^*)E_{CC}$ yields:

$$E_t^* = \beta_0^* + \beta_1^* E_{t-1}^* + \varepsilon_t \tag{3}$$

Expression (3) is identical to a regression of present on past earnings, and is later used to establish the links between the quality of matching and earnings persistence.

The benchmark case of perfect matching in expression (3) can be used to establish the link between economic volatility and volatility of earnings. Taking the variance of E_t^* yields:

$$Var(E_t^*) = \beta_1^{*2} Var(E_{t-1}^*) + Var(\varepsilon) \tag{4}$$

The variance of lagged-once earnings is in turn a function of lagged-twice earnings, and so on. Using recursive substitution allows one to reformulate expression (4) to:

$$Var(E_t^*) = Var(\varepsilon)(1 + \beta_1^{*2} + \beta_1^{*4} + \dots) \tag{5}$$ [1]

Expression (5) embodies the intuition that with perfect matching earnings volatility is entirely driven by economic factors. Specifically, the volatility of earnings is increasing in the volatility of economic shocks and in the persistence of these shocks over time.

Poor matching

As discussed earlier, for the purposes of this model revenue recognition is treated as given, and "poor matching" is defined as a method of expense recognition which

[1] This expression can be further simplified assuming that one can take the limit of variance of earnings over time: $\lim\{Var(E_t^*)\} = Var(\varepsilon)/(1 - \beta_1^{*2})$

deviates from the perfect matching case explored above. Specifically, expenses under poor matching (denoted with no asterisk) are modeled as:

$$Exp_t = Exp_t^* + \nu_t \quad (6)$$

Where $\nu_t = \tau_t - \tau_{t-1}$, and τ is a random variable, which is not correlated with *Rev** and *Exp**. Note that the essence of "bad matching" is modeled by two properties of the ν term in (6). First, ν_t is uncorrelated with *Rev** and *Exp** because by definition there is no causal economic relationship between the mismatched expense and the well-matched revenue and expense.[2] In other words, mismatched expenses are modeled as "noise" in the economic relation of advancing expenses to earn revenues. Second, ν_t has a strong negative first-order autocorrelation, which is clear when one considers that $\nu_t = \tau_t - \tau_{t-1}$ and $\nu_{t-1} = \tau_{t-1} - \tau_{t-2}$. The negative autocorrelation in the noise term captures the fact that accounting is self-correcting, and the mismatching of expenses is eventually resolved and corrected through time.[3] The same property also reflects the fact that in the long run the sum of expenses is expected to converge to the same amount, regardless of the expense recognition method employed. Specifically, in (6) all mismatching reversals are assumed to happen within one period of origination. Thus, the essence of expression (6) is that recorded expense (Exp_t) differs from the "perfectly-matched" expense (Exp_t^*) because of currently mismatched expenses (τ_t) and because of the current correction of previously mismatched expenses (τ_{t-1}). It is also clear from (6) that matching becomes worse when

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[2] Note that opportunistic managerial smoothing can create situations where the mismatched expenses are correlated with properly matched revenues, expenses, and earnings. For example, to keep earnings smooth managers may under-accrue some expenses when revenues are low or other expenses are high. This possibility is not modeled explicitly because our main interest is in how the evolution of accounting rules and the nature of the real economy could result in poor matching. Thus, the assumption that the mismatched expense and the well-matched revenue and expense are not correlated seems reasonable.

[3] For example, underestimating warranty expense is an example of bad matching but the underestimation will be corrected when the actual warranty expenditures prove to be higher than the initial underestimated expense.

the τ terms are large, and accordingly for the purposes of this model "quality of matching" is defined as the inverse of the variance of τ.

Note also that the representation in (6) is simple but it captures important aspects of matching and accrual accounting in general while allowing flexibility and imposing few restrictive assumptions. For example, consider that τ is a random variable and can be both positive (overaccrual of expenses) and negative (underaccrual of expenses). The τ variable can also have a non-zero mean implying that this framework can accommodate both systematic conservatism and aggressiveness in financial reporting. To illustrate, aggressive recognition of expenses can be modeled by assuming that τ has a negative mean, and the magnitude of the mean can be calibrated to reflect the degree of aggressiveness in reported numbers. Another example is the assumed horizon of mismatching reversals. The representation in (6) assumes that all mismatching of expenses is resolved within one period. However, this is just a convenience and simplification assumption. The analysis that follows and the conclusions remain virtually the same if the reversals happen over longer horizons.

The effects of poor matching

Using the definitions of perfect and poor matching, we turn to establishing the effects of poor matching. More formally, the effects are given by a series of four observations:

Observation 1: *Poor matching decreases the contemporaneous correlation between revenues and expenses.*

A formal proof is provided in Appendix 1. Intuitively, this observation results from the fact that poor matching "scatters" some of the perfectly matched expenses across periods, and therefore the contemporaneous correlation between observed revenues and expenses is lower than the underlying economic correlation of advancing expenses to produce revenues. Consistent with this intuitive appeal, there is at least one existing study that has used the contemporaneous correlation between revenues and expenses as a measure of matching quality (Sivakumar and Waymire 2003).

Observation 2: *Poor matching increases the volatility of earnings.*

Using (6) and the fact that revenues remain the same under both matching alternatives allows one to derive earnings under bad matching as:

$$E_t = Rev_t^* - Exp_t^* - \nu_t = E_t^* - \tau_t + \tau_{t-1} \qquad (7)$$

Taking the variance of earnings yields:

$$Var(E_t) = Var(E_t^*) + 2Var(\tau) = Var(\varepsilon)(1 + \beta_1^2 + \beta_1^4 + \dots) + 2Var(\tau) \qquad (8)$$

An inspection of expression (8) and a comparison with (5) reveal that poor matching increases the volatility of earnings. Intuitively, earnings with poor matching are more volatile because mismatched expenses acts as noise unrelated to the economic process of generating earnings, and thus mismatched expenses add an extra layer of volatility over and above the unavoidable economics-driven volatility.

Observation 3: *Poor matching decreases the persistence of earnings.*

Persistence of earnings is the slope coefficient from a regression of current earnings on lagged earnings. Recall that the "true relation" under perfect matching is:

$E_t^* = \beta_0^* + \beta_1^* E_{t-1}^* + \varepsilon_t$ (3)

However, under imperfect matching we observe $E_t = E_t^* - \nu_t$ and $E_{t-1} = E_{t-1}^* - \nu_{t-1}$. Substituting, using the fact that $\nu_t = \tau_t - \tau_{t-1}$, and re-arranging obtains:

$$E_t + \nu_t = \beta_0^* + \beta_1^*(E_{t-1} + \nu_{t-1}) + \varepsilon_t$$

$$E_t = \beta_0^* + \beta_1^* E_{t-1} + (\varepsilon_t + \beta_1^* \nu_{t-1} - \nu_t)$$

$$E_t = \beta_0^* + \beta_1^* E_{t-1} + \{\varepsilon_t - \tau_t + (1+ \beta_1^*)\tau_{t-1} - \beta_1^* \tau_{t-2}\} \quad (9)$$

Note that both the third and the fourth term in the error term in (9) are negatively correlated with the regressor E_{t-1} (since $E_{t-1} = E_{t-1}^* - \tau_{t-1} + \tau_{t-2}$), and denote the error term as $\lambda = \varepsilon - \tau_t + (1+ \beta_1^*)\tau_{t-1} - \beta_1^* \tau_{t-2}$. Since the error term is correlated with the independent variable, OLS estimation produces a biased and inconsistent estimate of β_1^*:

$$\beta_1^{OLS} = \beta_1^* + \frac{\sum E_{t-1}^{'} \lambda^{'}}{\sum E_{t-1}^{'2}} \quad (10)$$

An inspection of expression (10) allows one to conclude that poor matching decreases the slope coefficient β_1 since the summation term in the numerator is negative and the negative autocorrelation in the τ terms makes this effect stronger.

Corollary to Observation 3: *Poor matching induces a negative autocorrelation in earnings changes.*

Intuitively, this happens because poor matching introduces noise in the economic relation between revenues and expenses. Since noise has strong negative autocorrelation in changes (pure white noise has an autocorrelation in changes of -0.50), introducing noise means inducing a negative autocorrelation in earnings changes. The formal proof is in Appendix 1. This observation is presented as a corollary because the decreasing persistence of earnings and the increasing negative autocorrelation in earnings changes are really just two sides of the same effect, and one implies the other in our stylized model. We keep them separate to emphasize the point that low persistence in earnings implies high negative autocorrelation in earnings changes, which means that earnings innovations are largely devoid of new information with respect to future earnings realizations.

Observation 4: *The effects of poor matching are alleviated over longer-time horizons.*

The formal proof is in Appendix 1. Intuitively, this happens because accounting is self-correcting and therefore by their nature mismatching errors resolve over longer horizons. For example, assume that there is a substantial amount of mismatching at the level of one-year earnings and that all mismatching resolves within one year. Then, a five-year specification will have relatively much less mismatching because all mismatching errors in the middle three of the five years are resolved and only some of the mismatching errors in the first and the last years remain.

Discussion of the theory and its relation to existing research

The topic of matching has a long history in accounting, and discussions of matching and its importance can be found in a variety of accounting texts, including the classic Paton and Littleton (1940) monograph (hailed as Accounting Book of the Century) and virtually all financial accounting textbooks (e.g., Revsine, Collins, Johnson 2005, pages 41, 46, 51-53). For example, Paton and Littleton refer to matching as “the principal concern” and “the fundamental problem” of accounting. However, there has been little research effort aimed at matching during the last 10 to 20 years. Perhaps one reason for this lack of research is that in earlier years the dominant paradigm of market efficiency implied that the market fully sees through the accounting conventions and complications of measuring firm performance. It is only recently that there has been a renewed interest into “fundamental analysis”, which is the study of whether and how our knowledge of accounting yields superior insights into firm performance and security valuation, e.g., Fairfield, Sweeney, and Yohn (1996), Sloan (1996), Piotroski (2000), Nissim and Penman (2001) and many others; Dechow and Schrand (2004) provides a useful overview of this literature. In the spirit of fundamental analysis, we view the study of matching as a further step into enriching our knowledge about the determination and properties of earnings.

Perhaps another reason for the relative lack of research into matching is the evolution of accounting standards. Early standards recognized the importance of matching on both the conceptual and practical level, e.g., APB 11 used matching as the guiding principle for accounting for income taxes. However, during the last two to three decades the Financial Accounting Standards Board (FASB) has adopted an increasingly balance sheet-based perspective, where the determination of income is viewed more as resulting from revisions of asset and liability values rather than as the residual from revenues and matched expenses (Storey and Storey 1998). Recent examples of a predominantly balance sheet perspective include the accounting for goodwill and other intangible assets in SFAS 142 and the accounting for impairment and disposal of long-term assets in SFAS 144.

There are three strands of recent research which are close to the spirit or the measures of our study. The first strand comprises Su (2005) and the related studies of

Lane and Willet (1999) and Gibbins and Willet (1997). The common thread in these studies is the idea that proper matching of revenues and expenses has a smoothing effect on earnings, which is beneficial in the sense that it allows for better estimation of long-run economic profitability. Our study shares this core intuition about matching but is much different in terms of approach, aims, and empirical analysis. Su (2005) uses a technique called statistical activity cost theory to develop its ideas and relies on computer simulations for its empirical results. We use the language and models of capital market research and rely on actual financial data to draw our conclusions.

Second, a number of existing studies use measures of quality of earnings, which are similar to ours. For example, Francis, LaFond, Olsson, and Schipper (2004) use measures of earnings persistence and earnings smoothness (the reverse of volatility), which closely corresponds to our constructs; in addition, they provide a number of references to other research that uses comparable variables. Thus, our contribution is not so much in advancing the use of these variables but at providing the unifying matching framework for their use, which suggests a different perspective and different ways to utilize them.

A third strand of related research investigates the matching of cash flows and accruals. For example, Dechow (1994) shows that an important function of accruals is to resolve timing and mismatching problems in the underlying cash flows, e.g., the accrual for inventory purchase recognizes that cash spent on inventory does not necessarily lead to loss of firm value. Dechow and Dichev (2002) and Richardson, Soliman, Sloan, and Tuna (2005) argue that accruals alter the timing of the recognition of cash flows into earnings, increasing earnings timeliness and persistence but at the cost of earnings including the noise of unavoidable errors of estimation. Our investigation can be viewed as further development of these themes in the context of matching of revenues and expenses. Later in the paper, we provide some results on the interplay between the matching of revenues and expenses and the matching of cash flows and accruals.

III. Empirical tests

Our empirical tests concentrate on time-series specifications because the evolution of standard setting and the real economy provide strong reasons to believe that matching has become worse over time. As discussed above, in the late 1970s and early 1980s, the FASB started a deliberate and decisive move away from matching and toward embracing a more balance sheet-based accounting. We aim to document the effects of this evolution and discuss its implications with regard to the needs of various users of financial statements. We believe that these results are also helpful as a guide to the future, as the FASB and the IASB seem intent on further expanding and solidifying the balance sheet-based model.

Another factor that likely affects the temporal characteristics of revenues, expenses, and earnings is changes in the real economy. We believe that these changes also work in the direction of finding more poor matching over time, e.g., the general trend of more fixed vs. variable costs over time, the rise of R&D-type activities and more complicated production, marketing and financing arrangements. For the purposes of this paper, we are more interested in documenting the aggregate results from the confluence of these two factors rather than differentiating their relative roles, and therefore our main results do not control for the effects of one versus the other. Specifically, we test whether discernible patterns in the properties of revenues, expenses and especially earnings over time is consistent with the theoretical predictions above. Additional tests later provide some evidence on the differential roles of these two sources in poor matching.

Our focus on time-series tests is a primary determinant in the choice of our sample. A substantial problem with time-series tests, especially over long horizons, is preserving comparability while faced with continual and large fluctuations in available firms due to the addition of new firms, various forms of failure and exit, and the constantly changing relative importance of existing firms. An added problem is uneven firm coverage over time, where existing databases like Compustat have much wider and more complete coverage of firms in later years, which can introduce systematic biases in reported results, e.g., Klein and Marquardt (2006). Our pragmatic solution to these problems is at every point in time in our sample to use the top 1,000 firms in terms of total assets. This definition of the sample ensures that early coverage is similar to late coverage (the largest, most prominent firms), while it reflects the changing nature and prominence of firms as the economy evolves. Later, we present robustness tests which specifically consider and control for the changing sample composition over time.

Table 1 summarizes the remaining specifics of our sample selection. The initial sample is obtained from the Compustat annual industrial database, where the sample is restricted to firms-years with complete data for assets (Compustat item 6), revenues (item 12) and earnings before extraordinary items (item 18) and preceding 9 years of revenues and earnings. Since we use both one-year and two-year (the longer horizon) definitions for our variables, the sample selection criteria are mostly based on two-year availability because the two-year definitions are more restrictive. In order to limit the sample to economically substantial firms, we pick the largest 1,000 firms for each year in the sample where volatility in two-year earnings, volatility in two-year revenues and volatility in two-year expenses are available. As volatility in two-year earnings takes up to 10 years of data to calculate, the final two-year sample starts in 1967 and ends in 2003. To avoid the influence of extreme observations, we delete the top and bottom 1 percent of all two-year variables, including two-year earnings, prior two-year earnings, volatility in two-year earnings, volatility in two-year revenues and volatility in two-year expenses. The final two-year sample consists of 17,788 firm-year observations from 1967 to 2003. To ensure proper comparisons across samples, only firms in the two-year sample are included in the one-year sample. To avoid the influence of extreme observations, we delete the top and bottom 1 percent of all one-year variables, and the final one-year sample consists of 34,785 observations from 1967 to 2003.

Descriptive statistics for the final one-year and two-year samples are presented in Table 2. Variable definition is as follows. Expenses are estimated by taking the difference between revenues and earnings before extraordinary items. Earnings, revenues and expenses are deflated by average assets. Note that deflating by assets largely resolves scale issues, which can be problematic for long-horizon time-series studies. Revenue, expense and earnings volatility are calculated by taking the standard deviation of the deflated variable for the most recent five years. The correlation between revenues and expenses is calculated as the correlation between the deflated revenues and the deflated expenses for the most recent five years. Two-year earnings, revenues and expenses are calculated as the corresponding averages for the current and last-year periods. Accordingly, volatility in two-year earnings, revenues and expenses is calculated by taking the standard deviation of the corresponding two-year variable for the most recent five non-overlapping two-year periods. The correlation between two-year revenues and two-year expenses is calculated as the correlation between two-year revenues and two-year expenses for the most recent five non-overlapping two-year periods. For each year, earnings persistence is the slope coefficients from the regression of current deflated earnings on the previous period earnings on a cross-sectional basis. Autocorrelation in earnings changes is the cross-sectional correlation between current earnings changes and past earnings changes. Earnings persistence and autocorrelation in two-year earnings changes are defined analogously. The descriptive statistics in Table 2 are generally in line with much existing research on comparable samples and variables. For example, the sample-wide persistence of earnings is 0.78, indicating fairly high persistence coupled with mean reversion.

We start with an analysis of the trends in the relation between revenues and expenses. Since matching has likely become worse over time, based on Observation 1 we expect that the correlation between revenues and contemporaneous expenses has become weaker over the last 40 years. We also present results for the correlations between revenues and non-contemporaneous expenses based on the conjecture that poor matching scatters expenses to periods away from their associated revenues, resulting in an increased correlation between revenues and non-contemporaneous expenses. We test these predictions by examining the temporal behavior of coefficients in a regression of revenues on one-year back, present, and one-year forward expenses. The advantage of the multivariate specification is that it controls for the strong autocorrelation in expenses, which is especially important in examining the relation between revenues and non-contemporaneous expenses. In addition, since past, present and future expenses have about the same underlying variation, a comparison of the coefficients produces the same results as a comparison of the (incremental) correlations between revenues and expenses.

The yearly results for the expense coefficients are presented in Table 3, while results smoothed over five years are presented in Figure 1. An examination of Figure 1 reveals clear evidence of the hypothesized relations. The coefficient on present expenses starts at a high and consistent value of slightly over 1 but becomes much lower and more erratic in the second half of the examined period. In terms of numbers, Table 3 reveals that the average is 1.03 for the first half of the sample period but decreases to an average of 0.88 in the second half, for a difference of -0.15, which is highly statistically significant. In contrast, the coefficients for past and future expenses hover at or below zero in the beginning but later visibly increase, in a volatile but unmistakable manner. The increase is especially pronounced for past expenses, where the mean coefficient is 0.007 in the first half of the sample, increasing to 0.101 in the second half, for an increase of 0.094, which is highly statistically significant. The pronounced effect for past expenses is consistent with evidence of increased conservatism over time (Givoly and Hayn 2000), which implies that expenses are increasingly booked before the associated revenue. The increase for future expenses is more modest at 0.055 but is also highly statistically significant. To our knowledge, the relation between current revenues and future expenses has not been documented before. Using the intuition from our model, the possible driving forces for this relation are various underprovisionings of current expenses, which trigger a catch-up effect later. For example, understating necessary depreciation expense today maps into an asset impairment later or underprovisioning for current warranty or bad debt expense (driven by current revenue) triggers catch-up provisions in subsequent periods.

Next, we turn to documenting the effect of poor matching on earnings volatility. From Observation 2 and the conjecture that matching has become worse over time, we expect to see that earnings volatility has increased over time. To reflect the fact that earnings volatility arises from the volatility of the underlying fundamentals in addition to poor matching, we also include accompanying results for revenues and expenses. Specifically, since earnings is equal to revenues minus expenses, the volatility of earnings is equal to the volatility of revenues plus volatility of expenses, adjusted for the correlation between revenues and expenses, so we include the data for all these variables. The value of this analysis is that (as discussed above) the correlation between revenues and expenses reflects the quality of matching, while the volatilities of revenues and expenses can be thought of as capturing the volatility of the underlying business fundamentals, and thus one can assess whether the increase in earnings volatility is due to increase in the volatility of fundamentals.

Table 4, Panel A contains the results for the one-year specification, providing mean values for each year in the sample and t-tests for differences in means between the first and second half of the sample period. These results are also graphically depicted in Figure 2A, where all values are normalized to a beginning value of 100 and smoothed over five years to enhance comparability. An inspection of Figure 2 and Table 4 reveals that earnings volatility has substantially increased over the last four decades, and that this increase is highly statistically significant. The inspection also reveals that the increase in earnings volatility cannot be attributed to increase in the volatility of fundamentals because there is no increase (and an actual slight decrease) in the volatilities of revenues and expenses. In contrast, there is a material and highly statistically significant decrease in the correlation of revenues and expenses over time. The joint consideration of these two results implies that the trend of increasing earnings volatility over time is entirely due to poor matching.[4]

Note that the results for increasing volatility of earnings are not new. Givoly and Hayn (2000) find a great temporal increase in earnings volatility, interpreting it as due to the increase in reporting conservatism over time. While our interpretation is based on temporal deterioration of the matching process, it is useful to point out that these two perspectives share much of the same underlying process. In essence, conservatism can be viewed as a form of "poor matching", where the expenses precede the associated revenues. Thus, these two interpretations are often just two different lenses through which to view the same effects, and whether one adopts one versus the other partly depends on the goals and the particular needs of the user. We adopt the matching lens because it has not been explored before and because it allows us to offer insights unavailable from the existing conservatism perspective. For example, the matching perspective allows a clear explanation for the substantial increase in the correlation between current revenues and *future* expenses, which is the opposite of what increasing conservatism would predict.

[4] Note that whether one takes increased volatility as a sign of higher or lower earnings quality partly depends on the setting and the goals of the investigation. Leuz, Nanda, and Wysocki (2003) posit that higher earnings volatility indicates excessive smoothing, and therefore lower earnings quality. However, the Leuz, Nanda, and Wysocki perspective seems less relevant in our aggregate time-series setting. The reason is that a number of studies have documented a decline in the quality of earnings over time (e.g., Collins, Maydew, and Weiss 1997), while other studies have documented a steady increase in the volatility of earnings (e.g., Givoly and Hayn 2000); the combination of these two findings is at odds with the Leuz, Nanda, and Wysocki story.

As an aside, note that the results in Figure 1 and Table 3 essentially offer an interesting new measure of conservatism. They suggest that the extent to which "expenses lead revenues" can be used as a natural and practical measure of conservatism. This measure looks natural because recognizing expenses before their associated revenues seems to capture the very essence of conservatism, at least in its income statement implications. It is also practical because the specification in Table 3 is easy to replicate and adapt to a host of other settings, where the magnitude of the coefficient on "expenses lead revenues" is the quantitative measure of degree of conservatism. This new measure could be useful to other research, given the recent surge of interest in this area, and the limitation of some existing measures of conservatism, especially market-based specifications, e.g., Dietrich, Mueller, and Riedl (2007).

Table 4 Panel B presents the corresponding volatility results for the two-year specifications of all variables. From Observation 4 and the intuition that the effects of poor matching resolve over time, we expect that the temporal patterns of increased volatility of earnings and decreased contemporaneous correlation between revenues and expenses are less-pronounced for the two-year specifications. This expectation is partially borne out in the data. The decline in the correlation between revenues and expenses in Panel B is only half of that in Panel A, and this difference is significant at the 0.001 level based on bootstrap tests as in Noreen (1989).[5] Thus, there is clear evidence that the decline in the quality of matching is less pronounced for longer-horizon definitions. The

[5] The bootstrap tests are only a minor part of our analysis, so a complete exposition and explanation of these tests is omitted here, see "approximate randomization" in Noreen (1989) for more detail. The basic idea is that by randomly shuffling the time vectors of observed correlations, one can obtain the distribution of differences under the null hypothesis that the difference is purely due to chance, and then the comparison of the actual observed value of the difference vs. the simulated null distribution provides the test of statistical significance.

increase in volatility of earnings is also smaller for Panel B as compared to that in Panel A but in this case the difference is minimal (0.006 vs. 0.007) and not statistically significant (bootstrap p-value = 0.240). The most likely reason for the minimal difference in volatility is that our longer horizon is only two years. Thus, the included two-year results should be more properly considered as the lower limit on how the consideration of longer-horizon variables attenuates the effects of poor matching.[6]

The results for persistence of earnings and autocorrelation in earnings changes are presented in Figure 3 and Table 5, including one-year and two-year specifications. Based on Observation 3 and its Corollary, we expect that earnings persistence has declined over time and that the autocorrelation in earnings changes has become more negative. An informal inspection of the smoothed one-year results in Figure 3A reveals a clear support for this conjecture, with steady downward drift in both variables over time. The numerical results and tests in Panel A in Table 5 also confirm this pattern. The mean earnings persistence over the first half of the sample period is 0.855, while it is only 0.705 over the second half of the sample, for a difference of -0.15, which is highly statistically significant. The mean autocorrelation in earnings changes is only -0.019 in the first half but becomes -0.234 in the second half, for a difference of -0.215, which is highly statistically significant.

We aim to provide some additional feel for the economic importance of these results by using a regression of the yearly earnings persistence and autocorrelation variables on an ordinal time variable, where the calendar year is replaced by its time rank

[6] We also investigated a four-year and a quarterly specification to vary the relative horizon of the examined effects but eventually had to abandon these specifications because they led to unacceptable loss in comparability in our setting. The four-year specification and the need for five periods to calculate volatilities leads to losing half of our time series. For the quarterly specification, the difficulty is in substantial and varying differences in the properties of fourth quarter vs. the other quarters' variables.

(e.g., the first year 1967 is 0 and the last year 2003 is 36). The regression results in Panel B of Table 5 confirm that earnings persistence is declining over time, with a negative and highly significant coefficient on the time variable. More relevant in terms of economic importance, the regression reveals an adjusted R^2 of 0.54, which suggests that this downward trend is the defining feature of the evolution of earnings persistence over time, accounting for more than half of its time-series variation. The fitted value for earnings persistence for the first year of the sample (1967) is 0.91 and the corresponding number for the last year is 0.65, which reveals an economically substantial decline in earnings persistence over the last four decades.[7] We repeat the same regression analysis for the autocorrelation in earnings changes. The R^2 is 0.39, which suggests that more than a third of the total temporal variation in the autocorrelation variable is due to its secular decline over time. The fitted value for the first year is 0.053 and the one for the last year is -0.299. Thus, while the beginning value is close to zero, by the end of the sample, earnings exhibits economically strong reversal in changes, where nearly a third of the typical change is immediately reversed in the next period.

The two-year results in Figure 3 and Table 5 provide further evidence whether the effects of poor matching are alleviated for longer-horizon variables. An informal inspection and comparison of Figures 3A and 3B indicates that this is likely the case because the pronounced downward drifts in Figure 3A are attenuated in Figure 3B. Turning to the numbers in Panel C of Table 5, we find further support for this conjecture. The difference in means between the first half and the second half of the sample is -0.111

[7] We use the fitted values because, assuming that the fitted line is "correct", the fitted values are a better representative of the "true" relation. In any case, an inspection of the actual values in Panel A of Table 5 reveals pretty much the same impression in terms of magnitude of the decline, if anything, the actual difference between the first and the last year is 0.29, which is larger than the fitted difference of 0.26.

for the two year specification as compared to -0.150 in Panel A, and this attenuation is marginally significant (bootstrap p-value = 0.09). The results are much more emphatic for the autocorrelation in earnings changes, where the time-series difference in means in Panel C is only -0.058 as compared to -0.215 in Panel A, an attenuation which is both statistically and economically significant with a bootstrap p-value of 0.001. As already discussed, this pattern of attenuation in two-year results should be probably thought of as a lower limit on how the effects of poor matching are attenuated in longer-horizon specifications of variables.

IV. Robustness checks and additional results

The main results above provide strong evidence that there have been substantial changes in the properties of accounting earnings over the last 40 years. In this section we provide a number of additional tests, which serve as robustness checks and also offer evidence about the relative importance of the economic and accounting causes of this phenomenon.

First, we investigate the effect of one-time items and losses. A variety of one-time items have proliferated in frequency and magnitude over the last 30 years (e.g., Collins, Maydew and Weiss 1997 and Bradshaw and Sloan 2002), and this trend could provide an alternative explanation for some (but not all) of our results. For example, the proliferation of one-time items can potentially account for the decrease in the correlation between contemporaneous revenues and expenses, the increase in earnings volatility, and the decrease in earnings persistence (although it cannot explain the increased correlation between revenues and non-contemporaneous expenses and the lack of meaningful increase in the volatility of expenses). However, the analysis of one-time items has to be done with caution because the proliferation of one-time items is itself a prime manifestation of the deterioration of matching over time. Most one-time items arise because of various asset revaluations or "unusual" charges, which indicate an economic or rules-imposed lack of relation between revenues and expenses. Thus, a simple elimination of one-time items is objectionable because it is akin to "throwing out the baby with the bathwater" effect.

We address this problem in a pragmatic manner, where we re-run our main tests with expenses and earnings excluding one-time items while we emphasize that these results should be more properly viewed as an illustration for how much of the effects are concentrated in one-time items rather than as whether one-time items "explain" the main results in the paper. Operationally, one-time item is defined as Compustat item 17. We find that the exclusion of one-time items leads to qualitatively similar results. Specifically, the elimination of special items reduces the magnitude of the temporal differences to about half of their original values but these differences remain economically and statistically significant. For example, in the regression of revenues on expenses, the mean slope coefficient on contemporary expenses declines from 1.067 to 0.986 over the two subsample periods, and the difference is highly significant (p-value = 0.001). Mean earnings volatility increases from 0.014 to 0.019 over the two subsample periods, and this difference is also statistically significant (p-value = 0.001). The rest of the results excluding one-time items show the same pattern; the magnitude of the temporal effects is attenuated but they remain sizable and statistically significant.

A separate investigation checks for the previously documented effect of rising incidence of losses over time (e.g., Hayn 1995). Similar to special items, on one hand, the increasing incidence of losses could account for some of the documented patterns; on the other hand, the rising incidence of losses is itself a manifestation of worse matching, and thus, the interpretation of such tests and results has to be done with caution. Preliminary results confirm that our sample is generally less affected by loss-related effects because it comprises the largest firms, while loss incidence is heavily concentrated in small firms. In terms of actual results, the elimination of losses leads to a material attenuation of the documented pattern, although the attenuation is somewhat smaller than that for one-time items. Again, all main results remain statistically and economically significant.

Second, we investigate the effect of changing industry composition on our results, where industry composition can be viewed as a broad proxy for the changing nature of the economy and the firms over time. For example, if firms in certain industries tend to have more volatile and less persistent earnings, and these industries are becoming more prominent over time, this could account for our results even if there is no *within-industry* change in the properties of earnings. This concern seems warranted given the large changes in industry composition in our sample over time, as illustrated in Table 6. In Table 6, we use Fama and French's 12-industry-group classification (obtained from http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html), and list industry firm count as of the first and last sample year, 1967 and 2003 respectively. An examination of Table 6 reveals dramatic temporal changes in industry composition, e.g., Consumer Nondurables decreases from 13.75% to 5.46% of the sample, Manufacturing decreases from 26.99% to 11.54% of the sample, while Finance increases from 2.31% to 19.52% of the sample.

We investigate the effects of changing industry composition by re-running the main tests within two subsamples, one comprising industries that have increasing firm count over time and the other comprising industries that have decreasing firm count. The increasing subsample accounts for 29% of the firms at the beginning of the sample and 59% at the end, with the decreasing sub-sample accounting for 71% and 41% respectively. If changing industry composition fully accounts for the documented results, we expect to see substantial differences in average results *across* the two subsamples but little temporal variation in within-sample results. The actual results show the opposite pattern. We find that in all tests the results across the two subsamples show the same temporal patterns as the main tests above, i.e., decreasing correlation between sales and expenses, increasing volatility and decreasing persistence of earnings. For parsimony, we omit most of the actual results and only offer Figure 4 as an illustration of the tenor of the results. Figure 4 corresponds to Figure 1 in the main results, only here the coefficients in regression of revenues on past, current and future expenses are plotted for the two subsamples ("Decreasing" and "Increasing"). The figure clearly demonstrates the similarity of results across the two subsamples, and statistical tests confirm at high levels of confidence that for both samples there are substantial declines in the correlation between revenues and contemporaneous expenses and substantial increases in the correlations between revenues and past and future expenses (actual results not tabulated). Additional tests reveal that the results are largely the same for industries, whose membership in the sample remains relatively constant (e.g., utilities, energy, and wholesale, retail and some services). This evidence implies that industry composition and, more broadly, the evolution of the real economy are unlikely to fully account for the documented patterns in earnings.

Third, we provide further evidence on the relative role of accounting and real economy factors on the observed temporal patterns in reported revenues, expenses and earnings by examining the temporal properties of *cash-based* measures of revenues, expenses, and earnings. If the real economy is the primary determinant of our main results, then one would expect to see similar patterns in cash-based measures, which are unaffected by the accrual process. Our measure of cash-based revenues is revenue minus changes in accounts receivable plus changes in deferred revenue, our measure of cash-based earnings is cash flow from operations (CFO), and cash expenses is defined as the difference between cash-based revenues and CFO. We use the balance-sheet method of deriving cash flow from operations, as in Sloan (1996), because our sample stretches considerably before 1988, when precise measures of cash flows from operations become available.

An examination of the cash-based results reveals none of the temporal trends identified in accrual-based results. For parsimony, we present only a subset of the complete results in Figure 5. Panel A of Figure 5 presents the coefficients from a regression of current cash revenues on past, present, and future cash expenses, and represents the cash counterpart of the accrual-based results in Figure 1. In contrast to the patterns in Figure 1, the coefficient on current cash expenses substantially rises over time and the coefficients on past and future cash expenses fall over time, and the mean difference on current cash expenses across the two sub-sample periods is statistically significant at the 0.001 level. This result indicates that, if anything, the documented patterns in Figure 1 likely understate the temporal deterioration in accounting matching. Panel B of Figure 5 presents the persistence in CFO and the autocorrelation CFO changes over time, the cash counterpart of Figure 3. Consistent with Dechow (1994), a comparison between Figure 3 and Panel B of Figure 5 reveals that CFO has lower persistence and higher autocorrelation in changes than accrual-based earnings. However, this comparison also reveals dramatic differences in the temporal pattern of these two measures of performance. In contrast to Figure 3, the persistence of CFO and the autocorrelation of CFO changes remain largely the same over time. Specifically, the mean persistence of CFO is 0.440 and 0.472 for the two sub-sample periods, and the difference is not statistically significant (p-value = 0.359). Note also, that while in the beginning of the period the persistence of earnings is much larger than that of CFO (about 0.90 vs. 0.45), by the end of the period this difference (about 0.65 vs. 0.50) is eroded by two-thirds. Similar conclusions apply for the autocorrelation in CFO changes vs. the autocorrelation in earnings changes. The combined impression from this evidence is that changes in the real economy play only a secondary role in explaining the changing properties of earnings over time.

In additional tests, we use the Richardson, Sloan, Soliman, and Tuna (2005) accrual framework to split revenues and expenses into their cash and accrual components, and explore which of the interactions between these component variables is the chief driver of the documented decreased correlation between total revenues and expenses. We find that most of the pairwise correlations between the cash and accrual components decline over time but find little reliable evidence of a dominant pair (actual results not included). Perhaps our most useful finding is that the correlation between the cash components of revenues and expenses is much higher than the correlation between the accrual components of revenues and expenses, while the variations in accrual revenues/total revenues and accrual expenses/total expenses have both increased substantially over time. Essentially, these results imply that revenues and expense determination today relies much more on accruals than in the past, while accrual components have lower correlation, driving the correlation between total revenues and expenses down. Further tests split the accrual component of expenses into working capital, long-term operating, and financing accruals and search for the differential roles of these components in explaining the observed relations. The results indicate that the variations in all of these accruals have increased over time but failed to uncover meaningful differences in their relative roles.

Finally, we re-run the main tests within treciles of accrual quality. Our motivation is that if accounting-related factors play a role in the temporal evolution of earnings characteristics, we would find more pronounced results for firms where the quality of accruals and earnings is low because these firms are likely to be more affected by the general trend of deteriorating matching quality as compared to firms that have naturally good accrual quality. We use two proxies for accrual quality, absolute level of accruals based on Sloan (1996) and the residual accrual measure from Dechow and Dichev (2002). Since the results across these two measures are similar, we only discuss and present results for the Dechow and Dichev approach. We find that all results are more pronounced for low accrual quality treciles, consistent with our prediction. To avoid clutter, we only present the results for earnings volatility and its components in Figure 6, which contrasts the findings for the top and bottom treciles of accrual quality. An examination of Figure 6 reveals a clear difference in the temporal pattern of the results for these two subsamples. For firms with high accrual quality, the increase in earnings volatility starts late and is more moderate, with mean earnings volatility of 0.010 and 0.011 for the two sub-sample periods, and this difference is not statistically significant (p-value = 0.284). In contrast, for firms with low accrual quality, the increase in earnings volatility starts earlier and is more dramatic, with earnings volatility more than tripling by the end of the period. Mean earnings volatility increases substantially from 0.027 to 0.050 across the two sub-sample periods, and the difference is statistically significant (p-value = 0.001). Thus, these results confirm that accounting-related factors play a substantial role in the temporal trends of earnings characteristics.

Summarizing, the supplemental results are useful on two dimensions. First, they provide assurance that the main results are robust in a number of alternative specifications and relevant sample partitions. Second, the results suggest that accounting-based factors are a substantial and perhaps even primary determinant of the documented temporal patterns of earnings characteristics, while real-economy changes play a secondary role.

V. Discussion of the results and suggestions for future research

On the most immediate and obvious level, the results above serve to illustrate the economic importance of matching considerations for accounting earnings. The results indicate that poor matching leaves a large and perhaps decisive imprint on all key properties of earnings including persistence, volatility, and reversibility of changes.

Since earnings is the most widely used accounting variable, these results suggest that a consideration of matching quality can bring useful insights to users. Note that the empirical analysis in this study is limited to a large-firm time-series specification, while much more can be done exploring cross-sectional specifications. For example, Dichev and Tang (2007) use a matching motivation to link earnings volatility to practical earnings predictability.

The results in this study also seem useful as a plausible explanation for the pronounced temporal decline in the informativeness of earnings, e.g., Collins, Maydew, and Weiss (1997) find that the sensitivity of stock prices to earnings has substantially declined over time and Francis and Schipper (1999) find that the stock return benefits from perfect foreknowledge of earnings have diminished over time. Various explanations for this phenomenon have been advanced, for example, the increased role of technology and the proliferation of transactions and activities, which are difficult to capture in the traditional financial reporting model. However, the success of these explanations has been limited (Francis and Schipper 1999). The results in this study suggest an intuitive alternative story for the decline in the informativeness of earnings. The evidence suggests that matching has become worse over time and earnings have become more volatile and less persistent. Since there is strong evidence that stock prices are less sensitive to less persistent earnings (e.g., Collins and Kothari 1989), there seems to be a natural connection between the temporal declines in the quality of matching and the informativeness of the resulting earnings. Of course, at this point this connection is just a conjecture, which needs to be more carefully evaluated in future research.

Apart from the immediate and more clearly delineated research-related implications, the results of this study provide import for larger and more philosophical themes. For example, the results in this study can be useful in FASB's and IASB's considerations. They show that standard setters' deliberate and far-reaching move away from matching as the foundation of financial reporting and towards a balance sheet-based model has likely had a pronounced effect on the properties of earnings. Of course, whether this effect is considered desirable or undesirable depends on the goals of the financial reporting system, and indeed there are good reasons for why a balance-sheet model may be preferred, e.g., FASB's avowed emphasis on solid conceptual foundations and the demands of auditors and lawyers for verifiable and enforceable claims to asset-based wealth. However, it is important to consider that these gains have been achieved at the expense of the informativeness of earnings, which is still widely considered the most important output of the accounting system, especially for the needs of equity investors (Graham, Harvey, and Rajgopal 2005).

The problem in a nutshell is this. If investors should "buy earnings", as many of the classics in investment advise, then the key value metric is the long-run earnings power of the company. If accounting is dedicated to proper matching, the resulting earnings would be a fairly good representation of the long-run economic success of advancing expenses to produce revenues. Thus, properly matched earnings will have only economics-driven and comparatively little volatility, substantial persistence, and little reversibility in changes. In such a world, current earnings will be the best starting point for the prediction of earnings, and indeed it will be difficult to improve on their predictive ability by using other information. Such a world is far from a fantasy; in fact, the results in this study and other research like Ball and Watts (1972) indicate that real-world earnings had exactly these characteristics in the late 1960's and early 1970's. However, since then the situation has radically changed. Using the results of this study, earnings persistence for the largest 1,000 U.S. firms has declined from 0.91 in 1967 to 0.65 in 2003, a massive, seismic change. If this trend continues unabated for another 30 to 50 years, the persistence and forward-looking informativeness of earnings will be simply destroyed. This seems like a very real possibility considering that the FASB (and to a lesser extent the IASB) has been steadily increasing the scope of its balance-sheet based accounting, most notably with its recent efforts to expand mark-to-market accounting. It is useful to consider that pure mark-to-market accounting produces asset and liability revaluations (or earnings) which are very volatile and have zero persistence, and that such earnings will be of little forward-looking use to investors. At a minimum, it seems that standard setters should give a more explicit consideration to these very real costs of creeping earnings irrelevance in their deliberations about the ultimate scope of balance sheet-based accounting.

Of course, as discussed earlier, the powerful temporal trend of declining informativeness of earnings is probably not only a result of the evolution of standard setting but of changes in the real economy as well, and there is little that financial reporting can do about the nature of these changes *per se*. However, the evidence presented in this study suggests that changes in the real economy have played a secondary role in the evolution of the properties of earnings. In addition, if the question is "What can be done to counter the effect of these changes on the informativeness of earnings?", the answer and the discretion again lie in the design of the financial reporting system.

Whether and when standard setters will take such arguments into consideration is not clear since balance-sheet based accounting has its own considerable momentum now. However, what is safer to say is that the secular decline in the forward-looking informativeness of earnings is a material fact, which will unavoidably bring forth reactions from various users of financial information. Some such reactions are already underway. For example, the proliferation of "pro-forma" earnings in the 1990's can be viewed as a somewhat instinctive and disorderly attempt to provide the important distinction between persistent and recurring components of earnings from sporadic and non-recurring components. It is instructive to consider that even after the recent crackdown on pro-forma earnings and the ensuing greater cost in using them, most preparers and users of financial information have modified but not abandoned their use (Marques 2006). This experience suggests that the use of modified definitions of earnings serves a solid reason and it is here to stay and evolve in spite of chaotic beginnings. This is one place where academic research can make a difference and lead the way, e.g., see Ohlson (2006) for a proposal for a conceptually-sound and practical definition of pro-forma earnings. The evidence in this study also provides some clues about possible alternative definitions of earnings. The evidence on longer-horizon earnings suggests that the consideration of the historical record of earnings is becoming more important than in earlier years when earnings' behavior was close to random walk. The evidence that there is a strong reversibility in earnings changes suggests that various smoothing techniques could be useful in the specification of more informative earnings, a prescription similar in spirit to Ohlson (2006). These and other possibilities await future research.

VI. Summary and conclusion

This study presents a theory of matching and its effects on accounting variables and especially earnings. The principal insight of the theory is that poor matching acts as "noise" in the economic relation of advancing expenses to earn revenues, and thus poor matching decreases the contemporaneous correlation between revenues and expenses. As a result, poor matching increases the volatility of earnings, decreases the persistence of earnings, and induces more negative autocorrelation in earnings changes.

Our empirical results are strongly consistent with the conjecture that matching is becoming worse as a result of the evolution in accounting and the real economy over time. We find a clear decrease in the correlation between contemporaneous revenues and expenses and an increase in the non-contemporaneous correlation between revenues and expenses. The volatility of reported earnings has doubled, while the underlying volatilities of revenues and expenses have remained largely the same. There is a stark decline in the persistence of earnings, where persistence starts at 0.91 at the beginning of our sample and is down to 0.65 by the end. The first-order autocorrelation in earnings changes hovers near zero at the beginning of the sample, and is about -0.30 at the end. In contrast, there is none of these temporal patterns in cash-based measures of revenues, expenses, and earnings.

As discussed at more length in the paper, these results have a number of implications and can serve as a springboard for future research. One implication is that matching considerations have a pronounced effect on the properties of earnings, and one can use quality of matching measures to pursue quality of earnings investigations, possibly including earnings forecasting and equity valuation. Another implication is that standard setters' embrace of a balance sheet-based model of financial reporting has reduced the forward-looking informativeness of earnings, and this presents a real difficulty and cost to many users of financial reports. Lastly, these results imply that the need for more informative earnings is real, and will be growing, so research into various improved re-formulations of earnings is warranted.

Appendix 1

Proof of Observation 1:

The proof for the contemporaneous relation is given by considering the definition of correlation under perfect and poor matching and having in mind that mismatched expenses (τ_t) are uncorrelated with contemporary well-matched revenues and expenses:

Perfect matching: $Corr(Rev_t^*, Exp_t^*) = Cov(Rev_t^*, Exp_t^*)/\{Std(Rev_t^*)*Std(Exp_t^*)\}$

Poor matching: $Corr(Rev_t^*, Exp_t) = Cov(Rev_t^*, Exp_t^* + \nu_t)/$

$\{Std(Rev_t^*)*Std(Exp_t^* + \nu_t)\} = Cov(Rev_t^*, Exp_t^*) / \{Std(Rev_t^*)*Std(Exp_t^* + \nu_t)\}$

Since the numerators are identical and the denominator for bad matching is larger and increasing in the variance of ν, it follows that poor matching decreases the contemporaneous correlation between revenues and expenses.

Proof of Corollary to Observation 3:

The proof for a negative autocorrelation in earnings changes is given by expressing autocorrelation in earnings changes in terms of persistence coefficient.

Perfect matching:

$E_{t+1}^* = \beta_0^* + \beta_1^* E_t^* + \varepsilon_t$

By definition, $\Delta E_{t+1}^* = E_{t+1}^* - E_t^* = \beta_0^* + \beta_1^* E_t^* + \varepsilon_{t+1} - E_t^*$

$= \beta_0^* + (\beta_1^* - 1) E_t^* + \varepsilon_{t+1}$

Similarly, $\Delta E_t^* = E_t^* - E_{t-1}^* = \beta_0^* + (\beta_1^* - 1) E_{t-1}^* + \varepsilon_t$

Autocorrelation $(\Delta E_{t+1}^*, \Delta E_t^*) = Cov(\Delta E_{t+1}^*, \Delta E_t^*) / \{Std(\Delta E_{t+1}^*)*Std(\Delta E_t^*)\}$

$= Cov\{\beta_0^* + (\beta_1^* - 1) E_t^* + \varepsilon_{t+1}, \beta_0^* + (\beta_1^* - 1) E_{t-1}^* + \varepsilon_t\}/\{Std(\Delta E_{t+1}^*)*Std(\Delta E_t^*)\}$

Plug in equation (5) in the body of text: $Var(E_t^*) = Var(\varepsilon)*(1 + \beta_1^{*2} + \beta_1^{*4} + \ldots)$ and $\lim \{Var(E_t^*)\} = Var(\varepsilon) / (1 - \beta_1^{*2})$ into the autocorrelation formula yields:

Autocorrelation $(\Delta E_{t+1}^*, \Delta E_t^*) = \{\beta_1^* (\beta_1^* - 1)^2 *Var(\varepsilon) / (1 - \beta_1^{*2}) + (\beta_1^* - 1)Var(\varepsilon)\} / \{[(\beta_1^* - 1)^2 / (1 - \beta_1^{*2}) + 1] *Var(\varepsilon)\} = (\beta_1^* - 1) / 2$

Given that under perfect matching $E_t^* = \beta_0^* + \beta_1^* E_{t-1}^* + \varepsilon_{t,}$

Autocorrelation $(\Delta E_{t+1}^*, \Delta E_t^*) = (\beta_1^* - 1)/ 2$.

Poor matching:

Given that under poor matching $E_t = \beta_0 + \beta_1 E_{t-1} + \varepsilon_{t,}$

Autocorrelation $(\Delta E_{t+1}, \Delta E_t) = (\beta_1 - 1)/ 2$

From observation 3, persistence coefficient for earnings under poor matching (β_1) is lower than the persistence coefficient for earnings under perfect matching (β_1^*). Based on the relationship between earnings persistence in earnings and the autocorrelation in earnings changes, it follows that the autocorrelation is more negative under poor matching than under perfect matching.

Proof of Observation 4:

The proof that the effects of poor matching are attenuated over longer horizons is given by considering that accounting is self-correcting and therefore by their nature mismatched errors resolve over longer horizons. More specifically, assume mismatched error is corrected in the next period, in an n-year horizon, all mismatched errors in the middle n-2 of the n years are resolved and only some of the mismatched errors in the first and the last years remain.

Let $E(N)$, $REV(N)$ and $EXP(N)$ denote earnings, revenues and expenses over longer horizons, where N >=2. By definition,

Under perfect matching,
$Rev(N)_t^* = 1/N^* \Sigma\ (Rev_t^* + Rev_{t+1}^* \ldots + Rev_{t+N-1}^*)$
$Exp(N)_t^* = 1/N^* \Sigma\ (Exp_t^* + Exp_{t+1}^* \ldots + Exp_{t+N-1}^*)$
$E(N)_t^* = 1/N^* \Sigma\ (E_t^* + E_{t+1}^* \ldots + E_{t+N-1}^*)$

Under poor matching,
$Rev(N)_t = 1/N\ {}^*\Sigma\ (Rev_t^* + Rev_{t+1}^* \ldots + Rev_{t+N-1}^*) = Rev(N)_t^*$
$Exp(N)_t = 1/N^*\ \Sigma(Exp_t + Exp_{t+1} \ldots + Exp_{t+N-1})$
$= 1/N\ {}^*\Sigma(Exp_t^* + \tau_t - \tau_{t-1} + Exp_{t+1}^* + \tau_{t+1} - \tau_t \ldots + Exp_{t+N-1}^* + \tau_{t+N-1} - \tau_{t+N-2})$
$= 1/N\ {}^*\Sigma(Exp_t^* + Exp_{t+1}^* \ldots + Exp_{t+N-1}^* + \tau_{t+N-1} - \tau_{t-1})$
$= 1/N\ {}^*\Sigma(Exp_t^* + Exp_{t+1}^* \ldots + Exp_{t+N-1}^*) + 1/N^*(\tau_{t+N-1} - \tau_{t-1})$
$= Exp(N)_t^* + 1/N^*(\tau_{t+N-1} - \tau_{t-1})$
$E(N)_t = 1/N^*\ \Sigma(E_t + E_{t+1} \ldots + E_{t+N-1})$
$= 1/N\ {}^*\Sigma(E_t^* - \tau_t + \tau_{t-1} + E_{t+1}^* - \tau_{t+1} + \tau_t \ldots + E_{t+N-1}^* - \tau_{t+N-1} + \tau_{t+N-2})$
$= 1/N\ {}^*\Sigma(E_t^* + E_{t+1}^* \ldots + E_{t+N-1}^* - \tau_{t+N-1} + \tau_{t-1})$
$= 1/N\ {}^*\Sigma(E_t^* + E_{t+1}^* \ldots + E_{t+N-1}^*) + 1/N^*(- \tau_{t+N-1} + \tau_{t-1})$
$= E(N)_t^* + 1/N^*(-\tau_{t+N-1} + \tau_{t-1})$

Observation 1: contemporaneous correlation between revenues and expenses

As demonstrated in proof of observation 1, the effect of poor matching on contemporary matching is caused by the larger variance in mismatched expenses and is increasing in the difference between the variance of mismatched expenses and the variance of perfectly matched expenses.

For one-year horizon,
$Var(Exp_t) = Var(Exp_t^* + \tau_t - \tau_{t-1}) = Var(Exp_t^*) + Var(\tau_t - \tau_{t-1})$
$= Var(Exp_t^*) + 2Var(\tau)$
For N-year horizon,
$Var(Exp(N)_t) = Var\ \{Exp(N)_t^* + 1/N^*(-\tau_{t-1} + \tau_{t+N-1})\}$
$= Var(Exp(N)_t^*) + 1/N^2{}^*2Var(\tau)$

Compared with "perfectly matched" one-year expenses, the volatility of reported one-year expenses increase by $2Var(\tau)$. Compared with "perfectly matched" N-year earnings, the volatility of reported N-year expenses increase by $1/N^2{}^*2Var(\tau)$. As N becomes larger, the increase becomes smaller (as N approaches infinity, the difference in variance in expenses under perfect matching and poor matching approaches zero). It follows that as the horizon expands, the effect of poor matching on contemporaneous correlation between revenue and expenses is attenuated.

Observation 2: volatility of reported earnings

For one-year horizon,
$Var(E_t) = Var(E_t^* + \tau_{t-1} - \tau_t) = Var(E_t^*) + Var\ (\tau_{t-1} - \tau_t) + 2cov\ (E_t^*, \tau_{t-1} - \tau_t)$
$= Var(E_t^*) + Var\ (\tau_{t-1} - \tau_t) = Var(E_t^*) + 2Var(\tau)$

For N-year horizon,
$\text{Var}(E(N)_t) = \text{Var}(E(N)_t^* + 1/N^*(\tau_{t-1} - \tau_{t+N-1}))$
$= \text{Var}(E(N)_t^*) + 1/N^*1/N^*\text{Var}(\tau_{t-1} - \tau_{t+N-1})$
$= \text{Var}(E(N)_t^*) + 1/N^2{*}2\text{Var}(\tau)$

Compared with "perfectly matched" earnings, the volatility of reported one-year earnings increase by 2Var(τ). Compared with "perfectly matched" earnings, the volatility of reported N-year earnings increase by $1/N^2{*}2\text{Var}(\tau)$. The increase in the volatility of N-year mismatched earnings is only $1/N^2$ of that for one-year mismatched earnings. As N approaches zero, the difference between perfectly matched N-year earnings and mismatched N-year earnings approaches zero. It follows that the increase in the volatility of reported earnings induced by poor matching is attenuated in longer horizons.

Observation 3: persistence coefficient and autocorrelation in earnings changes

One-year horizon:

From equation (10) in the body of text, OLS estimation produces a biased and inconsistent estimate of β_1^*:

$$\beta_1^{OLS} = \beta_1^* + \frac{\sum E'_{t-1}\lambda'}{\sum E'^2_{t-1}}$$

where $\lambda = \varepsilon - \tau_t + (1+\beta_1)\tau_{t-1} - \beta_1\tau_{t-2}$

As the error term (λ) is correlated with the independent variable, the magnitude in the bias induced by poor matching is $\frac{\sum E'_{t-1}\lambda'}{\sum E'^2_{t-1}}$.

N-year horizon:

$E(N)_t - v(N)_t = \beta(N)_0^* + \beta(N)_1^*(E(N)_{t-1} - v(N)_{t-1}) + \varepsilon(N)_t,$
$E(N)_t = \beta(N)_0^* + \beta(N)_1^* E(N)_{t-1} + \{\varepsilon(N)_t - \beta(N)_1 v(N)_{t-1} + v(N)_t\}$

Rearrange,

$E(N)_t = \beta(N)_0^* + \beta(N)_1^* E(N)_{t-1} + \{\varepsilon(N)_t - \beta(N)_1^{*}{*}1/N^*(-\tau_{t+N-2} + \tau_{t-2})$
$\quad +1/N^*(-\tau_{t+N-1} + \tau_{t-1})\}$

Note that the second term in the error term is negatively correlated with $E(N)_{t-1}$ (since $E(N)_{t-1} = E(N)_{t-1}^* + 1/N(-\tau_{t+N-2} + \tau_{t-2})$, the OLS estimator is given by the following expression:

$$B(N)_1^{OLS} = \beta(N)_1^* + \frac{\sum E(N)'_{t-1}\lambda(N)'}{\sum E(N)'^2_{t-1}}$$

Where $\lambda(N) = \varepsilon(N)_t - \beta(N)_1^{*}{*}1/N^*(\tau_{t-2} - \tau_{t+N-2}) + 1/N^*(-\tau_{t+N-1} + \tau_{t-1})$

$$\frac{\sum E(N)'_{t-1}\lambda(N)'}{\sum E(N)'^2_{t-1}} = \frac{1/N*1/N*\sum E'_{t-1}\lambda'}{1/N*1/N*[N*\text{var}(E^*_{t-1}) + \text{var}(\tau_{\tau-2} - \tau_{\tau+N-2})]} < \frac{\sum E'_{t-1}\lambda'}{\sum E'^2_{t-1}}$$

The bias in N-year horizon is smaller than the bias in one-year horizon. As N approaches infinity, the bias approaches zero. It follows that the attenuation in persistence coefficient of earnings induced by poor matching is alleviated in longer horizons. As the autocorrelation in earnings changes is the other side of earnings persistence, it follows that the autocorrelation in earnings changes gets less negative over longer horizon.

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Table 1
Derivation of the sample

Compustat firm-years with available total assets, revenues and earnings	297,692
Firm-years with available deflated revenues, earnings and expenses	272,625
Firm-years with available non-overlapping two-year revenues, two-year earnings and two-year expenses	134,704
Firm-years with available data on volatility in two-year earnings, two-year revenues and two-year expenses	45,117
Firm-year observations in the two-year sample where firms are among the largest 1,000 firm for each odd-year from 1967 to 2003	18,564
Firm-years remaining in the two-year sample after truncating the top and bottom 1 percent of all two-year variables	17,788
Firm-years in the final two-year sample	***17,788***
Firm-year observations in the one-year sample where firms are in the two-year sample	37,116
Firm-years remaining after truncating the top and bottom 1 percent of all one-year variables	34,785
Firm-years in the final one-year sample	***34,785***

Table 2
Descriptive statistics

Variable	N	Mean	Std Dev	Median
Earnings	34,785	0.046	0.052	0.044
Revenues	34,785	0.988	0.838	0.850
Costs	34,785	0.942	0.826	0.802
Vol (Earnings)	34,785	0.018	0.020	0.012
Vol (Revenues)	34,785	0.097	0.095	0.069
Vol (Expenses)	34,785	0.091	0.091	0.063
Corr (Revenues, Expenses)	34,785	0.944	0.162	0.993
Two-year Earnings	17,788	0.047	0.047	0.045
Two-year Revenues	17,788	0.998	0.840	0.861
Two-year Expenses	17,788	0.951	0.828	0.813
Vol (two-year Earnings)	17,788	0.018	0.017	0.013
Vol (two-year Revenues)	17,788	0.126	0.120	0.092
Vol (two-year Expenses)	17,788	0.119	0.116	0.084
Corr (two-year Revenues, two-year Expenses)	17,788	0.965	0.113	0.995
Persistence in Earnings	37	0.782	0.107	0.786
Autocorrelation in Earnings change	37	-0.123	0.166	-0.110
Persistence in two-year Earnings	19	0.751	0.085	0.747
Autocorrelation in two-year Earnings change	19	-0.133	-0.131	0.132

Table 2 (continued)

Earnings is earnings before extraordinary items (Compustat item 18) deflated by average assets (Item 6). *Revenues* is net revenues (Compustat item 12) deflated by average assets. *Expenses* is the difference between *Revenues* and *Earnings*. *Vol (Earnings)* is earnings volatility, which is calculated by taking the standard deviation of the deflated earnings for the most recent five years. *Vol (Revenues)* is revenues volatility, which is calculated by taking the standard deviation of the deflated revenues for the most recent five years. *Vol (Expenses)* is expenses volatility, which is calculated by taking the standard deviation of the deflated expenses for the most recent five years. *Corr (Revenues, Expenses)* is the correlation between revenues and expenses, which is calculated as the correlation between the deflated revenues and the deflated expenses for the most recent five years. *Two-year earnings* are calculated as the average of deflated earnings for the current and previous periods. *Two-year revenues* and *expenses* are calculated analogously. *Vol(two-year Earnings)* is volatility in two-year earnings, which is calculated by taking the standard deviation of two-year earnings for the most recent five non-overlapping two-year periods. *Vol (two-year Revenues)* and *Vol (two-year Expenses)* is calculated analogously. *Corr (two-year Revenues, two-year Expenses)* is calculated analogously for the most recent five non-overlapping two-year periods. For each sample year, *Persistence in earnings* is the slope coefficients from the regression of current deflated earnings on the previous period earnings on a cross-section basis. *Autocorrelation in earnings change* is the cross-sectional correlation between current earnings change and past earnings change. For every other sample year, P*ersistence in two-year earnings* is the slope coefficients from the regression of current two-year earnings on past two-year earnings on a cross-section basis. *Autocorrelation in two-year earnings change* is the cross-sectional correlation between current two-year earnings change and past two-year earnings change.

Table 3
Regression of Revenues on previous, current and future Expenses
Model: $Revenues_t = \alpha + \beta_1 * Expenses_{t-1} + \beta_2 * Expenses_t + \beta_3 * Expenses_{t+1}$

Year	Coefficient on past expenses (β_1)	Coefficient on current expenses (β_2)	Coefficient on future expenses (β_3)
1967	-0.010	1.029	-0.013
1968	-0.014	1.044	-0.015
1969	-0.004	1.030	-0.012
1970	0.002	1.042	-0.033
1971	0.026	1.003	-0.016
1972	0.010	1.089	-0.077
1973	0.063	0.939	0.020
1974	-0.053	1.106	-0.038
1975	0.023	1.061	-0.066
1976	0.028	0.991	0.005
1977	-0.001	1.015	0.007
1978	-0.007	1.053	-0.022
1979	-0.007	1.027	0.006
1980	-0.021	1.070	-0.028
1981	0.063	0.965	-0.010
1982	-0.017	1.054	-0.024
1983	-0.016	1.087	-0.056
1984	0.051	0.972	0.003
1985	0.016	1.013	-0.013
1986	0.039	0.937	0.038
1987	0.145	0.762	0.111
1988	-0.013	1.032	0.007
1989	0.066	1.003	-0.053
1990	0.101	0.932	-0.018
1991	0.176	0.802	0.028
1992	0.117	0.871	0.029
1993	0.168	0.691	0.152
1994	0.033	0.986	0.006
1995	0.029	0.979	0.018
1996	0.020	1.000	0.006
1997	0.093	0.894	0.038
1998	0.032	0.977	0.016
1999	0.081	0.952	-0.005
2000	0.042	1.015	-0.037
2001	0.464	0.533	-0.012
2002	0.092	0.715	0.204
2003	0.132	0.797	0.091
Mean 1967 to 1985	**0.007**	**1.031**	**-0.020**
Mean 1986 to 2003	**0.101**	**0.882**	**0.034**
Difference	**0.094**	**-0.149**	**0.055**
P-value on Diff.	**< 0.001**	**< 0.001**	**0.002**

Table 3 (continued)

Earnings is earnings before extraordinary items (Compustat item 18) deflated by average assets (Item 6). $Revenues_t$ is net revenues (Compustat item 12) deflated by average assets for the current period. $Expenses_t$ is the difference between *Revenues* and *Earnings* for the current period. $Expenses_{t-1}$ is the difference between *Revenues* and *Earnings* for the previous period. $Expenses_{t+1}$ is the difference between *Revenues* and *Earnings* for the next period. The regression is run on a cross-sectional basis each year. The slope coefficients on past, current and future expenses are reported in the table. P-value on the difference is obtained from a two-tail t-test.

Table 4
Volatility of earnings and its components over time

Panel A: Volatility over time for the one-year sample

Year	N	Vol(Earnings)	Vol(Revenues)	Vol(Expenses)	Corr(Revenues, Expenses)
1967	779	0.014	0.099	0.092	0.972
1968	811	0.014	0.107	0.100	0.977
1969	810	0.014	0.108	0.101	0.978
1970	883	0.014	0.105	0.097	0.973
1971	884	0.015	0.110	0.101	0.966
1972	957	0.014	0.115	0.107	0.968
1973	955	0.013	0.105	0.098	0.969
1974	957	0.011	0.089	0.082	0.973
1975	955	0.014	0.106	0.098	0.979
1976	957	0.014	0.102	0.095	0.981
1977	957	0.014	0.100	0.094	0.980
1978	959	0.014	0.094	0.088	0.971
1979	959	0.014	0.090	0.084	0.972
1980	958	0.013	0.089	0.083	0.978
1981	956	0.012	0.089	0.084	0.976
1982	954	0.013	0.092	0.087	0.974
1983	955	0.017	0.102	0.094	0.970
1984	953	0.019	0.107	0.097	0.970
1985	957	0.018	0.104	0.095	0.968
1986	954	0.017	0.097	0.090	0.954
1987	958	0.018	0.106	0.100	0.951
1988	955	0.019	0.111	0.105	0.943
1989	955	0.020	0.113	0.107	0.933
1990	961	0.020	0.105	0.099	0.924
1991	958	0.020	0.094	0.089	0.909
1992	961	0.021	0.089	0.083	0.907
1993	959	0.020	0.080	0.075	0.905
1994	956	0.020	0.073	0.069	0.896
1995	956	0.020	0.069	0.066	0.892
1996	954	0.020	0.073	0.070	0.895
1997	957	0.020	0.077	0.073	0.901
1998	957	0.021	0.084	0.081	0.904
1999	960	0.021	0.092	0.089	0.920
2000	958	0.023	0.098	0.093	0.915
2001	959	0.026	0.102	0.097	0.916
2002	958	0.029	0.107	0.101	0.890
2003	953	0.030	0.107	0.101	0.898
Mean 1967 to 1985		**0.014**	**0.101**	**0.094**	**0.973**
Mean 1986 to 2003		**0.021**	**0.093**	**0.088**	**0.914**
Difference		**0.007**	**-0.008**	**-0.005**	**-0.059**
P-value on Difference		**< 0.001**	**0.057**	**0.140**	**< 0.001**

Table 4 (continued)

Panel B: Volatility over time for the two-year sample

Year	*N*	*Vol (two-year Earnings)*	*Vol(two-year Revenues)*	*Vol(two-year Expenses)*	*Corr (two-year Revenues, two-year Expenses)*
1967	776	0.017	0.134	0.126	0.979
1969	812	0.016	0.130	0.123	0.975
1971	883	0.015	0.126	0.119	0.976
1973	961	0.017	0.142	0.134	0.972
1975	956	0.014	0.124	0.117	0.977
1977	958	0.015	0.126	0.119	0.984
1979	959	0.014	0.121	0.114	0.983
1981	957	0.014	0.119	0.112	0.985
1983	957	0.014	0.123	0.117	0.980
1985	957	0.017	0.127	0.119	0.982
1987	956	0.017	0.122	0.114	0.978
1989	957	0.020	0.140	0.130	0.974
1991	958	0.020	0.143	0.135	0.966
1993	956	0.022	0.137	0.129	0.951
1995	957	0.022	0.128	0.121	0.943
1997	956	0.021	0.109	0.102	0.939
1999	957	0.023	0.106	0.100	0.930
2001	958	0.024	0.114	0.109	0.937
2003	957	0.026	0.129	0.121	0.933
Mean 1967 to 1985		**0.015**	**0.127**	**0.120**	**0.979**
Mean 1987 to 2003		**0.022**	**0.125**	**0.118**	**0.950**
Difference		**0.006**	**-0.002**	**-0.002**	**-0.029**
P-value on Difference		**< 0.001**	**0.730**	**0.674**	**< 0.001**

Earnings is earnings before extraordinary items (Compustat item 18) deflated by average assets (Item 6). *Revenues* is net revenues (Compustat item 12) deflated by average assets. *Expenses* is the difference between *Revenues* and *Earnings*. *Vol (Earnings)* is earnings volatility, which is calculated by taking the standard deviation of the deflated earnings for the most recent five years. *Vol (Revenues)* and *Vol (Expenses)* are defined analogously. *Corr (Revenues, Expenses)* is the correlation between revenues and expenses, which is calculated as the correlation between the deflated revenues and the deflated expenses for the most recent five years. *Two-year earnings* are calculated as the average of deflated earnings for the current and previous periods. *Two-year Revenues* and *Expenses* are defined analogously. *Vol (two-year Earnings)* is calculated by taking the standard deviation of two-year earnings for the most recent five non-overlapping two-year periods. *Vol (two-year Revenues)* and *Vol (two-year Expenses*) are defined analogously. *Corr (two-year Revenues, two-year Expenses)* is the correlation between two-year revenues and two-year expenses, which is calculated as the correlation between two-year revenues and two-year expenses for the most recent five non-overlapping two-year periods. P-value on the difference is obtained from a two-tail t-test.

Table 5
Persistence in earnings and autocorrelation in earnings changes over time

Panel A: Persistence and autocorrelation over time for the one-year sample

Year	*N*	*Persistence in earnings*	*Autocorrelation in earnings change*
1967	970	0.796	-0.089
1968	969	0.874	-0.060
1969	969	0.886	0.078
1970	967	0.832	0.065
1971	969	0.835	-0.025
1972	971	0.911	-0.069
1973	966	0.976	0.141
1974	964	0.855	0.072
1975	962	0.722	-0.298
1976	969	0.891	-0.111
1977	969	0.928	0.155
1978	967	0.936	0.115
1979	968	0.943	-0.023
1980	968	0.840	-0.132
1981	968	0.852	0.023
1982	970	0.780	0.004
1983	968	0.770	0.023
1984	964	0.829	-0.031
1985	965	0.795	-0.188
1986	969	0.718	-0.156
1987	969	0.659	-0.338
1988	966	0.842	0.008
1989	968	0.776	-0.195
1990	969	0.779	-0.180
1991	969	0.688	-0.161
1992	966	0.731	-0.327
1993	966	0.726	-0.137
1994	968	0.693	-0.395
1995	969	0.800	-0.093
1996	969	0.657	-0.499
1997	970	0.772	-0.115
1998	968	0.615	-0.396
1999	964	0.657	-0.343
2000	965	0.708	-0.186
2001	964	0.570	-0.167
2002	967	0.786	-0.106
2003	964	0.509	-0.422
Mean 1967 to 1985		**0.855**	**-0.019**
Mean 1986 to 2003		**0.705**	**-0.234**
Difference		**-0.150**	**-0.215**
P-value on Difference		**< 0.001**	**< 0.001**

Table 5 (continued)

Panel B: Regression results for time trends in persistence and autocorrelation

Persistence in $\text{earnings}_t = b_1 + b_2{*}t + \varepsilon$
Autocorrelation in earnings $\text{changes}_t = b_1 + b_2{*}t + \varepsilon$
Where t is an ordinal time variable (1967 = 0 and 2003 = 36)

Regression	**b_1 (t-stat)**	**b_2 t-stat)**	**R^2**		**Fitted value Year 1967**	**Fitted value Year 2003**
Persistence of Earnings	0.914 (38.97)	-0.0073 (-6.53)	0.54		0.914	0.651
Autocorrelation in E. changes	0.053 (1.25)	-0.0098 (-4.87)	0.39		0.053	-0.299

Panel C: Persistence and autocorrelation over time for the two-year sample

Year	***N***	***Persistence in two-year earnings***	***Autocorrelation in two-year earnings change***
1967	968	0.848	0.080
1969	966	0.786	-0.153
1971	967	0.746	0.049
1973	968	0.893	-0.213
1975	968	0.813	-0.006
1977	965	0.787	-0.494
1979	967	0.921	-0.056
1981	966	0.809	-0.182
1983	968	0.666	-0.073
1985	963	0.769	-0.012
1987	968	0.747	-0.129
1989	965	0.753	-0.004
1991	970	0.671	-0.257
1993	966	0.705	-0.131
1995	968	0.675	-0.207
1997	966	0.731	-0.228
1999	970	0.644	-0.212
2001	965	0.587	-0.123
2003	965	0.722	-0.183
Mean 1967 to 1985		**0.804**	**-0.106**
Mean 1987 to 2003		**0.693**	**-0.164**
Difference		**-0.111**	**-0.058**
P-value on Difference		**0.002**	**0.340**

Earnings is earnings before extraordinary items (Compustat item 18) deflated by average assets (Item 6). *Two-year earnings* are calculated as the average of deflated earnings for the current and previous periods. For each sample year, *Persistence in earnings* is the slope coefficients from the regression of current deflated earnings on the previous period earnings on a cross-section basis. *Autocorrelation in earnings change* is the cross-sectional correlation between current earnings change and past earnings change. For every other sample year, P*ersistence in two-year earnings* is the slope coefficients from the regression of current two-year earnings on past two-year earnings on a cross-section basis. *Autocorrelation in two-year earnings change* is the cross-sectional correlation between current two-year earnings change and past two-year earnings change. P-value on the difference is obtained from a two-tailed t-test.

Table 6
Changes in the sample composition over time

	Beginning sample year = 1967		Ending sample year = 2003	
Fama-French 12-industry group classification	**Count**	**Percentage**	**Count**	**Percentage**
Consumer Non-durables	107	13.75	52	5.46
Consumer Durables	40	5.14	27	2.83
Manufacturing	210	26.99	110	11.54
Energy	35	4.5	31	3.25
Chemicals and Allied Products	49	6.3	31	3.25
Business Equipment	44	5.66	85	8.92
Telecommunication	10	1.29	35	3.67
Utilities	119	15.3	142	14.9
Whole sale, retail and some services	65	8.35	87	9.13
Healthcare	23	2.96	51	5.35
Finance	18	2.31	186	19.52
Others - Mines, construction, transportation and business service	58	7.46	116	12.17

Details on the Fama-French 12-industry-group classification can be obtained from Kenneth French's personal webpage at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Figure 1
Coefficients in regression of revenues on past, current and future expenses over 1967-2003

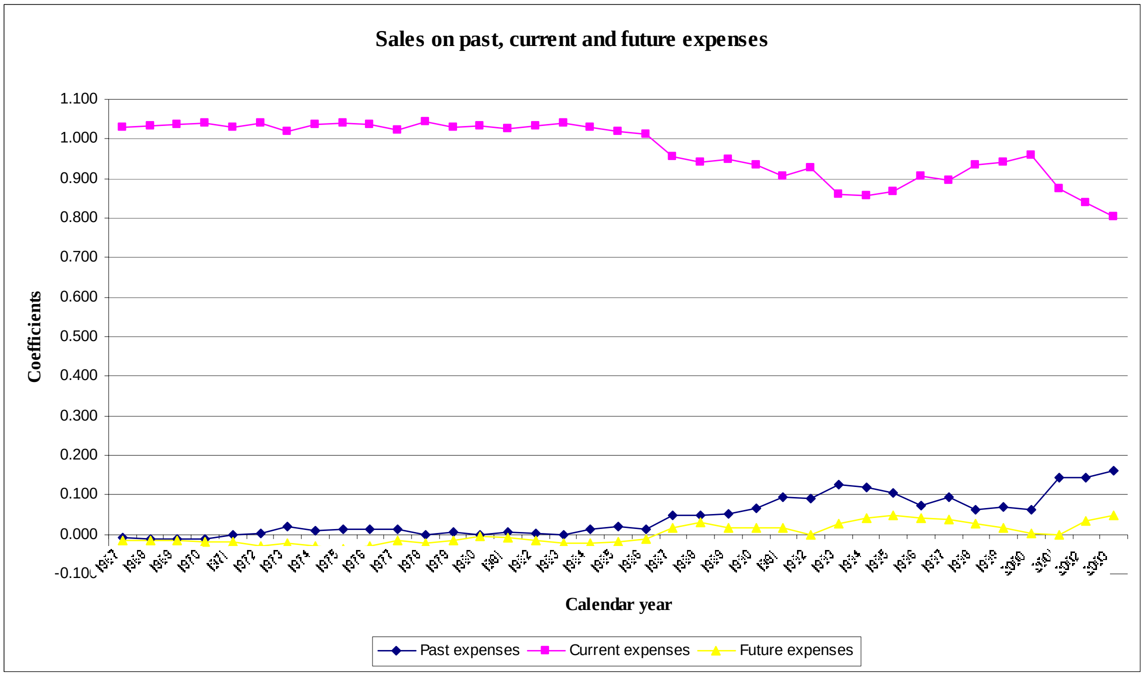


Figure 1 plots the five-year moving average (the average for the current and previous four years) of slope coefficients of regression of current revenues on past, current and future expenses from year 1967 to year 2003. *Earnings* is earnings before extraordinary items (Compustat item 18) deflated by average assets (Item 6). *Revenues* is net revenues (Compustat item 12) deflated by average assets. $Revenues_t$ is net revenues (Compustat item 12) deflated by average assets for the current period. $Expenses_t$ is the difference between *Revenues* and *Earnings* for the current period. $Expenses_{t-1}$ is the difference between *Revenues* and *Earnings* for the previous period. $Expenses_{t+1}$ is the difference between *Revenues* and *Earnings* for the next period. Fore ach sample year, the regression of current revenues on past, current and future expenses is run on a cross-sectional basis.

Figure 2
Earnings volatility and its components over time

Figure 2A: volatility for the one-year sample

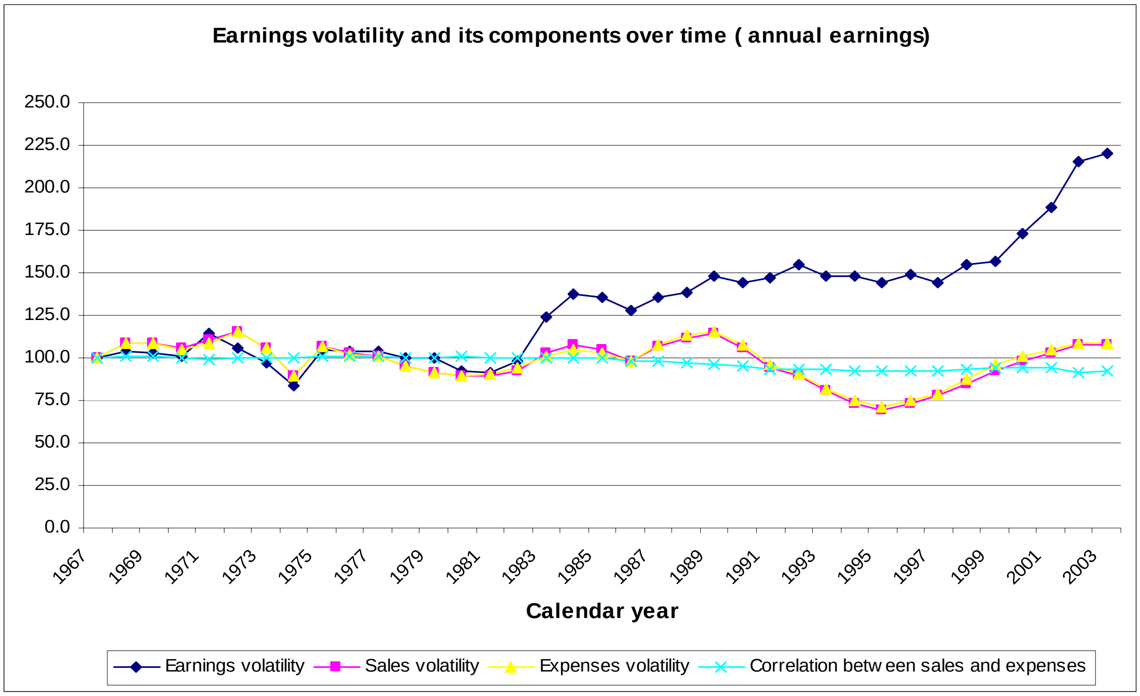


Figure 2B: volatility for the two-year sample

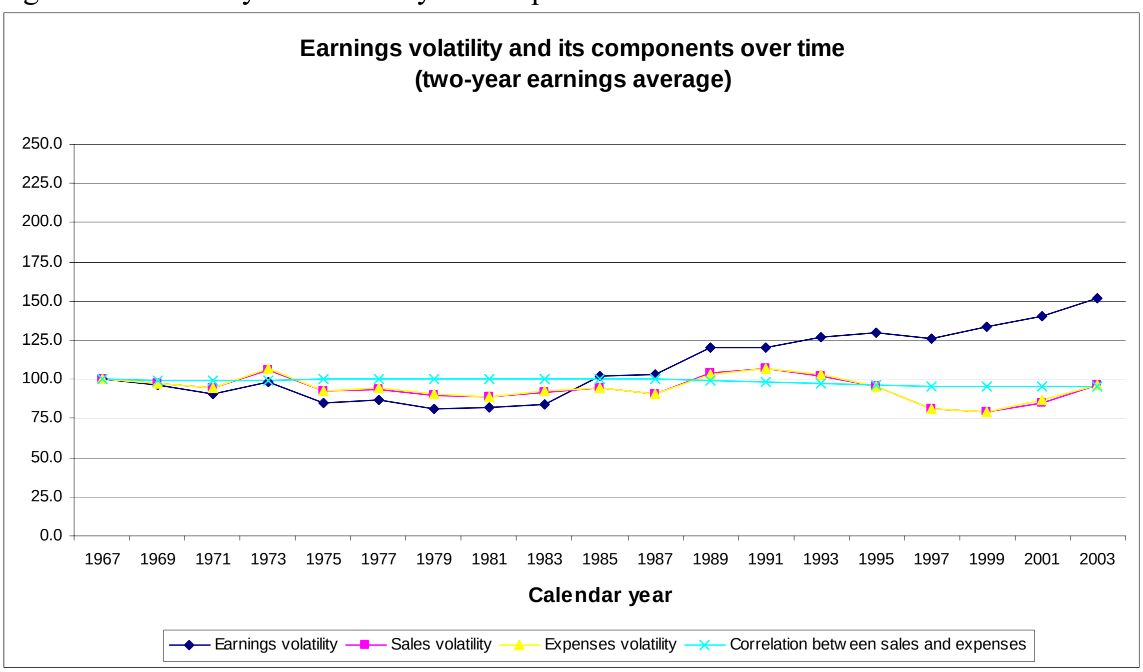


Figure 2 (continued)

Figure 2a plots the normalized earnings volatility, revenues volatility, expenses volatility and the correlation between revenues and expenses. Figure 2b plots the normalized two-year earnings volatility, two-year revenues volatility, two-year expenses volatility and the correlation between two-year revenues and two-year expenses. The sample starts from 1967 and ends on 2003. In order to limit the sample to economically substantial firms, we pick up the largest 1000 firms for each year in the sample where volatility in two-year earnings, volatility in two-year revenues and volatility in two-year expenses are available. *Earnings* is earnings before extraordinary items (Compustat item 18) deflated by average assets (Item 6). *Revenues* is net revenues (Compustat item 12) deflated by average assets. *Expenses* is the difference between *Revenues* and *Earnings*. *Vol (Earnings)* is earnings volatility, which is calculated by taking the standard deviation of the deflated earnings for the most recent five years. *Vol (Revenues)* is revenues volatility, which is calculated by taking the standard deviation of the deflated revenues for the most recent five years. *Vol (Expenses)* is expenses volatility, which is calculated by taking the standard deviation of the deflated expenses for the most recent five years. *Corr (Revenues, Expenses)* is the correlation between revenues and expenses, which is calculated as the correlation between the deflated revenues and the deflated expenses for the most recent five years. *Two-year earnings* are calculated as the average of deflated earnings for the current and previous periods. *Two-year revenues* and *expenses* are calculated analogously. *Vol(two-year Earnings)* is volatility in two-year earnings, which is calculated by taking the standard deviation of two-year earnings for the most recent five non-overlapping two-year periods. *Vol (two-year Revenues)* and *Vol (two-year Expenses)* is calculated analogously. *Corr (two-year Revenues, two-year Expenses)* is calculated analogously for the most recent five non-overlapping two-year periods. Normalize all volatility and correlation variables by their values for the beginning year of 1967.

Figure 3
Earnings persistence and autocorrelation in earnings changes over time

Figure 3A: persistence and autocorrelation for the one-year sample

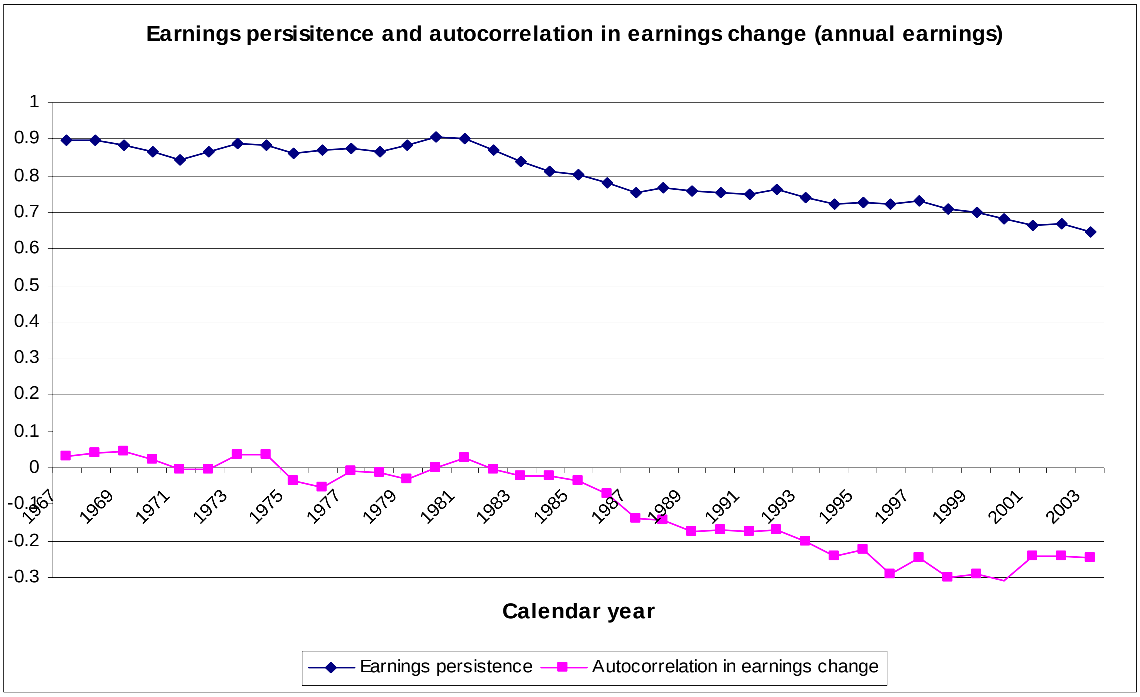


Figure 3B: persistence and autocorrelation in earnings changes for the one-year sample

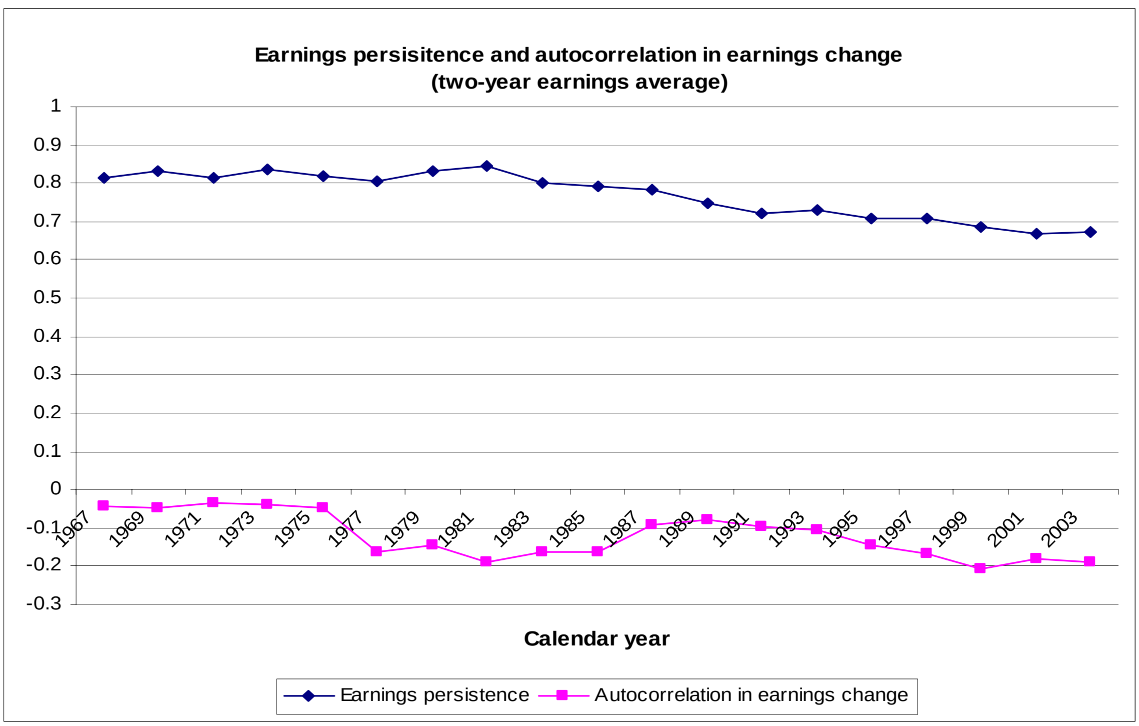


Figure 3 (continued)

Figure 3a plots the five-year moving average (the average for the current and the previous four years) of persistence in earnings and autocorrelation in earnings change. Figure3b plots the five two-year moving average (the average for the current and the previous four two-year periods) of persistence in two-year earnings and autocorrelation in two-year earnings change. The sample starts from 1967 and ends on 2003. In order to limit the sample to economically substantial firms, we pick up the largest 1000 firms for each year in the sample where volatility in two-year earnings, volatility in two-year revenues and volatility in two-year expenses are available. *Earnings* is earnings before extraordinary items (Compustat item 18) deflated by average assets (Item 6). *Revenues* is net revenues (Compustat item 12) deflated by average assets. *Expenses* is the difference between *Revenues* and *Earnings*. For each sample year, *Persistence in earnings* is the slope coefficients from the regression of current deflated earnings on the previous period earnings on a cross-section basis. *Autocorrelation in earnings change* is the cross-sectional correlation between current earnings change and past earnings change. For every other sample year, P*ersistence in two-year earnings* is the slope coefficients from the regression of current two-year earnings on past two-year earnings on a cross-section basis. *Autocorrelation in two-year earnings change* is the cross-sectional correlation between current two-year earnings change and past two-year earnings change.

Figure 4
Coefficients in regression of revenues on past, current and future expenses by industry composition

Figure 4A: coefficients in regression of revenue on past, current and future expenses for the “DECREASING” sub-sample

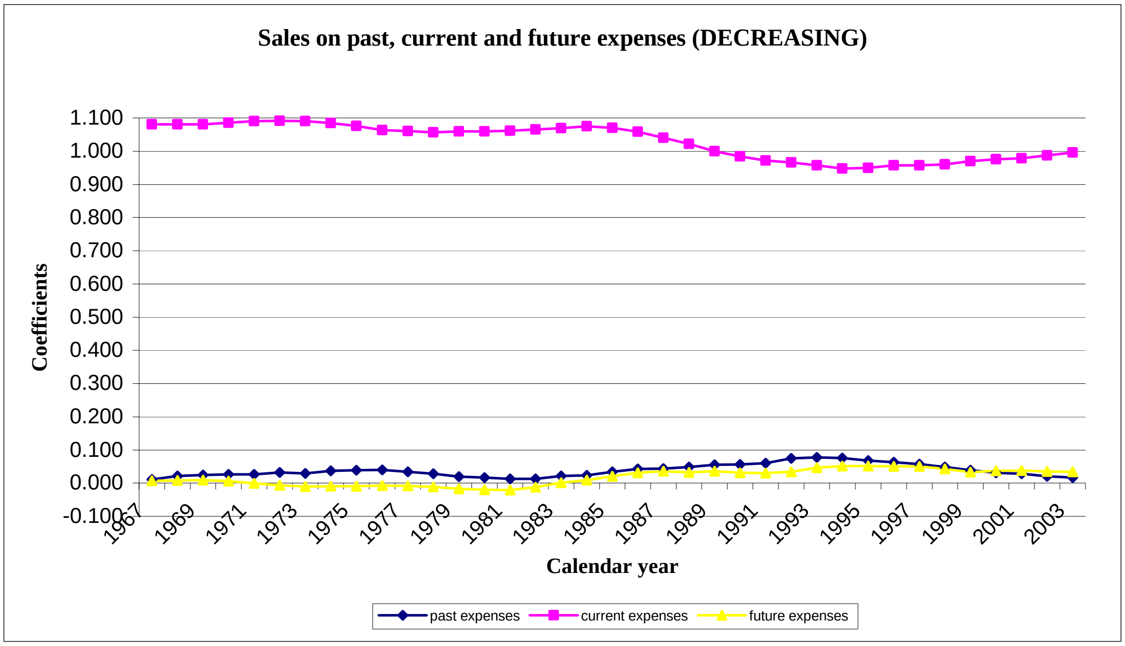


Figure 4B: coefficients in regression of revenue on past, current and future expenses for the “INCREASING” sub-sample

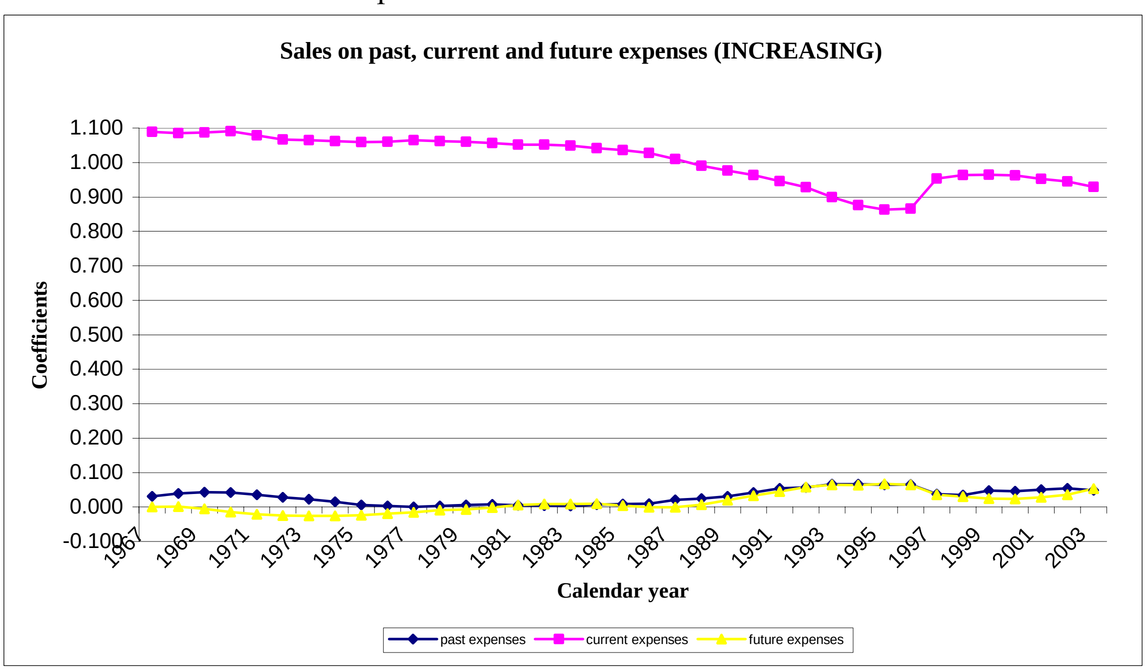
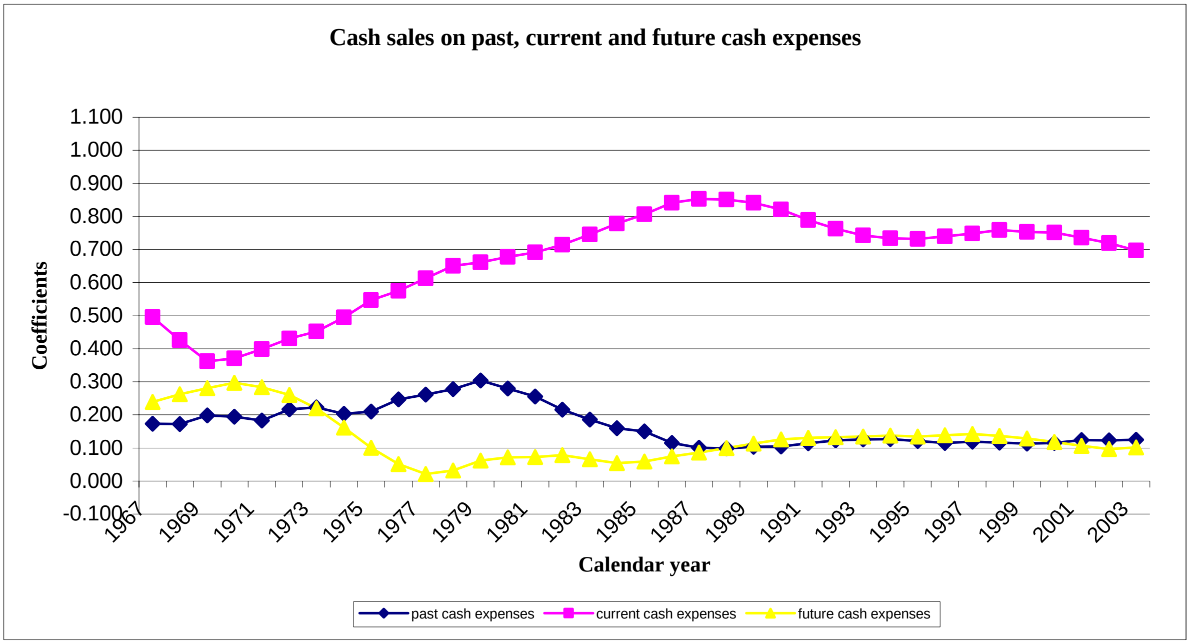


Figure 4 (continued)

Figure 4A plots the five-year moving average (the average for the current and previous four years) of slope coefficients of regression of current revenues on past, current and future expenses for firms in industries whose proportion in the sample is decreasing over time. "DECREASING" industries include the following six industry groups: consumer non-durables, consumer durables, manufacturing, energy, chemical & allied products and utilities. Figure 4B plots the five-year moving average (the average for the current and the previous four years) of slope coefficients of regression of current revenues on past, current and future expenses for firms in industries whose proportion in the sample is increasing over time. "INCREASING" industries include the following six industry groups: business equipment, telecommunication, wholesale and retail, health care, finance and others, including mine, construction, transportation and business service. The division of the two sub-samples is based on the change in industry composition as shown in Table 6. The overall sample starts from 1967 and ends on 2003. In order to limit the sample to economically substantial firms, we pick up the largest 1000 firms for each year in the sample where volatility in two-year earnings, volatility in two-year revenues and volatility in two-year expenses are available. $Revenues_t$ is net revenues (Compustat item 12) deflated by average assets for the current period. $Expenses_t$ is the difference between *Revenues* and *Earnings* for the current period. $Expenses_{t-1}$ is the difference between *Revenues* and *Earnings* for the previous period. $Expenses_{t+1}$ is the difference between *Revenues* and *Earnings* for the next period. Fore ach sample year, the regression of current revenues on past, current and future expenses is run on a cross-sectional basis. Details on the Fama-French 12-industry-group classification can be obtained from Kenneth French's personal webpage at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Figure 5
Cash-based measures of earnings, revenues and expenses

Panel A: Coefficients in regression of cash revenues on past, current and future cash expenses over time



Panel B: Cash flows from operations (CFOs) persistence and autocorrelation in CFO changes over time

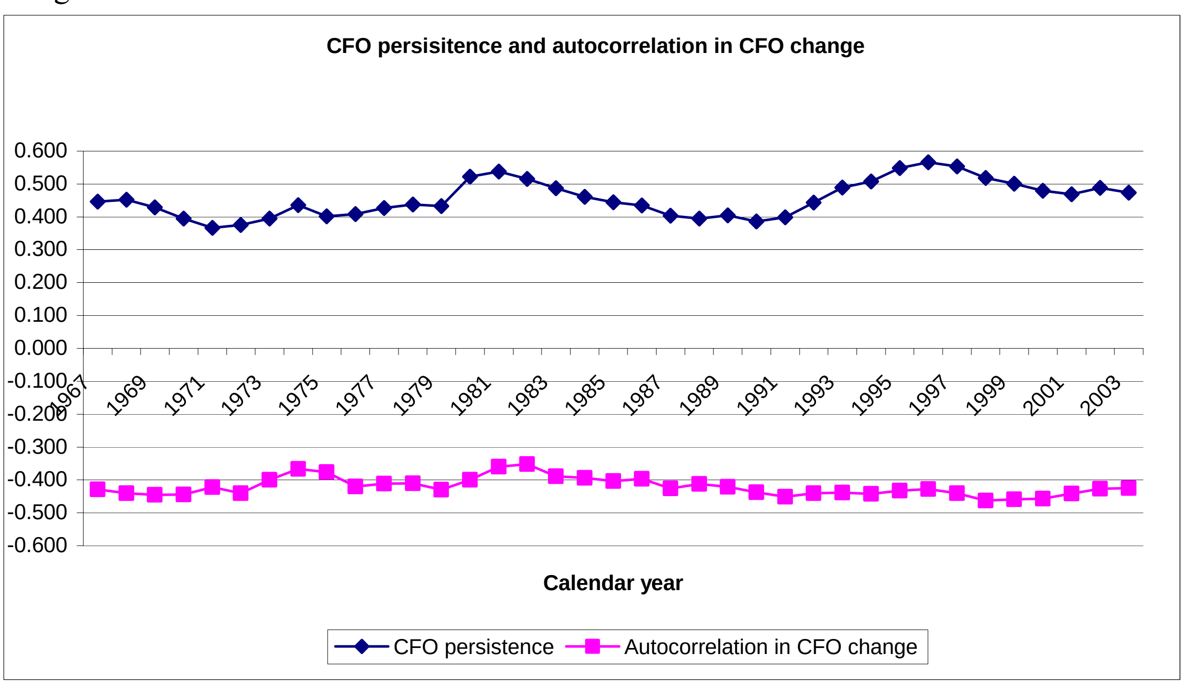
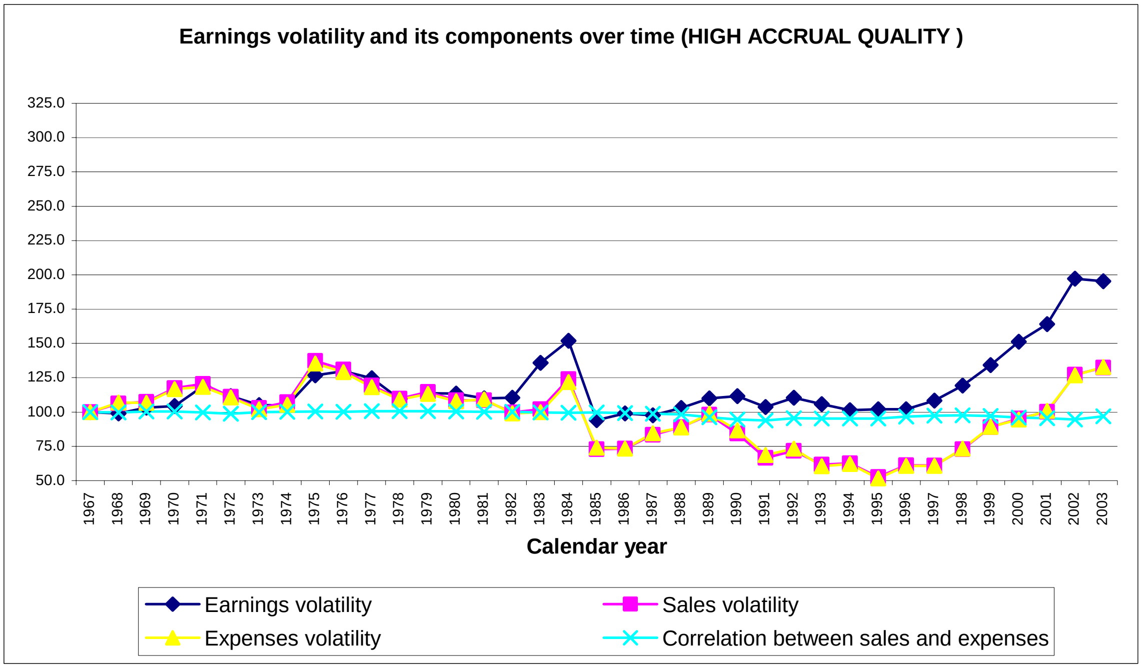


Figure 5 (continued)

Figure 5A plots the five-year moving average (the average for the current and previous four years) of slope coefficients of regression of current cash revenues on past, current and future cash expenses from year 1967 to year 2003. Figure 5B plots the five-year moving average (the average for the current and the previous four years) of persistence in CFOs and autocorrelation in the change in CFOs. The overall sample starts from 1967 and ends on 2003. In order to limit the sample to economically substantial firms, we pick up the largest 1000 firms for each year in the sample where volatility in two-year earnings, volatility in two-year revenues and volatility in two-year expenses are available. *Cash flows from operations* is the difference between earnings (Compustat Item 18) and accruals as in Sloan (1996). More specifically, accruals is calculated as {the change in current assets (Compustat Item 4) – the change in cash (Compustat Item 1) – [change in current liabilities (Compustat Item 5) – the change in current debt (Compustat Item 34) – change in tax payable (Compustat Item 71)] – Depreciation (Compustat Item 14)}. *CFOs* is cash flows form operations deflated by average assets. *Cash Revenues* is net revenues (Compustat Item 12) minus changes in trade accounts receivables (Compustat Item 151) plus the change in deferred revenues (Compustat Item 356 + 397) deflated by average assets. $Cash\ Revenues_t$ is cash revenues deflated by average assets for the current period. $Cash\ Expenses_t$ is the difference between *Cash Revenues* and *CFOs* for the current period. $Cash\ Expenses_{t-1}$ is the difference between *Cash Revenues* and *CFOs* for the previous period. $Cash\ Expenses_{t+1}$ is the difference between *Cash Revenues* and *CFOs* for the next period. For each sample year, *Persistence in CFOs* is the slope coefficients from the regression of current CFOs on the previous period CFOs on a cross-section basis. *Autocorrelation in CFOs change* is the cross-sectional correlation between current CFOs change and past CFOs change.

Figure 6
Earnings Volatility and Its Components Conditional on High and Low Accrual Quality



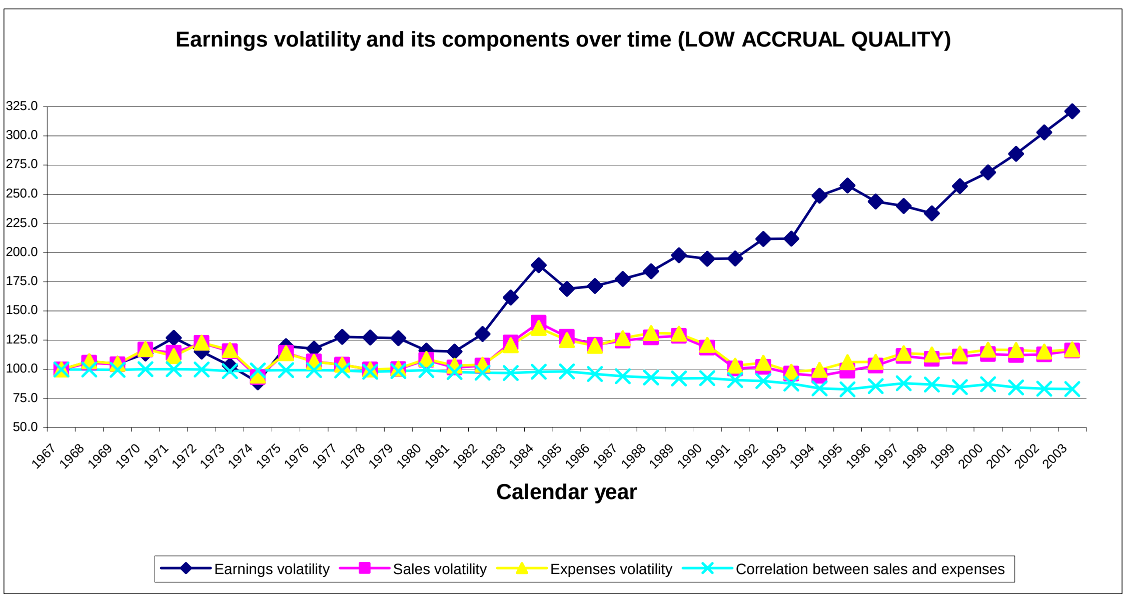


Figure 6 (continued)

Figure 6 plots the normalized earnings volatility, revenues volatility, expenses volatility and the correlation between revenues and expenses conditional on the quality of accruals. The sample starts from 1967 and ends on 2003. In order to limit the sample to economically substantial firms, we pick up the largest 1000 firms for each year in the sample where volatility in two-year earnings, volatility in two-year revenues and volatility in two-year expenses are available. The quality of accruals is the residual accrual measure from Dechow and Dichev (2002). More specifically, for each firm-year observation, we use the prior 10 firm-year observations to estimate the following regression: $\Delta WC_{i,t} = \alpha + \beta_1 {*} CFOs_{i,t-1} + \beta_2 {*} CFOs_{i,t} + \beta_3 {*} CFOs_{i,t+1} + \varepsilon_{i,t.}$ The resulting standard deviation of $\varepsilon_{i,t}$ is the measure of accrual quality for the specific firm-year observation. For each sample year, we partition the whole sample into three groups based on accrual quality. Figure 6 plots earnings volatility and its components over time for firms within the highest accrual quality trecile and for firms within the lowest accrual quality trecile respectively. *ΔWC* is calculated as {the change in current assets (Compustat Item 4) – the change in cash (Compustat Item 1) – [the change in current liabilities (Compustat Item 5) – the change in current debt (Compustat Item 34) – the change in tax payable (Compustat Item 71)]}. *Cash flows from operations* is the difference between earnings (Compustat Item 18) and accruals as in Sloan (1996). More specifically, accruals is calculated as {the change in current assets (Compustat Item 4) – the change in cash (Compustat Item 1) – [change in current liabilities (Compustat Item 5) – the change in current debt (Compustat Item 34) – change in tax payable (Compustat Item 71)] – Depreciation (Compustat Item 14)}. $CFOs_t$ is the cash flows from operations deflated by average assets for the current period. $CFOs_{t-1}$ is the cash flows from operations deflated by average assets for the previous period. $CFOs_{t+1}$ is the cash flows from operations deflated by average assets for the future period. *Earnings* is earnings before extraordinary items (Compustat Item 18) deflated by average assets (Item 6). *Revenues* is net revenues (Compustat Item 12) deflated by average assets. *Expenses* is the difference between *Revenues* and *Earnings*. *Vol (Earnings)* is earnings volatility, which is calculated by taking the standard deviation of the deflated earnings for the most recent five years. *Vol (Revenues)* is revenues volatility, which is calculated by taking the standard deviation of the deflated revenues for the most recent five years. *Vol (Expenses)* is expenses volatility, which is calculated by taking the standard deviation of the deflated expenses for the most recent five years. *Corr (Revenues, Expenses)* is the correlation between revenues and expenses, which is calculated as the correlation between the deflated revenues and the deflated expenses for the most recent five years. Normalize all volatility and correlation variables by their values for the beginning year of 1967.