The effect of sales and collection disclosures on cash flow forecasting and income smoothing*

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Abstract. Based on a model of sales and collection events of a firm, this paper analyzes the effect of different levels of disclosures about the two events on cash flow forecasting and income smoothing. A comparison of disclosure of credit sales from the sales accrual method and disclosure of cash collection from the cash collection (installment) method shows that when cash flows occur in a period subsequent to sales realization, the cash flow forecasts from earnings based on the sales accrual method are superior to forecasts from earnings based on cash collection. This is because the sales accrual method provides information on management's expectations about future cash flows. The analysis also shows that, for a similar reason, earnings based on the sales accrual method can be expected to be generally smoother than earnings based on the cash collection method. The model is also examined through a simulation study of a firm for a variety of parameter values.

Résumé. Fondé sur un modèle des événements de vente et de recouvrement d'une société, cet article analyse l'effet de divers niveaux de divulgation de ces deux événements sur la prévision de trésorerie et le lissage des bénéfices. Une comparaison de la divulgation des ventes à crédit selon la méthode de comptabilité d'exercice et de la divulgation des recouvrements selon la méthode de la constatation des profits au prorata des encaissements, montre que lorsque les flux monétaires se produisent dans un exercice postérieur à la constatation des ventes, les prévisions de trésorerie fondées sur les résultats produits par la méthode de comptabilité d'exercice, sont supérieures aux prévisions fondées sur les résultats issus de la méthode de constatation du profit au prorata des encaissements. Ceci est attribuable au fait que la méthode de comptabilité d'exercice fournit de l'information sur les prévisions de la direction au sujet des flux monétaires futurs. L'analyse montre également, pour des raisons similaires, que les résultats produits par la méthode de comptabilité d'exercice seront probablement plus nivelés que les résultats générés par la méthode de constatation du profit au prorata des encaissements. Le modèle est en outre examiné par l'entremise d'une étude de simulation d'une société pour différentes valeurs attribuées aux paramètres.

Introduction

Using a model of sales and collection events of a firm, this paper analytically compares the disclosure effects of income recognition based on credit sales and

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bad debt expense (the sales accrual method) with the alternative of income recognition based on collection (the cash collection or installment method), and examines how changes in disclosure can affect reporting objectives such as smoothing and cash flow forecasting. Cash flow forecasting has been recognized as a primary objective of accrual accounting by the Financial Accounting Standards Board in its Concepts Statement No. 1 (FASB, 1978).[1] Additionally, volatility reduction, or income smoothing, is often postulated by researchers and practitioners to describe management behavior with respect to accounting choice.[2]

The cash collection basis of income recognition, called the installment method when collection extends over many periods, is different from a strictly cash basis of accounting in that the concept of matching is still retained for reporting the expenses of a period. Under sales accrual accounting, which is mandated by Accounting Principles Board Opinion No. 10, revenue is recognized when the earnings process is complete or virtually complete and when cash collection is reasonably certain. The timing of cash collection is irrelevant for the timing of sales recognition, though it may affect the measurement of bad debt expense. The accounting standards in the U.S. allow the cash collection basis only in those unusual cases where collection is not reasonably assured and uncollectible amounts cannot be estimated (APB Opinion No. 10). However, a choice between the two methods is available in many other countries (e.g., Canada). Nevertheless, this paper uses these two simple disclosure alternatives mainly as analytical tools rather than policy alternatives to model the effect of disclosures on the two reporting objectives. The analysis is expected to highlight whether meeting one reporting objective (e.g., cash flow forecasting) is consistent with meeting a second objective (e.g., smoothing). Such an approach is potentially useful to regulators in establishing principles when comparing more complicated disclosure alternatives by explicitly considering the effects of the alternatives on various reporting objectives.

The analysis based on a model of sales and collection events shows that when cash flows occur in a period subsequent to sales realization, the cash flow forecasts based on credit sales disclosure are *superior* to forecasts based on cash collection information, because of the ability of the sales accrual method to disclose management expectations about the future through bad debt expense. By contrast, if collection precedes sales, this ability of the sales accrual system to incorporate management expectations becomes irrelevant, and the cash flow forecasts based on cash collection disclosure are equivalent to those based on the sales accrual method.

The sales accrual disclosure is also shown to produce generally smoother income measures when smoothing is defined as variance reduction. As in the case of cash flow forecasting, the primary reason for this result is that earnings

1 The FASB (1979, p. 3) refers to the process of forecasting cash flows from accrual earnings as a "two-stage process".

2 See Ronen and Sadan (1981) for a survey. The FASB also has acknowledged the possible importance of volatility reduction to users (Kirk, 1983).

based on accrued sales reflect *expected* cash flows rather than the more volatile actual cash flows. Thus income smoothing appears to be a basic characteristic of accrual systems.

The next section defines the firm and its disclosures under the sales accrual and cash collection alternatives. In the third section, the cash flow forecasting ability of the two disclosure systems is examined. The volatility of the earnings from the two methods is compared in the fourth section which also gives a brief review of the smoothing literature. Results from a simulation study of the model are reported in the fifth section. These results are generally consistent with the two propositions developed in the third and fourth sections. Some concluding thoughts are provided in the last section.

Model

This section defines the disclosures under the sales accrual and cash collection alternatives. It is assumed throughout that the matching principle is used under both methods to report expenses. Thus the cash collection method modeled here is based on accrual rather than cash basis accounting.

The model of the firm consists of three main components: sales, collection, and expenditure. These are described below, and are followed by a discussion of the information contained in the two alternative disclosure methods.

Sales

The sales in period t are given by

$$S_t = k_1 G_{1t} + k_2 G_{2t} + \dots + a_t = kG_t + a_t \tag{1}$$

where S_t is the dollar sales in period t, k is a vector of coefficients $(k_1, k_2, \dots)$, and G_t is a vector of exogenous variables (G_{1t}, G_{2t}, etc.) influencing the firm's operations (e.g., GNP, money supply, interest rate, etc.). A constant term may be included in (1) by defining $G_{1t} = 1$. The main variable of interest in equation (1) is the residual, a_t, which may be viewed as a random event affecting period t sales such that $E(a_t) = 0$, $E(a_t^2) = V_a$, and $E(a_t a_s) = 0$ for all t not equal to s.[3] This model of the sales generating process is attractive for its simplicity, since all firms are indeed affected by external events. Any seasonality in sales can also be accommodated by simply making some components of G_t seasonal. Lagged terms such as G_{t-1} may also be added to equation (1) without changing model results.

Collection

To model the cash collection method, it is necessary to make an assumption about when credit sales are collected. Normally, sales made in period t are partly collected in period t, $t + 1$, $t + 2$, etc. Since collection of period t sales in period t itself is accounted for the same way by both sales accrual and cash collection

3 The firm is assumed to have enough inventory to meet the demand.

methods, it is ignored here. Let m_1, m_2, etc. be the proportions of period t sales collected in $t + 1$, $t + 2$, etc. Then the following model describes period t collection:

$$C_t = m_1 S_{t-1} + m_2 S_{t-2} + \dots + e_t \tag{2}$$

where m_1, m_2, etc. are firm-specific constants. For convenience, let $m = m_1 + m_2 \dots$. Then m can be viewed as the proportion of credit sales ultimately collected *on the average*. For example, of the total sales S_t made in period t, $m_1 S_t$ is collected in period $t + 1$, $m_2 S_t$ is collected in $t + 2$, etc., for a total collection in future periods of mS_t. Since not all sales may be collected, m is expected to be less than one. The main variable of interest in equation (2) is the random event, e_t, affecting period t collection. It is defined similar to a_t, i.e., $E(e_t) = 0$, $E(e_t^2) = V_e$, and $E(e_t e_s) = 0$ for all t not equal to s.[4] The sales event, a_t, and the collection event, e_t, are assumed to be independent.

Expenditure

To keep the focus of the paper on sales and collection, it is assumed that the firm produces in each period an amount sufficient to meet the sales of that period. Thus the inventory level remains constant so that the accounting for inventory does not affect the earnings computation. In addition, the production cost is assumed constant, since assuming stochastic cost will only add to the model's complexity without providing new insight on the sales accrual and cash collection methods. Similarly, the timing of payment for production factors is not relevant to this study since both sales accrual and cash collection methods report expenses based on the timing of revenue recognition (i.e., the matching principle) rather than the timing of cash payment. Hence expenditures on production in period t are assumed to be given by

$$X_t = nS_t \tag{3}$$

where n is the constant production cost per dollar of sales (one minus gross profit ratio of the firm).[5] The cash flow from operations, Z_t, is then given by the difference between cash collection and cash expenditure, i.e.,

$$Z_t = C_t - X_t \tag{4}$$

Sales accrual disclosures

In the sales accrual method, the gross sales amount, S_t, is reported, but not the collection, C_t. In addition, a *net* sales amount, based on a provision for uncollectible accounts, is also reported. This amount reflects management's expectations about total future collections from period t sales, and is given by

4 Given the distribution of e_t, the collection could exceed S_{t-1}. This is remote, though, if $m < 1$ and V_e is sufficiently small.

5 Semivariable costs can be accommodated in the above equation without altering any of the results, by adding a fixed cost term and by assuming that it is allocated equally over units produced. The simulation results reported below were insensitive to the addition of a fixed cost term.

mS_t. Finally, following the matching concept, expenses reported in period t would be nS_t as given by equation (3). Hence the earnings, Y^s, based on the sales accrual method is

$$Y_t^s = (m - n)S_t \tag{5}$$

In this disclosure system, investors observe the total sales, and hence the sales event, a_t, but not the collection, C_t, or the collection event, e_t. Let IS_t be the information set of the investors in period t when the firm uses the sales accrual method. Then IS_t includes data on the exogenous variables, sales, and expenses. It also includes the sales error terms a_t, a_{t-1}, ... since these are obtainable from the data on exogenous variables and sales. However, it excludes data on collection and hence e_t, e_{t-1}, etc.

Cash collection disclosures

In the disclosure system based on the cash collection method, the cash collection, C_t, is reported as period t revenue. Following the matching concept, the expense reported in period t is proportional to the cash collected in period t, i.e., nC_t, where n is the cost of production per dollar of revenue. Hence earnings, Y^c, based on the cash collection method will be:

$$Y_t^c = C_t - nC_t = (1 - n)C_t \tag{6}$$

Since S_t is not observed, investors in this disclosure system cannot estimate equations (1) or (2) directly. However, substituting (1) into (2), we find that investors *can* estimate the following equation using the values observed in this disclosure system:

$$C_t = m_1 kG_{t-1} + m_2 kG_{t-2} + \dots + u_t \tag{7}$$

where

$$u_t = m_1 a_{t-1} + m_2 a_{t-2} + \dots + e_t$$

The residual term, u_t, satisfies the following conditions: $E(u_t) = 0$ and $E(u_t^2) = V_u$ = constant. Though the error term is autocorrelated, standard iterative procedures are available to estimate transfer functions such as equation (7). Let IC_t be the investor's information set in period t under the cash collection method. It includes data on the exogenous variables, collection, and expenses. It does not, however, include the collection errors or the sales errors because these are not directly disclosed. Only a combination of e_t and a_t, viz., the residual terms u_t, u_{t-1}, ... from equation (7), is included in IC_t.

Cash flow forecasting

In line with FASB's Concepts Statement No. 1 (FASB, 1978), it will be assumed in this section that earnings signals from the two disclosure systems are used for forecasting future cash flows. The forecast errors will be compared using the criterion of mean square forecast error (MSFE) which is defined as the *expected* value of the square of actual value minus forecast of a variable. This criterion is a joint measure of both variance and bias in forecasts (Ijiri and Noel, 1984), and has been widely used in the statistical literature.

Moreover, the MSFE criterion can be used to evaluate any type of forecast, such as one-step-ahead forecast, two-step-ahead forecast, etc. In this paper, since the cash flow forecasts from the two accounting methods for periods $t + 1$, $t + 2, \ldots$ are defined as expected values of cash flows conditional on the *period t* information set, the forecasts for the various forecast horizons would be equivalent except to the extent that the forecasts of the exogenous events (G_t) differ. For convenience, this paper abstracts from the issue of forecasting G_t. Hence only the one-step-ahead forecasts are discussed below.

Consider first the operating cash flow forecasts made with disclosures from the sales accrual method. The forecasts can be defined as

$$Z_t^s = E(Z_t | \mathrm{IS}_{t-1}) \tag{8}$$

The forecast in (8) is formed at the end of period $t - 1$ using the information set IS_{t-1}. Similarly, let Z_t^c be the cash flow forecast, made at the end of period $t - 1$, based on the disclosures from the cash collection method:

$$Z_t^c = E(Z_t | \mathrm{IC}_{t-1}) \tag{9}$$

A comparison of the two forecasts yields the following result.

Proposition 1

For the firm described by equations (1) to (7), the cash flow forecasts from the sales accrual disclosures have smaller forecast errors than those from the cash collection disclosures.[6]

Proof

To compute the MSFE of Z_t^s, it is preferable first to write the cash flows, Z_t, in terms of the random error terms. Substituting the equations for C_t and X_t into the cash flow definition (equation (4)), and the equation for sales into equation (3), we get

$$Z_t = (m_1 S_{t-1} + m_2 S_{t-2} + \ldots + e_t) - n(kG_t + a_t) \tag{10}$$

All variables in (10) except for the period t values of the exogenous variables (G_t) and the error terms (e_t and a_t) are already known at $t - 1$, i.e., they are in IS_{t-1}. As noted above, this paper abstracts from the issue of how the exogenous forecasts are made. Consequently, the expected value of Z_t given IS_{t-1} is computed from (10) by setting the two error terms, e_t and a_t, to their expected values of zero. Hence the forecast error is $e_t - na_t$. Since e_t and a_t are independent, the MSFE of the forecast is given by

6 In the degenerative case when $V_a = 0$ or $m = 0$, the two forecast errors are equal. See equation (14) below.

$$E(Z_t - Z_t^s)^2 = E(e_t - na_t)^2 = V_e + n^2 V_a \tag{11}$$

To compute the forecast errors from the cash collection method, it is necessary to rewrite the equation for cash flow (equation (4)) in terms of the variables present in IC_{t-1}. Substituting the estimated cash collection equation (7) and the definition for expenditure into (4), and the equation for sales into equation (3), we get:

$$Z_t = (m_1 kG_{t-1} + m_2 kG_{t-2} + \ldots + u_t) - n(kG_t + a_t) \tag{12}$$

All variables in (12) except period t values of u_t, a_t, and G_t are in IC_{t-1}. Ignoring the error from forecasting G_t, which is common to both disclosure systems, the forecast error from the cash collection method is $u_t - na_t$, and the MSFE of Z_t^c is given by

$$E(Z_t - Z_t^c)^2 = E(u_t - na_t)^2 = V_u + n^2 V_a \tag{13}$$

Since, from (7), $V_u = V_e + m_1^2 V_a + m_2^2 V_a + \ldots$, a comparison of (11) and (13) yields the result contained in the proposition:

$$\text{MSFE}(Z_t^c) - \text{MSFE}(Z_t^s) = (m_1^2 + m_2^2 + \ldots)V_a. \tag{14}$$

From (14), it is clear that the relative superiority of the sales accrual method is an increasing function of the proportion of sales expected to be collected (i.e., the collection fractions m_1, $m_2, \ldots$) and the volatility of the sales event (V_a).[7] The forecast accuracy of the sales accrual method degenerates to that of the cash collection method only if virtually none of the credit sales are expected to be collected (i.e., m is close to zero) and/or if sales are relatively deterministic (i.e., V_a is zero). In these degenerative cases, the information provided by the sales accrual method about expected collection has no incremental value for the purpose of predicting future cash flows, as one would expect. In general though, this method's ability to disaggregate the joint information about sales and collection proves superior to the cash collection method's mixed signal, u_t, about collection and sales events.

This analysis points out that a necessary condition for the cash collection method to have superior forecasting ability is that it disclose some unambiguous signal about the collection event. An example of this situation might be a firm for which cash flows *precede* sales recognition. For example, consider a travel agency which sells tickets and collects cash in one period and renders travel services in the following period. However, even in this case, sales recognition in each period would depend on the actual service rendered in that period rather than the cash collected in that period. This is because of the accrual accounting requirement that the earnings process be virtually complete before sales are recognized. Thus both sales accrual and cash collection methods would report

7 The collection error variance, V_e, is absent in equation (14) because it affects both the MSFE terms equally, as shown in equations (11) and (13). However, evaluation measures such as the percentage improvement in MSFE (the MSFE difference divided by the MSFE of the cash collection method), would depend on V_e since the denominator depends on V_e.

the same earnings and have the same forecast errors when cash is collected before service is rendered. In general, if cash flows precede sales recognition, then the value of the information in the sales accrual method about management expectations on collection is nullified, and the cash collection method does as well as the sales accrual method for cash flow forecasting. Similar examples can be constructed for manufacturing firms (e.g., a construction contractor). Only when the cash collection method is applied without regard to the earnings process, i.e., when the cash basis rather than accrual accounting is used, does this method give information superior to the sales accrual method.

Income smoothing

Although the cash flow forecasting objective has been emphasized by the FASB in the choice of accounting methods, an additional reporting objective has been proposed in the past to explain accounting choices. This is the volatility reduction, or smoothing, objective. This section examines the smoothness characteristics of the reported earnings in the sales accrual and cash collection methods.

The smoothing hypothesis, which says that managers would choose information systems to reduce the volatility of reported income or performance measures, was originally proposed by Hepworth (1953). Although Hepworth had assumed the welfare maximization of management only, the hypothesis may also be a descriptive model of managerial choice in a more general stockholder-manager agency setting, as shown by Lambert (1984). Even as a conjecture, however, the hypothesis has been empirically tested extensively.[8] Also, the feasibility, rather than the existence, of smoothing has been studied by Ball and Watts (1972) and Gonedes (1972).

Despite the abundance of studies, there is a surprising lack of consensus in the literature on the definition or measurement of "smoothing". The usual approach is to define smoothing as reducing the variance of reported income measures. Less frequently, smoothing is defined as increasing the serial correlation in the reported data. Composite measures incorporating both variance and serial correlation have also been proposed. The two measures of smoothing are not, however, independent. Serial correlation, or more accurately autocorrelation at lag 1, is defined as the autocovariance of a variable at lag 1 divided by its variance. Thus, *ceteris paribus*, an increase in variance would imply a reduction in autocorrelation. Hence variance, rather than autocorrelation, is used below as a measure of smoothing.

For the firm modeled here, the variances of the earnings reported by the two accounting methods are easy to define. For the earnings, Y_t^s, from the sales accrual method, the expected value is

$$E(Y_t^s) = (m - n)E(S_t) \tag{15}$$

8 Examples of accounting methods and economic decisions analyzed in the past are accounting changes (Cushing, 1969), extraordinary items (Barnea, Ronen and Sadan, 1976), foreign currency exposure (Burns, 1976), and nonsubsidiary investments (Barefield and Comiskey, 1972).

Hence the variance is

$$E(Y_t^s - E(Y_t^s))^2 = (m - n)^2 E(S_t - E(S_t))^2 = (m - n)^2 V_a \tag{16}$$

which follows from the sales process defined in (1). For the earnings, Y_t^c, from the cash collection method, the expected value is obtained from equations (5) and (2) defining earnings and collection:

$$E(Y_t^c) = (1 - n)E(C_t) = (1 - n)(m_1 E(S_{t-1}) + m_2 E(S_{t-2}) + \ldots) \tag{17}$$

The variance is then given by

$$E(Y_t^c - E(Y_t^c))^2 = (1 - n)^2 V_e + (1 - n)^2 (m_1^2 + m_2^2 + \ldots) V_a \tag{18}$$

Since the collection rate, m, is less than 1, and since it must exceed the cost of production (i.e., $m > n$) for a firm to be viable, $(m - n)^2$ is less than $(1 - n)^2$. Hence a comparison of the two variances given by equations (16) and (18) yields the following result:

Proposition 2

For the firm defined in equations (1) to (7), a *sufficient* condition for the variance of the sales accrual-based earnings to be less than that of the cash collection-based earnings is given by: $(1 - m_1^2 - m_2^2 - \ldots)V_a < V_e$.

To understand the implication of this proposition, consider the case where all the collection takes place during one period, i.e., $m_1 = m$. Then the sufficient condition becomes $(1 - m^2)V_a < V_e$. In practice, m is likely to be close to 1 (i.e., most of the credit sales are generally collected), and hence $(1 - m^2)$ is generally close to zero. Therefore, provided cash collection is not deterministic (i.e., V_e is not zero), the condition favoring the sales accrual method is expected to hold generally. (This is borne out by the simulation results reported below.) If variance reduction is desired, it seems then that the sales accrual method would *generally* be the preferred method. An intuitive motivation behind this result is that some components of sales accrual earnings are based on expectations of cash flows rather than actual cash flows and hence are less volatile. Thus it appears that income smoothing, in a variance reduction sense, is a basic characteristic of accruals.

A simulation study

The two propositions from the theoretical analysis are consistent with the widespread use of the sales accrual method to meet the reporting objectives of cash flow forecasting and income smoothing. Moreover, these are empirically testable propositions, though the tests may involve some potential econometric and data collection problems, which are discussed below.

Proposition 1 can be tested by estimating the validity of equation (14) which predicts the relative accuracy of sales accrual-based cash flow forecasts to be an increasing function of collection rate (m_1, m_2, etc.) and the sales variance (V_a). Proposition 2 can be tested by examining whether the difference between the variance of sales accrual-based earnings and that of cash collection-based earnings satisfies the sufficient condition given in the proposition. First, the main problem in carrying out these tests may be in estimating the collection rate. Most firms do not disclose accounts receivable amounts in their quarterly reports and hence annual data may have to be used to get m_1, m_2, etc., which would weaken the power of the tests. Second, some of the exogenous variables in the sales process may be nonstationary (e.g., random walk), requiring the use of variance bound tests as in Shiller (1981) to estimate equations (16) and (18).

Proposition 1 can also be tested by first identifying *a priori* a set of firms that realize revenues prior to collection and a second set of firms that recognize revenue after collection, and then comparing the cash flow forecasts of the two groups. As discussed earlier, the hypothesis is that the cash flow forecast errors of the former firms should be less than those of the latter firms. For example, magazine publishers which collect cash ahead of revenue recognition can be compared with retail firms which collect cash typically after sales. The main problem may be in forming the groups correctly since firms often have both types of revenues and thus reduce the power of the test. Additionally, this test requires a cross-sectional study involving more than one industry to which the model in the paper may not apply.

As a substitute for an empirical study based on actual data, a simulation study of the model was undertaken, using a realistic model of sales generation (i.e., a model estimated with real world data). The sales process of the firm (say, a meat processor) was assumed to depend on monthly hog production (i.e., equation (1) was assumed to have one exogenous factor). The equation to generate data on monthly hog production was taken from Pindyck and Rubinfeld (1975), which is based on actual hog production statistics.[9] Cash collection was assumed to be spread over two months following sales. For model generation, the collection error variance (V_e) was treated as a constant, and the sales error variance and collection percentages were varied.

Simulations necessarily involve decisions on the part of the researcher about various model parameter values. The following is a summary of the input parameters common to all models. An explanation for their values is given next.
Mean hog production = 100,000.
Standard deviation of hog production = 5,000.
Standard deviation of cash collection ($\sqrt{V_e}$) = 500.
Sales equation coefficients: k_1 (constant) = 10,000. $k_2 = 0.125$.
Production cost (n) = 0.7.
Collection fractions: $m_1 = 0.7\text{m}$, $m_2 = 0.3\text{m}$.

9 The equation (Pindyck and Rubinfeld, 1975, p. 494) has three autoregressive terms, a 12-month differencing for seasonality, and a simple differencing for time trend. It thus provides a reasonably complex and realistic exogenous factor for the sales generating process. After expanding the various differencing terms, the equation appears as follows:

$$\begin{aligned}\text{HOG}_t = {} & 0.0014 + 0.3319\text{HOG}_{t-1} + 0.4666\text{HOG}_{t-2} + 0.3313\text{HOG}_{t-3} \\ & + \text{HOG}_{t-12} - 0.3319\text{HOG}_{t-13} - 0.4666\text{HOG}_{t-14} - 0.3313\text{HOG}_{t-15} \\ & + 0.1298\text{HOG}_{t-16} + \text{error term for time } t.\end{aligned}$$

The mean hog production value, needed to initialize the hog production time series, was chosen to keep the cash flows positive so that the percentage forecast errors reported below have correct interpretations. The standard deviation of hog production was chosen to provide a reasonable variation in the production data. A larger value would have made the seasonal pattern in the time series less transparent. The sales equation constants were chosen to get sales that were approximately 10–15 percent (say, market share) of hog production. The standard deviation of cash collection was therefore chosen to be ten percent of that of hog production. A fixed ratio was chosen for m_1/m_2 instead of varying each constant separately because only the sum $m_1^2 + m_2^2 + \ldots$ (rather than individual values of m_1, m_2 etc.) appears in the propositions. The simulation results were found to be insensitive to the choice of values for V_e, n, k_1, k_2, and $m1/m2$.

A total of 90 models was generated using the following parameter combinations: $\sqrt{V_a} = 0$ to 400 percent of $\sqrt{V_e}$, in increments of 50 percent (nine values), and $m = 0.9$ to 0.99, in increments of 0.01 (ten values).[10] Random normal deviates were used to generate hog production errors, sales errors, and collection errors. Each model was simulated as follows: First, the hog production was determined (common for all models). Then sales were determined using equation (1) and cash collection from equation (2). The sales-accrual and cash-collection earnings were then determined using equations (5) and (6). Cash flow forecasts were determined using equations (10) and (12) by setting the appropriate unknown error terms to zero. The first 150 simulated periods were discarded and the MSFEs and variances were calculated using periods 151 to 200.

Proposition 1 was examined by running a regression, in the logarithm form, of equation (14):

$$\log(\mathrm{MSFE}(Z^c) - \mathrm{MSFE}(Z^s)) = a + b_1 \log(m_1^2 + m_2^2 + \ldots) + b_2 \log(V_a)$$

where, from equation (14), b_1 and b_2 are expected to have a value of 1. Excluding the ten models with $V_a = 0$, the estimated coefficients based on 80 observations are given below, with standard errors in parentheses:

$a = -10.6300$	$b_1 = 1.3971$	$b_2 = 0.9541$	$R^2 = 0.9355$
(0.5669)	(0.6191)	(0.0286)	

For testing the null hypotheses of $b_1 = 1$ and $b_2 = 1$, the t-ratios are 0.641 and 1.602, not significant at the five percent level. Thus the estimation does not reject the proposition.

Though the proposition is stated mainly as the difference in MSFE which is based on the squared sum of forecast errors and hence depends on the *level* of cash flows, an alternate test of the proposition is to compare the forecast errors expressed as percentages. The following two widely used forecast error measures (e.g., see Foster, 1986, pp. 266–267) were computed for each model:

10 Thus models 1 to 10 had standard deviation of sales ($\sqrt{V_a}$) = 0 and $m = 0.9, 0.91, \ldots 0.99$; models 11 to 20 had $\sqrt{V_a} = 250$ and $m = 0.9$ to 0.99; etc.; and models 81 to 90 had $\sqrt{V_a} = 2{,}000$ and $m = 0.9$ to 0.99.

TABLE 1
Mean square and mean absolute percentage errors

Model	Sales std. dev. $\sqrt{V_a}$	Collec. rate m	MSE% Sales Accrual	MSE% Cash collec.	MSE% Difference %	MAE% Sales accrual	MAE% Cash collec.	MAE% Difference %
1	0	0.90	230.99	230.99	0.00	10.25	10.25	0.00
6	0	0.95	66.41	66.41	0.00	6.70	6.70	0.00
11	250	0.90	5888.97	8337.79	29.37	22.75	25.74	11.64
16	250	0.95	214.53	247.08	13.18	10.56	11.05	4.43
20	250	0.99	63.54	81.94	22.45	6.20	7.22	14.22
23	500	0.92	231.70	338.33	31.52	10.60	12.41	14.58
27	500	0.96	239.13	308.56	22.50	10.64	12.59	15.50
32	750	0.91	819.68	1777.94	53.90	15.64	23.95	34.69
36	750	0.95	798.88	2108.36	62.11	15.75	22.43	29.78
44	1000	0.93	455.95	620.08	26.47	14.54	18.43	21.11
49	1000	0.98	209.34	350.33	40.24	10.97	13.28	17.39
54	1250	0.93	458.64	1731.30	73.51	14.34	24.24	40.85
59	1250	0.98	887.87	1015.92	12.60	14.99	18.94	20.87
62	1500	0.91	12432.65	19397.20	35.90	37.13	47.11	21.19
65	1500	0.94	730.51	2347.52	68.88	18.49	32.23	42.63
70	1500	0.99	432.47	1321.01	67.26	14.93	22.90	34.81
74	1750	0.93	4407.36	16343.64	73.03	31.19	45.73	31.80
80	1750	0.99	1023.16	2174.09	52.94	21.88	26.05	16.00
84	2000	0.93	2759.30	5346.21	48.39	28.67	39.03	26.56
90	2000	0.99	716.77	2324.54	69.17	19.00	33.45	43.20

Note: The collection rate ranged from 0.9 to 0.99, in increments of 0.01, for models 1 to 10, models 11 to 20, etc. For convenience, only 20 of the 90 simulated models are displayed above. Results for the models not displayed were similar.

$$\text{MSE\%} = 100 \times [\Sigma(Z_t - Z_t^f)^2/Z_t)]/50$$

$$\text{MAE\%} = 100 \times [\Sigma|Z_t - Z_t^f|/Z_t]/50$$

where MSE% is the mean square percentage error, MAE% is the mean absolute percentage error, Z_t is the actual cash flow, Z_t^f is the forecast (where f is either the sales-accrual or cash-collection method), and the summation is over $t =$ 151, ... 200. The two forecast error measures were calculated for each model and the two disclosure systems.

Recall that for each of nine different values of the sales standard deviation ($\sqrt{V_a}$), ten models were simulated by varying m from 0.9 to 0.99 in increments of 0.01. For convenience, Table 1 presents the results for a sampling of the 90 models rather than for all of them (results for other models were similar). As can be seen from the table, the sales accrual system had smaller forecast errors than the cash collection system for every model for which $V_a > 0$, under either forecast criterion.[11] When $V_a = 0$, the two forecast errors were equal as predicted. Moreover, the percentage improvement in forecast errors for the sales

11 One model had negative cash flows in one period. Because of this, percentage forecast errors could not be calculated.

accrual method is an increasing function of V_a and m as suggested by equation (14).

To examine proposition 2, the variances of earnings under the two disclosure methods were calculated using the simulated data for periods 151 to 200. The sufficient condition in proposition 2 was satisfied for 32 of the models simulated. For 21 (66 percent) of these models, the variance of sales-accrual earnings was smaller as suggested by the proposition. Of the 58 cases where the sufficient condition was not satisfied, 33 (57 percent) had smaller variances for accrual earnings. While these results are not sufficient to either accept or reject proposition 2, they do indicate that sales-accrual based earnings are more likely to be smoother than cash-collection based earnings.

A closer look at the data showed that the variance of sales-accrual earnings was greater than that of cash-collection earnings whenever the collection rate (m) was 0.97 or higher. For smaller m values, the sales-accrual earnings almost always had the lower variance. For example, of the 54 models where m was 0.90 to 0.95, the sufficient condition was not satisfied for 36 models, but only four of these models had higher variance for the sales-accrual earnings. It is not clear from an examination of equations (16) and (18) why the variance of cash-collection earnings should be lower whenever m is close to 1. A possible explanation may be that, given the time series model used for hog production, the variance in hog production may make $E(S_{t-1})^2$, $E(S_{t-2})^2$, etc. unequal, unlike the assumption made in equation (18). To test this possibility, the models were rerun with the variance of hog production errors set to zero.[12] Now 30 of the 32 models for which the sufficient condition was satisfied had lower variance for sales-accrual earnings. Of the remaining 58 models, 31 had lower variance for sales-accrual earnings. Thus the proposition is supported more strongly.

To test the sensitivity of the results to the input parameters, various combinations of parameter values for cash collection error variance (V_e), sales equation (x_1 and x_2), and production cost (n and a fixed cost term) were tried. Also, the interest rate was tried as an exogenous factor instead of hog production by using an estimated time series equation from Pindyck and Rubinfeld (1975) to generate interest rates. The results were insensitive to these assumptions.

Conclusion

Using a model of sales and collection processes, this paper examined the characteristics of the earnings from two revenue recognition methods, viz., sales accrual and cash collection. It was shown that when accruals reflect management expectations, earnings from the sales accrual method produce superior cash flow forecasts than do earnings from the cash collection method. The income number from the sales accrual method was also shown to be generally less volatile than the collection-based income number. These propositions are consistent with the

12 To get some variation in the hog production data, the first 16 values needed to initialize the hog production equation were varied around the mean value.

widespread use of the sales accrual method to meet these reporting objectives. Results from the simulation study reported in the preceding section support both propositions.

Some empirical research design issues were also discussed in the preceding section. It should be emphasized, however, that the disclosure model used here is only a stylized representation of income statement disclosures. While the simplicity in the model was useful to illustrate the methodology and to get tractable results, empirical tests may require a more realistic model of a firm's balance sheet in addition to its income statement.

Finally, more research is needed to identify the importance of different reporting objectives for different managerial decisions. Moreover, a catalog of the differences in disclosure signals from different accounting systems will be useful for further modeling effort in this area. The resulting models would complement the current literature on accounting choice (Holthausen and Leftwich, 1983) to explain how different management interests influence firms' decisions to select or modify reporting systems.

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