The Time-Series Properties of Operating Cash Flows —Evidence from Japan—

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Abstract

This study provides evidence on the time-series properties of operating cash flows (OCF) and the expectation models for predicting one year ahead OCF for a sample of Japanese firms. First, we assess the OCF time-series pattern for an average firm using the cross-sectional sample autocorrelation function. Next, we study whether individual firms' OCF can be accurately described by a random walk (RW) process. In addition, we examine the diversity of individual firms' OCF processes using the Box-Jenkins methodology. Finally, we compare the accuracy of forecasts from firm-specific ARIMA, RW, and multivariate, time-series regression approaches (MULT). The results indicate that, (1) the OCF time-series can be generally depicted as a moving average process, (2) a number of individually identified OCF processes differ significantly from RW, (3) there is diversity in the firm-specific ARIMA structures for OCF, and (4) that, when predicting OCF, MULT outperforms the firm-specific ARIMA as well as the premier RW. We find that one year ahead CF prediction is enhanced by accrual components as well as the prior CF.

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1. INTRODUCTION

The relevance and usefulness of the cash flow and accrual components of current earnings for firms' expected future attributes have been examined widely (e.g. Sloan 1996; Barth et al. 2001; Dechow and Dichev 2002; Tazawa 2004). The FASB asserts that information about enterprise earnings and its components measured by accrual accounting generally provides a better indication of enterprise performance than information about current cash receipts and payments (FASB 1978, para. 44). Barth et al. (2001) find that the cash flow and accrual components of current earning have substantially more predictive ability for future cash flows rather than several lags of aggregate earnings. Sloan (1996) indicates that earnings performance attributable to the accrual component of earnings shows lower persistence than earnings performance attributable the cash flows, and that most of the mean reversion takes place in the first year. He also finds that firm's earnings performance is affected by cash flows. However, Dechow and Dichev (2002) find that the measure of accrual quality is positively related to earnings persistence.

Thus, from the previous evidence, it seems that the cash flow and accrual components of current earnings have an impact on the time-series properties of accounting information.[1] Although a number of studies have been conducted regarding the time-series properties of accounting earnings[2], a few studies examine the time-series properties and the predictive ability of the cash flow and accrual components of current earnings for future attributes. In particular, while most prior studies focus on the U.S. firms, we investigate Japanese companies to determine if the U.S.-based results hold. An analysis of operating cash flow time-series properties is important since researchers try to use models of cash flows to value securities; this requires estimates of expected future cash flows. In addition, researchers utilize predicted

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[1] Foster (1977) asserts that because management knows the stochastic process generate the reported accounting series when making 'smoothing' decisions, an estimate of the expected accounting information is based on the past accounting series. In this context, knowing of a descriptively valid time-series model of accounting information is critical in determining the weights to be placed on each past period's accounting information.

[2] In Japan, Sakurai (1994) investigates the time-series properties of accounting earnings numbers on the basis of 'average' results of annual data from Japanese 794 listed firms over the period 1977-1988 cross-sectionally and finds that the time-series properties of accounting earnings follow the random walk models, consistent with Ball and Watts (1972). Mori (1997) provides evidence on the time-series properties of industry' s average annual accounting earnings,using data of Bank of Japan' s "Shuyo Kigyo Keiei Bunseki" for periods from 1951-1990 and find that undeflated earnings do not follow the RW models and the MA models can be described for deflated earnings.

earnings as surrogates for future cash flows.[3)]

For a set of Japanese companies, we investigate whether the cash flow and accrual components of current earnings can be used as predictors of future cash flows. One way of predicting future cash flows is to estimate the process using the time-series properties of past cash flows.[4)] First, in this study we assess the operating cash flow time-series properties of an "average" firm using the cross-sectional sample autocorrelation function. Second, we investigate whether individual firms' operating cash flows processes can be described by a random walk model. Third, using the Box-Jenkins methodology (Box and Jenkins 1994), we identify and estimate firm-specific ARIMA models for operating cash flows. Fourth, we compare the predictive performance of random walk models, firm-specific ARIMA models, and multivariate, time-series regression models (MULT) using prior accrual components and operating cash flows as independent variables (Lorek and Willinger 1996).

This study contributes to the cash flow forecasting literature in following respects ; first, for a set of Japanese companies, we not only develop the expectation models appropriate to the time-series properties of operating cash flows through the use of the B-J methodology, but we also compare the predictive performance of the various cash flow expectation models for future cash flows. Previous studies have not tested operating cash flows time-series through the use of the B-J methodology for individual Japanese firms. Second, we assess the accuracy of the forecasts generated from the univariate cash flows models against the forecasts generated from the multivariate, time-series regression model to investigate the role of accrual components. Furthermore, since our variables are derived from the statements of cash flows, not the balance-sheet approach, they are much less noisy.

The reminder of the paper is organized as follows ; Section Two reviews the

3) In order to predict earnings, researchers need to estimate a process that describes thetime series properties of past earning. Also, they want to obtain better earnings expectations models in order to study the relation between stock prices and earnings. They need to know the time-series of past earnings to try to derive a surrogate for the market' s expectation of earnings (Watts and Zimmerman, 1986, pp. 129-136).

4) Even if cash flow information has predictive value, in order to prove that the cash flow information is useful for decision making, it is necessary to clarify that cash flow information makes a difference to decisions, by improving decision makers' capacities to predict or by confirming or correcting their earlier expectations (FASB, 1980, para. 51) and to alter the security' s price (Yurikusa, 2001, p. 10). The market' s expectation of future earnings is likely to impound this information. Thus, in trying to investigate the information content of cash flows, it is important to identify the expectation models in order to describe the unexpected cash flows appropriately (Yurikusa, 2001, pp. 139-140).

extant research. Section Three develops the hypotheses. Section Four describes the data sample and specifies the cash flow expectation models, and reports diagnostic tests. Section Five presents the results from the analyses. Section Six summarizes and concludes this study.

2. LITERATURE REVIEW

In the U.S., Hopwood and Mckeown (1992) investigate the time-series properties of earnings per share and cash flows per share for all manufacturing firms. The averages of the autocorrelations are presented for both earnings per share and operating cash flows per share. Both individually-identified and premier models are compared on the basis of their fit and the accuracy of predictions. Their results suggest that for both variables individually-identified models outperform premier models. They also find that the time-series properties of cash flows are quite different than those of earnings, and that cash flow time-series are considerably less predictable.

Lorek et al. (1993) provide evidence that univariate ARIMA models of cash flows generate more accurate forecasts than the multivariate cross-sectional regression models. They focus on quarterly data rather than annual data and find that SAR ARIMA models are good candidates for modeling and predicting cash flow series. Lorek and Willinger (1996) provide evidence on the time-series properties and predictive ability of undeflated cash flow, cash flow per-share and cash-flow deflated by total assets. They identify a diverse set of firm-specific ARIMA models for cash flow and suggest that multivariate, time-series prediction models (MULT), which employ lagged values of earnings and short-term accruals, outperform firm-specific ARIMA models, common-structure ARIMA (SAR and SMA) models, and multivariate cross-sectional regression models in one-step-ahead quarterly cash-flow predictions.

McLeay et al. (1997) provide evidence that using the Ljung-Box serial correlation test of goodness-of-fit, the random walk model does not fit cash flow data well. The integrated moving average (IMA) and the exponentially-weighted moving average (EWMA) models have better fits, particularly the EWMA models.

Dechow and Dichev (2002) examine the relation between accrual quality and earning persistence, based on the firm-specific regression, using the variable from the statements of cash flows from 1987 through 1999. They find that firms with low accrual quality have more accruals that are unrelated to cash flow realization, and so have more noise and less persistent in earnings. They also show that accrual quality and level of accruals are incremental to each other in explaining earnings persistence with accrual quality the more powerful determinant.

In Japan, Yurikusa (2001) investigates the time-series properties of cash flows from operations (OCF), cash flows from financing (FCF), and cash flows from investing (ICF) of an "average" firm using funds flow statements data for Japanese listed parent firms from 1987 through 1999. He provides evidence that operating cash flows are better described by the integrated moving average models (IMA) since the IMA models outperform the white-noise (WN) models and the random walk (RW) models. His results indicate that the predictive ability of the IMA models for OCF and ICF are superior to the WN models and the RW models. For FCF, the predictive ability of the IMA models and the WN models are superior to the RW models. He indicates that the RW models do not always suit the time-series properties of cash flows.

Tazawa (2001) investigates the serial correlations of earnings changes, accruals changes, and cash flow changes across 1, 012 firms through the use of the income statement and balance sheet data over 1967 to 1997. He provides evidence that the serial correlation for earnings changes is close to zero and finds that accruals offset the negative correlation in cash flow changes to produce earnings changes that are much less negatively serially correlated. In addition, his evidence, consistent with Dechow et al.(1998), shows that current earning is a better predictor of future operating cash flows. Also, Tazawa (2004) examines the a relation between the quality of accruals and the predictive ability of forecast models for future cash flows across 1,381 firms employing the income statement and balance sheet data spanning 1989-2001. He finds that after controlling for forecast errors with the model based only on cash flows, the accruals quality is positively related to the predictive ability of the model including accruals.

3. HYPOTHESES DEVELOPMENT

Ali (1994) suggests that the mean serial correlation for changes in cash flows for the low operating cash flows (CFO) group is -0.08 and for the high CFO group is -0.43. These results indicate that cash flows exhibit significant levels of mean reversion for both groups, and a differenced CFO has a first-order negative autocorrelation. Therefore, this evidence suggests the time-series of CFO do not follow a random walk. McLeay et al. (1997) suggest that the ACFs tend to decay after lag one and the PACFs tend to dampen towards zero for cash flows, suggesting an IMA (d, 1) process. They also suggest that a test of residual autocorrelation using the Box-Pierce Q-statistic confirms that for $d=1$, residual autocorrelation is not significantly different from zero at the 5% level and that the residual shocks are independent. Lorek and Willinger (1996) suggest that the SACFs and PACFs of the undeflated cash flows exhibit a monotonic decline in the SACF at the seasonal lags (n=4, 8, and 12). This evidence supports the seasonal autoregressive models (SAR) (000)×(100). They also find that the seasonal differenced cash flows exhibit a singular spike at lag 4 and this is supportive of the seasonal moving-average process models (SMA) (000)×(011).

Although previous studies provide evidence that accounting earnings of an "average" firm are generated by a random walk process[5], few studies investigate whether the time-series properties of operating cash flows of an "average" firm can be described by a random walk. Because the patterns of cash flows as components of current earnings over time affect firms' ability to sustain future cash flows, this study examines the time-series behavior of operating cash flows of an "average" firm and determines if the OCF time-series process of an "average" firm can be characterized by a random walk. Also, we determine whether the deflator affects the underlying time-series properties of operating cash flows. Thus, this leads to the following hypothesis ;

H1 : The time-series properties of the operating cash flows of an "average" firm follow a random walk model and the autocorrelation for any lag τ for operating cash flows changes is zero.

Hopwood and Mckeown (1992), Lorek and Willinger (1996), and McLeay et al. (1997) discuss if individual firms' operating cash flow differ from a random walk model. Hopwood and McKeown (1992) suggest that most of the cash flow models do not involve differencing, 50 of the 60 cash flow series contain no differencing and that the most frequently identified models are AR (000)×(100) model (6 of the 60 firms) and MA (001)×(000) model (5 of the 60 firms). Lorek and Willinger (1996) suggest that only one firm of 62 firms follows a random walk model when firm-specific ARIMA models are identified for individual firms' quarterly cash flow series. They identify firm-specific ARIMA models for cash flows, suggesting that 38 of 62 firm-specific ARIMA models for the cash flow series are the seasonal AR models or the seasonal MA models. The most frequently identified firm-specific ARIMA structure is the (000)×(011) SMA model, appearing 10 of 62 times for the cash flows series.

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[5] Ball and Watts (1977) and Sakurai (1994) test the null hypothesis that autocorrelation for any lag for earnings changes is zero, and Ball and Watts (1977) provide evidence that the median autocorrelations for all five lags for the changes in earnings per share are close to zero and are insignificantly different from zero and Sakurai (1994) suggests that the null hypothesis is not rejected at 5% level for 87.3% (693 firms) of the 794 firms. These two results suggest that the time-series properties of accounting earnings follow the random walk models.

If the best fitting model is identified for individual firms, a number of firms' estimated processes may differ significantly from random walk models. There might be diversity among the processes generating individual firms' operating cash flows. As Lorek and Willinger (1996) assert, the cash flow time-series properties of an "average" firm may not necessarily be similar to those of individual firms because the mean ACF and PACF values may mask firm-specific behavior. We identify the ARIMA models to estimate the processes of cash flows time-series for each firm, using the B-J methodology. Thus, this leads to the following hypothesis.

H2 : A number of firms' estimated processes generating operating cash flows significantly differ from a random walk.

Hopwood and McKeown (1992) indicate that for cash flows, individually-identified models outperform the premier models. This suggests that individually-identified models are uniformly the most accurate although their advantage over the Brown-Rozeff and Griffin-Watts models are small for one-quarter-ahead forecasts. Lorek et al. (1993) suggest that the univariate autoregressive-integrated-moving average models for quarterly cash flows provide more accurate cash-flow prediction than multivariate cross-sectional models. In addition, Lorek and Willinger (1996) provide evidence that multivariate, time-series regression cash flow prediction models are superior to common-structure ARIMA models and random walk models. They also demonstrate that cash flow prediction is enhanced by considering prior earnings and accruals. Mcleay et al. (1997) suggest that the predictive ability of an exponentially weighted moving average model is superior to the predictive ability of random walk models as well as integrated moving average models by the comparison among the mean absolute error from those models.

Beaver asserts that accruals reflect management's expectations about future cash flows and are based on an information system potentially more comprehensive than past and current cash flows (Beaver 1998, pp. 5-6). Barth et al. (2001, pp. 56-57) suggest that each accrual component may have a significant relation with future cash flows. This implies that the accrual components aid in predicting future cash flow beyond current cash flow. A number of studies that find that accrual components of current earnings have more predictive ability for future cash flows have been conducted in the US (e.g. Lorek and Willinger 1996 ; Dechow et al. 1998 ; Barth et al. 2001).

To examine this, we compare the accuracy of the forecasts of future operating cash flows based on individually identified ARIMA models with (1) forecasts based on random walk models applied for all the sample firms, and (2) forecasts obtained from a multivariate, time-series regression that uses past values of accrual components. These results will provide evidence that accrual components are useful in cash flow prediction. Hence, this leads to the following hypothesis ;

H3 : There is no difference in absolute percentage error among (1) the forecasts of multivariate, time-series regression models using accrual components, (2) the forecasts from firm-specific ARIMA models, and (3) the forecasts of a simple random walk model.

4. RESEARCH METHODOLOGY

4.1 Data Selection

The data used in this study are from the annual reports for the Japanese firms enrolled in the U.S. Securities and Exchange Commission (SEC). These Japanese firms have prepared and disclosed consolidated financial statements in accordance with the U.S. GAAP in order to finance from the US capital market through the issuance of American Depositary Receipt than before the reporting system of consolidated financial statements was introduced in Japan in 1977.[6)] Although these Japanese SEC firms should have prepared and submitted the consolidated financial statements in accordance with the Japanese GAAP to Ministry of Finance[7)] as well as the other Japanese listed firms, the Business Accounting Deliberation Council (BADC) approved as exception that these Japanese SEC firms could submit just consolidated financial statements in accordance with the U.S. GAAP to Ministry of Finance in stead of the Japanese GAAP statements.[8)] However firms enrolled in the SEC after 1977 have not been approved as the exceptional firms, and have submitted each statement to the SEC and the Financial Service Agency, respectively. Since data from these firms enrolled in the SEC after 1977 are available just from the year 1999,[9)] we drop these firms from sample in this study. Some of the Japanese firms have abolished the enrollment in the SEC since 2003.[10)] Therefore, we employ data of these Japanese SEC firms whose data spanning the years 1989

[6)] Accounting Principle for Consolidated Financial Statements has required Japanese listed firms to prepare and submit consolidated financial statements to the Ministry of Finance since then.

[7)] The Japanese listed firms submit consolidated financial statements to Ministry of Finance than before 1998. With one of series of structural reform of financial systemin Japan, the role which Ministry of Finance is responsible as for securities transactions is moved to the Financial Supervisory Agency (FSA), the Japanese listed firm submitted them to the FSA from 1998-2000. The FSA was reorganizedto establish the Financial Service Agency, the Japanese listed firm submitted to the Financial Service Agency since July, 2000.

TABLE I
Sample firms

Industry	*Number of Firms*	*Name of Firms*			
Food	1	Nippon Ham			
Textiles	1	Wacol			
Chemicals	1	Fuji Photo Film			
Machinery	2	Komatsu	Kubota		
Electric instruments	13	Hitachi	Toshiba	Mitsubishi denki	
		NEC	Matsushita	Sony	
		Sanyo	TDK	Omron	
		Pioneer	Murata	Makita	Kyocera
Transportation equipments	1	Honda			
Precision instruments	2	Canon	Ricoh		
Trading and retail merchandise	4	Itochu	Marubeni	Mitsui	Itoyokado

to 2003 is available as sample.

There are several justifications regarding why we use reported cash flow and accruals based on the SEC's standard cash flow statements for the Japanese firms in this study. First, while for the Japanese firms, there are just five years of the Japanese standard consolidated cash flow statement data available, there are fifteen years of the SEC data available. Fifteen years' data works for time-series analyses. Second, employing the Japa-

[8] Since, once these Japanese SEC firms chose to submit consolidated financial statements in accordance with the Japanese GAAP to the Ministry of Finance, this exception was not approved any more, the number of these exceptional firms decreased year by year. Also, because the firms which were enrolled inthe SEC after 1977, such as, Toyota, NTT, or Orix were not approved for this exception, these firms need to prepare one consolidated financial statements in accordance with the U.S. GAAP to submit them to the SEC and another consolidated financial statements in accordance with the Japanese GAAP to submit them to the Financial Service Agency in Japan. Preparing two kinds of consolidated financial statements incurred burdensome costs over these firms. Thus, in order to mitigate the burden and avoid investors confused about the dual standard problem, the Financial Service Agency has approved all Japanese firms which are enrolled in the U.S. SEC can submit consolidated financial Statements in accordance with the U.S. GAAP to the Financial Service Agency but in Japanese since 2003.

[9] These firms include Advantest, Konami, Toyota, Nomura Holdings, NTT, NTT docomo, Orix, and Trend Micro.

[10] These firms are Nippon Ham, Toshiba, Mitsubishidenki, Omron, Murata, Itochu, Marubeni, Komatsu, and Mitsubishishoji. In 2005, there are 23 firms which submit the U.S. GAAP consolidated financial statements to the Financial Service Agency.

nese firms' data in accordance with the U.S. GAAP will make our results more comparable with the prior studies of the U.S. firms. One of objectives of this study is to investigate Japanese firms to determine if the U.S.-based research results hold. Although, since the Accounting Standard Board of Japan (ASBJ) respond to world globalization and has tried to let the Japanese GAAP approaching the U.S. GAAP, there are still minor differences of accounting standards between the U.S. and Japan, that is, there are different accounting methods and the disclosure format of financial statements[11]. As for statements of cash flows, we can find many similarities between the U.S. and Japan ; the structure, scope of cash flows, the method of presenting operating cash flows ; the direct method or indirect method. However, there are still some minor differences between the U.S. and Japan. The differences in accounting standards between the U.S. and Japan[12] should affect the results of studies. Therefore, in order to examine regarding whether the role of accruals for future cash flows should be applied to the Japanese firms, we employ the same cash flow statement data following the U.S.GAAP.

Third, although the cash flow and accrual components of current earnings can be estimated from analyzing balance sheets and income statements, there may be measurement errors[13] (e.g. Bahnson et al. 1996 ; Cheng et al. 1997 ; Nakashima 2004). Furthermore, although the listed firms in Japan had produced funds flows statements from 1987 through 1999, the funds flows statements had been unavailable. Also, the funds flow statements were not required to be audited by certified accountants. In addition, the funds flow statements were produced on an individual entity basis, not on a consolidated basis.

The FASB links a firm's future cash flows to dividends and capital gains which investors receive. Since an enterprise's ability to generate favorable

[11] Although as for tax affect accounting, accounting for post-retirement benefit, accounting for foreign-currency translation and accounting for financial instrument, ASBJ has reformed the Japanese accounting standards to be harmonized with the U.S. GAAP, there are still differences in accounting for lease, business combination, and impairment between the U.S. and Japan.

[12] For the Japanese GAAP statements of cash flows, even if we choose a direct method or indirect method in presenting OCF, the items "interests and dividends received", "interests paid," and "income taxes paid" should be presented after "subtotal" and before "cash flows from operating activities." We display "interests paid" and "income taxes paid" in the category of OCF of the cash flows statement, not in a footnote. Also, if OCF are presented based on indirect methods, we start pretax net incomes and provide a reconciliation of net incomes to net cash flow from operating activities to compute the subtotal. These items are major classes of deferrals of past operating cash flows and accruals of expected future operating cash flows, including "interest and dividend revenues" and "interest expenses." Including these "interest and dividend revenues" and "interest expenses" into the reconciliation of net incomes is a characteristic of the Japanese statements of cash flows.

cash flows affects both its ability to pay dividends and interest the market prices of its securities, expected cash flows to investors and creditors are related to expected cash flows to the enterprise (FASB 1978, para. 39). Therefore, this study focuses on operating cash flows as a future attribute.[14)]

4.2. Cash Flow Expectation Models

We use a cross-section analysis of the firms' autocorrelation function (ACF) and partial autocorrelation function (PACF) of the operating cash flows series in order to verify whether the differenced OCF are essentially white noise. If none of the values of the ACF or PACF for the first differences series are close to zero, and no confidence limits on the plot for any lag are exceeded, then we infer that the first differenced OCF is white noise. Accordingly, the original series of OCF can be described as a random walk process expressed in the following equation :

$$OCF_t = OCF_{t-1} + \varepsilon_t \qquad (1)$$

where

OCF_t = operating cash flows at time t,

ε_t = the white-noise forecast error at time t.

In order to test H2, for each firm, we identify tentative B-J type ARIMA models consistent with the series. Model identification is carried out by examining the pattern of ACF and PACF. The potential models for OCF process are described below, that is autoregressive (AR (1)), moving average (MA (1)), or autoregressive-moving average (ARMA (1,1)). We obtain estimates of parameters of the tentative model and then we generate the final model for series of each

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[13)] Cheng et al. (1997) find that reported cash flows from operations have more incremental value-relevance in market than estimated cash flows from operations. They suggest that errors in estimates of cash flows from operations may impede their utility in explaining security prices. Nakashima (2004) discusses the difference between the amount of cashflow from operating computed from a balance sheet and an income statement and the reported amount of cash flows from operating in a statement of cash flows for SEC Japanese firms. She finds that for 75% of the sample, the measurement error in estimating operating cash flows is less than 3% and that this proxy used in the study does not match the actual operating cash flows for 100% of the sample.

[14)] Researchers to date have defined these future attributes in many ways. Beaver (1998, pp. 69-76) develops three important links between earnings and stocks: a link between stock price and future dividends, a link between future dividends and future earnings, and a link between future earnings and current earnings and treats future earnings and future dividends as future attributes. Sakurai (1994, p. 100) predicts future accounting earnings to use as a proxy of future cash flows in assessing the value of firms' stock. Watts and Zimmerman (1986, p. 65) assert that underlying the tests of association-between abnormal returns and unexpected earnings and the information content of earnings is the notion that earnings are measures of current and future cash flows. On the other hand, for the cash flow literature, Hopwood and Mckeown (1992) predict OCF per share. Lorek et al. (1993) and Lorek and Willinger (1996) measure future attributes as estimated OCF by the balance sheet approach. Barth el al. (2001) define future attributes as OCF reported in the statements of cash flows.

firm.

$$OCF_t=\delta+\varphi_1(OCF_{t-1})+\varepsilon_t, \quad (2)$$

$$OCF_t=\mu+\varepsilon_t \quad \Theta_1\varepsilon_{t-1}, \quad (3)$$

$$OCF_t=\delta+\varphi_1(OCF_{t-1})+\varepsilon_t \quad \Theta_1\varepsilon_{t-1}, \quad (4)$$

where

OCF_t = operating cash flows at time t,

$\varphi_1 \Theta_1$ = the parameters of the model,

μ, δ = the constant coefficients,

We also employ a multivariate time-series regression model (MULT) to provide a comparative assessment of the predictive ability of the RW and ARIMA models for future cash flows. MULT includes a richer set of independent variables and is based on the following equation :

$$OCF_t=\Phi+\Phi OCF_{t-1}+\Phi\Delta AR_{t-1} + \Phi\Delta INV_{t-1}+\Phi\Delta AP_{t-1} + \Phi DEP_{t-1}+\mu_t (5)$$

where

OCF_{t-1} = cash flow from operations at time t-1,

Φ = regression coefficient,

ΔAR_{t-1} = decrease (increase) in receivables at time t-1,

ΔINV_{t-1} = decrease (increase) in inventory at time t-1,

ΔAP_{t-1} = increase (decrease) in accounts payable and accrued liabilities at time t-1,

DEP_{t-1} = depreciation expense at time t-1,

μ_t = current disturbance term at time t.

The independent variables for MULT are derived from the statement of cash flows. Each independent variable is lagged one period. The first set of independent variables includes operating cash flows. The second, third, fourth, and fifth sets of independent variables are accrual components. In this analysis, MULT relies on time-series data for OCF, ΔAR, ΔINV, ΔAP and DEP variables that are obtained over the same time period we use when the ARIMA models are estimated. MULT allows firm-specific parameter estimation and includes a larger set of explanatory variables than does RW and ARIMA models. MULT, unlike the ARIMA and RW models, incorporates a parsimonious set of accrual components in addition to past values of the cash flow series. The use of MULT helps resolve the discussion about whether the accrual components enhance the accuracy of cash flow predictions.

4.3. Diagnostic Tests

It is customary to have the process stationary. This implies a constant variance, no trend, and seasonality removed. Since plotting the series of operating cash flows shows neither trend[15], nor seasonality for each firm, we employ the original data. For detection of heteroskedasticity, it is useful to review the residuals. A

[15] Trends should be removed from the series to make data stationary. If the original series contain trends, they can be transformed into series without trends by taking first and second differences of the data.

histogram of standardized residuals shows departures from the normal probability plot and it shows a positive kurtosis. Although there is a constant variance, the data depicts heteroskedasticity. There are two methods for solving the heteroskedasticity problem : transforming the data using logs, and deflating the variable by some measure of size (Maddala 2001, pp. 212-217). Although transforming the data to log is often used to remove the trend from the data, we choose to use the deflator. After deflating variables, the histogram and the normal probability plot look much better than the original data.

Diagnostic tests are employed to check the validity of MULT. First, an F-test is employed to assess the overall prediction significance by testing the observed F value is highly significant at .05 level. If $F_0 > F_{(p,\ n-p-1)}$, the hypothesis that the prediction by MULT is not useful can be rejected at .05 levels. When the degree of freedom and F value of each firm are assessed, the null is rejected for only five firms.

Second, multicollinearity among the independent variables should be inspected. Since serious multicollinearity may result in overstated standard errors for the coefficients and instability in the estimates, inferences regarding the statistical significance of individual independent variables may be impacted (Dielman 2001, p. 366). Specifically, in our study there are ten pairwise correlation coefficients between the five variables in MULT. The minimum, maximum and median of the correlation coefficients (AR and AP) are .153, .971, and .760 respectively. This indicates that multicollinearity may only be problematic for a few of the variables. However, we do not believe this is a problem since our focus is not on the statistical significance of individual coefficients. Also, Dielman (2001, p. 368) asserts that for values larger than 10 for the variance inflation factors (VIF), multicollinearity may be influencing the least-squares estimates of the regression coefficients. The minimum, maximum and median of VIF regarding AP is 1. 234, 146.590, and 5.670 respectively and there are seven of the variables with a VIF larger than ten. Pelosi and Sandiffer (2002, p. 620) indicate that, although multicollinearity causes significant problems with the regression coefficients, the overall ability of the model to predict values of the dependent variable is not affected.

Third, when there is autocorrelation between the error terms arising in time-series data, this autocorrelation of residuals may result in a misstatement of R^2 values. Accordingly, we need to observe the plot of the residuals arising in series. The Durbin Watson test is not applicable if the models have lagged variables as dependent variables (Maddala 2001, pp. 245-246). The ACF and PACF of MULT plots show 95% confidence limits and the estimated coefficients of the lagged residual are significantly different from zero. Also, none of these particular coefficients was significant for MULT estimated on the cash flow data for the 25 sample firms, indicating that the residuals are white noise and autocorrelation is not present in the residuals. On the other hand, when we observe the plot of the residuals arising by multivariate regression, the ACF and PACF of regression plots exceed confidence limits and the probability value of the Box-Ljung statistic is high at all lags, indicating that the residuals arising in regression are not generated by a white noise process. Therefore, we use the MULT model in this study, not regression model.

In addition, we compare the incremental explanatory power of MULT employing the accrual components as independent variables with the incremental explanatory power of MULT using only lagged cash flow variables as independent variables. The median adjusted R^2 for MULT using the accrual components is increased from the median adjusted R^2 for MULT using only the cash flows. This increase in explanatory power is attributable to including the set of accrual components employed in MULT.

Finally, another diagnostic test performed in this study in order to the check the distribution of absolute percentage errors of cash flow prediction. If they are normally distributed, standard parametric test are used to test the hypotheses three. However, since they are not normally distributed, we employ nonparametric tests, a Friedman's S statistic test to test the hypothesis three.

5. RESULTS

5.1. Descriptive Statistics

Panel A of Table 2 presents descriptive statistics for the components of earnings. Consistent with Barth et al. (2001), Table 2 reports that the means and medians of NI and OCF are positive and ACCRUALS are negative. The negative mean and median of ACCRUALS come from the inclusion of DEP in ACCRUALS. Also, consistent with Barth et al. (2001), while current accruals i.e., ΔAR, ΔINV, and ΔAP are very smaller in magnitude and more variable, DEP, a noncurrent accruals, are great in magnitude and less variable.

Panel B of Table B provides the Pearson correlations which illustrate the relations between our sample variables. Specifically, we find OCF and accruals to be significantly negatively correlated (−0.598), suggesting these correlations are in agreement with existing studies (Dechow et al.1998 ; Dechow and Dichev 2002 ; Tazawa 2001) This means that the negative correlations between accruals and OCF offset negative serial correlation in accrual changes and the negative serial correlation in OCF changes respectively (Dechow et al. 1998, p. 144). Thus, as Dechow et al. (1998, p. 140) assert that accruals adjust cash flows for temporary cash flows due to the outlay for the expected increase in long-term working capital and the difference in timing of cash flows for purchases and inflows from sales, it is expected that this accrual adjustments help predict future cash flows.

5.2. Premier Model Analysis

Table 3 presents the sample autocorrelation and partial autocorrelation function averaged across the firms, for the original data, the first differenced data, and the original data deflated by total assets. In accordance with the methodology of Foster (1977), these firm-specific values are summed across firms and averaged to obtain the values reported in Table 3. The ACF of the series process has one significant spike at lag 1, where the PACF exhibits gradual attenuation and the ACF and PACF are negative. That is supportive of the first-order Moving Average (MA (1)) models (Yaffee 2000).

Panel A and C of the table 1 present similar patterns. The patterns of autocorrelation in the operating cash flow data are unaffected by the deflator. Because these two series exhibit nearly identical time-series properties, these findings sug-

TABLE 2

Panel A : Descriptive Statistics on Variables

Sample of 399 Firm-Year Observations, 1989-2003

Variable	*Mean*	*Median*	*S.D.*	*Minimum*	*Maximam*
NI	0.0207	0.0179	0.0241	−0.0695	0.1270
OCF	0.0616	0.0591	0.0516	−0.0903	0.5966
ACCRUALS	−0.0551	−0.0556	0.0682	−0.7195	0.1638
ΔAR	−0.0060	−0.0053	0.0285	−0.3447	0.1240
ΔINV	−0.0040	−0.0038	0.0223	−0.1925	0.2428
ΔAP	0.0043	0.0037	0.0243	−0.0567	0.2407
DEP	0.0408	0.0037	0.0191	0.0015	0.1164

Panel B : Correlations

	ΔAR	ΔINV	ΔAP	OCF	ACCRUALS
ΔAR	1.000	0.437	−0.814	−0.512	0.883
ΔINV	0.437	1.000	−0.487	−0.185	0.682
ΔAP	−0.814	−0.487	1.000	0.579	−0.872
OCF	−0.512	−0.185	0.579	1.000	−0.598
ACCRUALS	0.883	0.682	−0.872	−0.598	1.000

The variables are defined as follows.
NI=income before extraordinary items and discontinued operations.
OCF=cash flow from operations
ACCRUALS=total operating accruals, calculated as ΔAR+ΔLNV−ΔAP−DEP
ΔAR=change in accounts receivable per the statement of cash flows
ΔINV=change in inventory per the statement of cash flows
ΔAP=change in accounts payable per the statement of cash flows
DEP=depreciation expense
All variables are deflated by total assets at the end of the year.

gest that this deflator does not affect the underlying time-series properties of cash flows. This result is consistent with Lorek and Willingers' (1996) findings.

Next, we investigate whether the time-series process of the first differenced operating cash flows of an "average" firm follows a random walk model. From the distribution of autocorrelations for operating cash flows differences reported in panel B, the median ACF and PACF for all lags for the series are not close to zero and are insignificantly different from zero at any reasonable probability level. Also, we observe the plot of ACF and PACF for the first differenced operating cash flows, values of the ACF or PACF on the plot for any lag exceed the confidence limits on the plots. Accordingly, the null hypothesis is rejected. This finding suggests annual operating cash flows for an "average" firm in general cannot be characterized as a random walk.

5.3. Firm-Specific Models

In the previous section, the premier model is identified based on the average patterns in firm-specific ACF and PACF. It is possible that the cash flow time-series properties of an "average" firm may not necessarily be similar to those of individual firms (Lorek and Willinger 1996). Because the aggregation of firm-specific ACF and PACF values may conceal the particular firm-specific properties, each firm's individual ACF and PACF values are examined and time-series properties of operating cash flows are analyzed by the individual firm model approach in this section.

First, we examine the distribution of autocorrelations for operating cash flows changes for all lags in order to investigate whether individual firms' processes of operating cash flows differ significantly from a random walk. The autocorrelations for operating cash flows changes for all lags are not close to zero. The ARIMA (010) models are fitted to the processes for each firm in order to investigate whether the Box-Ljung statistics is statistically significant at any lag. There are two firms that the Box-Ljung statistics to the right of the plot are not statistically significant and the probability is substantially greater than .05. Since the null hypothesis that the residuals are white noise cannot be rejected at .05, the residuals from the series of the two firms appear to be white noise. However, because most individual firms' OCF are statistically significant and the probability is smaller than .05, the null hypothesis that the residuals are white noise can be rejected. Also, when we examine the plot of the ACF and PACF for the individual firms' first differenced series, there are just four firms that the plotted autocorrelations all fall within the 95% confidence intervals. These results show that most individual firms' operating cash flows cannot be described by a random walk model.

Next, the time-series properties of individual firms' cash flow information are

TABLE 3
Cross-Sectional Sample Autocorrelations and Partial Autocorrelations (1990-2003)

	ACF		PACF	
Panel A : No Difference of Undeflated OCF				
LAG	*Mean*	*S.D.*	*Mean*	*S.D.*
1	0.271	0.315	0.268	0.320
2	0.062	0.283	−0.109	0.194
3	0.101	0.253	0.023	0.204
4	0.029	0.170	−0.096	0.175
5	−0.017	0.165	−0.045	0.150
6	−0.020	0.123	−0.088	0.173
7	−0.064	0.133	−0.101	0.154
8	−0.168	0.165	−0.118	0.132
9	−0.140	0.144	−0.100	0.123
10	−0.100	0.159	−0.051	0.123
11	−0.111	0.160	−0.047	0.110
12	−0.091	0.136	−0.057	0.109
13	−0.094	0.133	−0.045	0.090
14	−0.095	0.106	−0.040	0.106
Panel B : First Differences of Undeflated OCF				
LAG	*Mean*	*S.D.*	*Mean*	*S.D.*
1				
2	−0.309	0.228	−0.344	0.166
3	−0.152	0.216	−0.341	0.200
4	0.058	0.236	−0.164	0.189
5	−0.031	0.122	−0.143	0.218
6	−0.024	0.216	−0.078	0.181
7	0.067	0.190	−0.084	0.208
8	0.020	0.163	−0.062	0.150
9	−0.080	0.160	−0.089	0.120
10	−0.016	0.118	−0.120	0.138
11	0.008	0.111	−0.136	0.130
12	−0.019	0.118	−0.039	0.136
13	0.024	0.098	−0.087	0.090
14	−0.013	0.105	−0.042	0.112
Panel C : No Difference of OCF Deflated by Total Assets				
LAG	*Mean*	*S.D.*	*Mean*	*S.D.*
1	0.179	0.283	0.179	0.283
2	−0.004	0.219	−0.128	0.205
3	0.087	0.206	0.071	0.182
4	−0.011	0.150	−0.104	0.205
5	−0.046	0.168	−0.062	0.141
6	−0.005	0.157	−0.102	0.184
7	−0.081	0.165	−0.081	0.174
8	−0.184	0.146	−0.095	0.122
9	−0.130	0.143	−0.081	0.116
10	−0.078	0.158	−0.051	0.104
11	−0.083	0.127	−0.026	0.117
12	−0.033	0.138	−0.053	0.103
13	−0.052	0.113	−0.044	0.098
14	−0.058	0.085	−0.077	0.100

Note : ACF=Autocorrelations function. PACF=Partial Autocorrlations function.

examined in accordance with the methodology of B-J ; identification of the model, estimation of parameters, and the diagnostic tests of model fit. After the data is made stationary a tentative model is identified. The identification procedure is carried out by studying the behavior of the autocorrelation and partial autocorrelation functions. The time-series of observations for each firm's operating cash flows beginning 1988 and ending 2003 are constructed. In the estimation step, we compute initial estimates for the parameters of the tentative model and allow the computer program to generate the final estimates by an iterative process. After estimation of the tentative model has been derived, diagnostic checks are carried out to test the adequacy and the closeness of the fit of the model to data, by checking whether its residuals are random (white) noise.

Table 4 shows the frequency of identified firm-specific ARIMA model structure of deflated operating cash flows. The most frequently identified firm-specific ARIMA structures are the ARIMA (210). There are four firms with ARIMA (200). ARIMA (100) ARIMA (001), and ARIMA (101) appear each for three of the 25 firms we study. The remainder of the firms have various model structures. These results suggest that there is a great diversity in the firm-specific ARIMA structures for operating cash flows.

5.4. The Predictive Ability

One-period-ahead operating cash flow predictions are generated for the three prediction models ; RW, firm-specific ARIMA, and MULT.[16] All models are estimated using data beginning with 1990 and ending with 2003, within sample. The accuracy of one-period-ahead cash flow predictions is assessed by comparing the mean absolute percentage error (MAPE) of each model. Table 5 presents descriptive statistics for the MAPE of each model.[17] The result shows that MAPE from MULT is the lowest, while MAPE from RW is the largest. This indicates that the MULT forecasts outperform the firm-specific ARIMA as well as

TABLE 4
Fequency of Identifed Firm-Specific ARIMA Model Structure of CFO deflated by Total Assets

$(pdp)\times(PDQ)$	*Number of Firms*
(000) × (000)	0
(100) × (000)	3
(200) × (000)	4
(001) × (000)	3
(002) × (000)	2
(101) × (000)	3
(102) × (000)	0
(201) × (000)	1
(301) × (000)	0
(110) × (000)	0
(210) × (000)	6
(011) × (000)	0
(012) × (000)	1
(013) × (000)	1
(220) × (000)	1
	25

TABLE 5
Descriptive Statistics on Mean Absolute Percentage Errors of One-Period-Ahead Deflated Cash Fow Prediction

Model	*Mean*	*Median*	*S.D.*	*Minimum*	*Maximum*
ARIMA	0.3585	0.2389	0.3280	0.0000	1.0000
RW	0.4076	0.2970	0.3406	0.0016	1.0000
MULT	0.3065	0.1829	0.3031	0.0013	1.0000

Where ;
ARIMA＝Firm-specific univariate ARIMA model
RW＝Random walk model
MULT＝Multivariate, time-series regression model

the RW forecasts.

Next, we use these prediction models as benchmark models. Table 6 shows the MAPE metrics for the deflated cash flows series across the three cash flow prediction models for each year (1990-2003) and on a pooled basis across all years. We also assess the accuracy of one-year-ahead cash flow predictions by employing the Friedman ANOVA ranks test. For each year, the cash flow prediction model yielding the smallest absolute percentage error is given a rank of one ; the next smallest error is given a rank of two and so on until the model yielding the largest error is given a rank of three. This test examines whether there is a statistically significant difference in the average ranks of the models compared.

The best performing deflated cash flows prediction model on the basis of the pooled MAPE metrics is MULT (.276), outperforming firm-specific ARIMA (.400) and RW (.347). This indicates that MULT outperforms firm-specific ARIMA as well as RW. In addition, firm-specific ARIMA enhances the predictive ability better than the premier random walk models do. The predictive performances of the models are also compared by examining the average rank for each model. MULT has the smallest average rank for 1990, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2003, and on the pooled basis. Friedman's S-statistics are significant at 0.1 level for 1990, 1991, 1992, 1994, 1995, 1997, 1998, 2001, 2003, and on the pooled basis. Overall, these results suggest that MULT has a better predictive performance. These results indicate that cash flow prediction is enhanced by considering accrual accounting data.

[16] All variables employed in this analysis are deflated by total assets at the end of the year to reduce heteroscedasticity.
[17] We truncate all forecast errors greater 100 percent to 100 percent.

TABLE 6

Mean Absolute Percentage Errors of One-Step-Ahead Deflated Cash Flows Predictions (1990–2003)

Model	*1990*		*1991*		*1992*		*1993*		*1994*		*1995*		*1996*	
	MAPE	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*
ARIMA	0.418	2.15	0.391	2.38	0.497	2.10	0.358	1.90	0.411	2.20	0.434	2.04	0.455	2.08
RW	0.440	2.20	0.361	1.78	0.515	2.26	0.430	2.24	0.385	2.16	0.492	2.25	0.408	2.04
MULT	0.294	1.65	0.288	1.84	0.343	1.64	0.354	1.86	0.265	1.64	0.380	1.71	0.408	1.88
Friedman														
ANOVA	4.765		5.871		5.453		2.449		5.191		3.909		0.667	
Significance	*		**		*				*		*			
	1997		*1998*		*1999*		*2000*		*2001*		*2002*		*2003*	
	MAPE	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*	*MAPE*	*Avg Rank*
ARIMA	0.352	1.84	0.368	2.02	0.343	2.06	0.285	2.00	0.200	1.76	0.316	1.94	0.228	2.17
RW	0.477	2.42	0.376	2.26	0.354	2.02	0.356	2.20	0.381	2.32	0.395	2.04	0.289	2.29
MULT	0.294	1.74	0.306	1.72	0.333	1.92	0.267	1.80	0.217	1.92	0.350	2.02	0.171	1.54
	7.489		4.207		0.274		2.174		4.333		0.149		7.750	
	**		*						*				**	
	Pooled													
	MAPE	*Avg Rank*												
	0.347	1.92												
	0.400	2.77												
	0.276	1.31												
	14.000													
	***													

Where :
ARIMA=Firm-specific, univariate ARIMA model
RW=Random walk model
MULT=Multivariate, time-series regression model
* 0.01 level
** 0.05 level
*** 0.001 level

6. CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

In this study, we provide evidence regarding the time-series properties of operating cash flows and the accuracy of the predictive performance of the expectation models for one year ahead operating cash flows. First, this study assesses operating cash flows time-series properties of an "average" firm by cross-sectional sample autocorrelation function. Secondly, we investigate the individual firms' operating cash flows properties in accordance to the B-J methodology. Thirdly, we compare the predictive performance of RW, firm-specific ARIMA, and MULT that employ past values of accruals components and operating cash flows as independent variables.

Our results indicate that the time-series properties of operating cash flows of an "average" firm can be depicted as a moving average (MA (1)) process and, in general, cannot be characterized as a random walk. We provide evidence that the autocorrelation patterns in operating cash flow data are unaffected by the deflator we used. Our results suggest that, in general, individual firms' operating cash flows cannot be described by RW. Also, we identify the diversity in firm-specific ARIMA structures for operating cash flows. We provide evidence that the predictive accuracy of MULT is clearly superior to firm-specific ARIMA as well as RW. Consistent with the results in the U.S. (e.g. Loreck and Willinger 1996 ; Barth et al. 2001), these findings indicate that one year ahead cash flow prediction is enhanced by including accrual components.

Although the sample firms in this study may be representative of firms in Japan that complied with the U.S. GAAP, the limited number may affect the generalizability of our results. In addition, identification of the best fitting model may be limited since the standard errors for the ACF and PACF are large when there are less than fifty observations. Nevertheless, it is expected that this study provides a first step in understanding the OCF time-series properties of Japanese companies. The recent availability and the long-term accumulation of actual cash flow statements data in Japan will provide opportunities for significant future research to determine the robustness of these findings. Also, while we examine the predictive performance across various models using in-sample tests, the robustness of the results can be best determined by out-of-sample forecast comparisons.

Although we discuss the role of the cash flow and accrual components of current earnings for future cash flows, the quality of accruals has not examined yet. The quality of accruals, and the predictive performance and the quality of the individual components of accruals should be investigated in the future.

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