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The prediction of stock returns using financial statement information*

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We examine the profitability of a trading strategy which is based on a logit model designed to predict the sign of subsequent twelve-month excess returns from accounting ratios. Over the 1978–1988 period, the average annual excess return produced by the trading strategy ranges between 4.3% and 9.5%, depending on the specific measure of excess return and weighting scheme involved. However, our implementation of the Ou and Penman (1989) trading strategy in the 1978–1988 period, which is based on a logit model that predicts subsequent unexpected earnings-per-share from accounting ratios, does not earn excess returns.

1. Introduction

Ou and Penman (1989) document the existence of significant abnormal returns to a trading strategy that is based on the prediction of the sign of unexpected annual earnings-per-share (*EPS*), where unexpected *EPS* is determined from the assumption that annual *EPS* follow a random walk (with drift) process. Their prediction model for the sign of unexpected *EPS* is developed using logit, where the independent variables are traditional financial statement ratios. Ou and Penman's trading strategy takes a long (short) position in the common stocks of firms where the prediction model indicates that unexpected earnings are likely to be positive (negative). They document an average market-adjusted return over the 1973–1983 period associated with this trading strategy of 8.3% for a 12-month holding period and 14.5% for a 24-month holding period. Ou and Penman (1989, p. 328) conclude, based on this result as well as

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other extensive empirical analyses, that '. . . financial statements capture fundamentals that are not reflected in prices'.[1]

In this paper, we examine the ability of accounting information to generate profitable trading strategies by developing a model to directly predict the sign of subsequent one-year excess return measures. Since the success of a trading rule is judged by the magnitude of its associated excess returns, it is reasonable to predict that measure directly, rather than to predict unexpected earnings which previous research has indicated is only weakly correlated with returns [e.g., Larcker (1989)]. Ou and Penman (1989, p. 297) reject the direct prediction of excess returns because in their view such a model would be more susceptible to simply detecting misspecification in the excess return measures. While that is a danger with our approach (as well as Ou and Penman's), we attempt to mitigate that possibility by examining several alternative measures of excess returns and by controlling for other previously documented anomalies which may proxy for asset pricing misspecifications.

We develop logit models, which are based on accounting ratios, to predict three different measures of 12-month excess returns which cumulate from the fourth month following the company's fiscal year-end. The three excess return metrics are: (i) market-adjusted returns, (ii) excess returns computed using the Capital Asset Pricing Model (CAPM), and (iii) size-adjusted returns. The predictor variables considered are the 68 financial accounting ratios used by Ou and Penman. The trading strategy takes a long position in firms predicted to have positive excess returns and a short position in firms predicted to have negative excess returns over the next 12 months. The data encompasses portfolios formed from 1978 to 1988 which contain New York Stock Exchange, American Stock Exchange, and Over-the-Counter firms. When firm-year observations are equally weighted over time (a nonimplementable weighting scheme), the average 12-month market-adjusted return to the trading strategy is 4.3%, the 12-month excess return measured relative to the CAPM is 5.9%, and the 12-month size-adjusted return is 8.0%. Moreover, when observations are weighted equally within year and then equally over time (a truly implementable strategy), estimates of the profitability of the trading strategy are 7.3% for the market-adjusted returns, 9.5% for the excess returns measured relative to the CAPM, and 7.9% for the size-adjusted returns. Moreover, the returns to the hedge strategy are positive in virtually every year from 1978 to 1988 regardless of the excess return measure used.

We also reexamine the Ou and Penman trading strategy using our data. Since we consider a different period and also include Over-the-Counter firms, we estimate new logit models to predict the sign of unexpected earnings. Our results

[1]Others who have examined the ability of financial ratios to earn subsequent excess returns include O'Conner (1973), Katz, Lilien, and Nelson (1985), Wansley, Roenfeldt, and Cooley (1983), Palepu (1986), and Reinganum (1988).

suggest that the returns to the trading strategy based on an earnings prediction model are much *smaller* than the returns earned by our returns prediction model. Our implementation of the Ou and Penman trading strategy for the 1978–1988 period produces, on average, annual returns of between -0.1% and 1.6% (depending on the excess return metric).

Our results differ markedly from Ou and Penman for at least two reasons. First, their trading strategy performs poorly in the period subsequent to 1983 which is not part of their study (the average annual return to the hedge portfolio in the 1983–1988 period is -2.1% to -4.0% depending on the excess return metric). Second, our trading strategy results do not incorporate the 1973–1977 period, a period in which Ou and Penman report that the trading strategy works well. As such, the profitability of the Ou and Penman trading strategy appears more fragile than suggested by their study.

The remainder of the paper consists of five sections. Section 2 discusses the estimation procedure used for developing the logit models for predicting excess returns, and the classification accuracy of the models is described. Section 3 provides information about the abnormal returns to the trading strategy using the excess return prediction model. Section 4 discusses the procedures we use in estimating the logit model which predicts unexpected earnings. Section 5 provides evidence of the profitability of the trading strategy based on predicting unexpected earnings. Some concluding comments are offered in section 6.

2. Estimation and predictive ability of the excess return logit prediction models

2.1. Estimation of the excess return logit models

Ou and Penman select the potential financial statement items for their model from a comprehensive set of 68 accounting ratios which texts on fundamental analysis had emphasized prior to the beginning of their sample period, 1965 [see Ou and Penman (1989, table 2)]. We drop eight of the 68 ratios because they have considerable numbers of missing observations in our sample period.[2] Moreover, we probably do not define each of the remaining ratios in exactly the same manner as Ou and Penman. For example, for a ratio that is a mixture of a stock and a flow (e.g., sales/total assets), we calculate the *average* total assets value from the beginning and end of the year, as opposed to just using the

[2]The eight ratios dropped are purchase of treasury stock and percentage changes in the following seven variables: R&D, R&D/sales, advertising, advertising/sales, total uses of funds, total sources of funds, and funds from operations. The funds variables are dropped because changes in Generally Accepted Accounting Principles (Financial Accounting Standards Board SFAS #95 issued in 1987) require the Statement of Cash Flows which resulted in large number of missing observations for the COMPUSTAT funds variables for the post-1987 period. None of these variables appear in Ou and Penman's models.

year-end value. Moreover, we define a ratio as missing if it has a nonpositive denominator or if it is outside logical bounds (e.g., inventory turnover must be greater than or equal to zero). Data for calculating the accounting ratios are taken from the 1990 Annual Industrial, Research and Full Coverage COMPUSTAT files.

In order to use a firm-year observation in the estimation sample for the logit analysis, we require that a firm's fiscal year-end remain unchanged from three years before to one year after the firm-year observation. We also eliminate firm-year observations where any of the 60 required accounting ratios is missing, since this is a requirement of the stepwise logit estimation procedure. Finally, the appropriate excess return measure (the dependent variable) must be available for estimation of the logit model.

In order to obtain a parsimonious model for predicting subsequent 12-month excess returns from the 60 accounting ratios, the logit model is estimated using the BMDP stepwise LR procedure, with step selection based on an approximate asymptotic covariance estimate of the vector of parameter estimates. Similar to Ou and Penman, we assume that the 60 ratios can be calculated for each firm three months after the fiscal year-end, since 10-K reports are due by that time. For example, an observation based on a company with a December 31, 1977 fiscal year-end would enter the logit model with various accounting ratios computed with December 31, 1977 data and with 12-month excess return measures based on returns from April 1978 to March 1979. If many firms release their annual reports or 10-K's more than three months after the fiscal year-end, then it is possible that the estimated returns associated with the trading strategy are overstated because the financial statements would not be available for use at the assumed time (the end of the third month following the fiscal year-end).

We implement the following steps in an attempt to minimize any bias that may occur when a firm delists or ceases trading temporarily:

1. The CRSP New York/American Stock Exchange return series is linked with the CRSP Over-the-Counter return series. This avoids losing observations because of changes in exchange. If a firm switches exchanges and begins trading on the other exchange within 60 trading days of its delisting from the first exchange, we calculate a return based on the final price on the first exchange, the first price on the second exchange, and any intervening distributions. That return is then spread evenly over the number of trading days in the period between delisting on the first exchange and listing on the second exchange.

2. When a firm delists from an exchange, CRSP includes information about a delisting return for that security when available. This return is not the last return in the CRSP return vector. Estimates of returns to the trading strategy include the delisting return for any firm which delists while being held by the trading strategy.

3. Occasionally a firm does not trade for more than 10 days, and then begins trading again. The return vector of CRSP does not include a return for the first day on which the firm resumes trading. If the firm trades within 60 days of its last trade, we calculate a return for the period based on beginning and ending prices and intervening distributions. That return is then spread evenly over the number of trading days on which the firm did not trade.

Three different measures of 12-month buy-and-hold excess returns are used to examine the sensitivity of the results to alternative specifications. The three different excess return measures are market-adjusted returns, excess returns as measured by the Capital Asset Pricing Model (in particular, the Jensen alpha), and size-adjusted returns. Since the CRSP NYSE/AMEX and CRSP OTC tapes are linked, monthly returns for all series are constructed by compounding daily returns. Stock return data are obtained from the 1990 versions of the CRSP Daily New York, American, and Over-the-Counter files. Only value-weighted indices are used because there is relatively little portfolio rebalancing required in mimicking a value-weighted index, hence it represents a benchmark which is a passive strategy (at least relative to the rebalancing implicit in the calculation of an equally-weighted index). The market index used for firms listed on the New York Stock Exchange and American Stock Exchange is the CRSP combined New York and American value-weighted market index, and the market index for Over-the-Counter firms is the CRSP Over-the-Counter value-weighted market index.[3]

The market-adjusted buy-and-hold return calculation measures the cumulative buy-and-hold return earned on a security up to some month m from a starting month, $t = 1$ (the fourth month after a firm's fiscal year-end), in excess of the buy-and-hold return earned on the market. The market-adjusted buy-and-hold return measure for security i up to month m (in this case month 12), MAR_{im}, is defined as

$$MAR_{im} = \prod_{t=1}^{m} (1 + R_{it}) - \prod_{t=1}^{m} (1 + R_{Mt}),$$

where R_{Mt} is the return on the market and R_{it} is the return on asset i.

The return in excess of that predicted by the CAPM is measured using Jensen's alpha [see Jensen (1968)], which is the estimated intercept obtained from the following regression:

$$R_{it} - R_{ft} = \alpha_{im} + \beta_{im}(R_{Mt} - R_{ft}) + \varepsilon_{it},$$

[3]The general tenor of the results in this paper is that they are not sensitive to the weighting used in the index. When using equal-weighted indices, the trading strategies based on excess return prediction models are still profitable and the Ou and Penman strategy based on earnings prediction models is not profitable.

where R_{ft} is the return on one-month U.S. Treasury bills and β_i is the estimated systematic risk of the security. The regression is estimated with continuously compounded monthly returns. To calculate the abnormal return for a security over the 12-month period, $m = 12$, the regression is estimated with 12 monthly observations and the estimated α_{im} is multiplied by 12 and that product is then converted into a simple return. Jensen alphas assume that the Sharpe–Lintner version of the Capital Asset Pricing Model is an appropriate specification of asset pricing, and that the asset is being held in a mean–variance efficient portfolio (if the portfolios constructed in the trading strategy are not well diversified, the Sharpe measure would be a more appropriate performance measure).

The size-adjusted buy-and-hold return calculation measures the cumulative buy-and-hold return earned on a security up to some month m from a starting month, $t = 1$ (the fourth month after a firm's fiscal year-end), in excess of the buy-and-hold return earned on a value-weighted portfolio of firms which have a similar market value of equity. The size portfolios are based on size deciles of NYSE/AMEX firms or size deciles of NASDAQ firms. Membership in a particular portfolio is determined by exchange listing and size as of December 31 before the calendar year in question. The appropriate size portfolios are determined by CRSP and the returns on the value-weighted size portfolios are also constructed by CRSP. The size-adjusted buy-and-hold return measure for security i up to month m (in this case month 12), SAR_{im}, is defined as

$$SAR_{im} = \prod_{t=1}^{m} (1 + R_{it}) - \prod_{t=1}^{m} (1 + R_{St}),$$

where R_{St} is the value-weighted return of the appropriate size portfolio and R_{it} is the return on asset i.

For each of the three excess return measures, we estimate four different logit models (two time periods, 1973–1977 and 1978–1982, and two exchange listings, NYSE/AMEX firms and OTC firms). Hence, there are 12 different logit models estimated for predicting excess returns. The models estimated with accounting data from 1973 to 1977 are used to form portfolios based on accounting data which become available between 1978 and 1982. Similarly, the models estimated with accounting data from 1978 to 1982 are used to form portfolios based on accounting data that become available between 1983 and 1988.[4]

[4]To be more exact, data from 1973 to 1977 are actually data for firms with fiscal year-ends between June 1973 and December 1977. Data from 1978 to 1982 are actually data for firms with fiscal year-ends between June 1978 and December 1982. Data for firms with fiscal year-ends between January 1978 to May 1978 and January 1983 to May 1983 are eliminated from the estimation procedures because those data would not be available at the time the models would be estimated in order to implement the strategy. Models could be updated more frequently and it is conceivable that the profitability of the trading strategies would improve. However, we decided to update our models with the same frequency as Ou and Penman in order to make the studies comparable.

Since there are so many different models, we do not report the estimated coefficients of each of the models. The typical logit model retained eight or nine ratios, with four ratios being the smallest and fourteen variables being the largest. Virtually all of the logit parameter estimates are statistically significant at conventional levels. Forty-one of the potential 60 accounting ratios are included in the 12 models.[5] Sixteen variables enter the 12 models three or more times. Moreover, for variables entering the models multiple times, the signs are generally consistent across models.[6]

The variables which enter the models are not simple variants of accounting rate of return measures and consequently the models appear to be capturing a variety of facets of the firm's operations. The models do contain return on assets, changes in dividends per share, percentage changes in sales, and other variables that would at least be contemporaneously correlated with returns. However, the models also contain changes in inventory, changes in depreciation, liquidity, asset turnover, and financing variables that have a somewhat less direct relation to accounting rates of return.[7]

In order to gain further understanding of these statistical models, we examine the correlations between out-of-sample probability scores and various variables of interest. Out-of-sample probability scores are computed for all firms which have the variables required for a particular prediction model. Notice that the requirement that a firm-year observation have all 60 accounting ratios available is no longer required. In panel A of table 1, we report correlations between the estimated probability scores for the market-adjusted returns model (*PR-MAR*), the Jensen alpha model (denoted *PR-ALPHA*), and the size-adjusted return model (*PR-SAR*). In addition, we include the estimated probabilities from a model that predicts unexpected earnings-per-share, denoted *PR-EPS* (our

[5]Though the variables which enter the models vary over time, the probability scores which the models generate exhibit some intertemporal stability. For example, if we take the two models estimated for market-adjusted returns for NYSE/AMEX companies (one based on 1973–1977 data and one based on 1978–1982 data) and examine the correlations of the out-of-sample probability scores for firms in the 1983–1988 period, the correlation between the two groups of probability scores is 0.60. The correlations in the scores for market-adjusted returns for NASDAQ firms is considerably less, 0.15. Models which predict Jensen alphas are somewhat less correlated (0.25 for NYSE/AMEX firms and 0.13 for NASDAQ firms), while predictions for size-adjusted returns are correlated 0.44 for NYSE/AMEX firms and 0.37 for NASDAQ firms.

[6]Two variables, depreciation divided by plant assets and percentage change in total assets, enter the models eight times. Percentage change in total assets always enters negatively indicating that increases in total assets suggest negative excess returns in the following year. Depreciation divided by plant assets enters the models positively six times and negatively twice. Other variables which appeared in four or more of the 12 models include gross margin (5 positive signs, 1 negative sign), percentage change in depreciation/plant assets (5 positive signs), change in dividend per share (4 negative signs), and percentage change in sales (3 negative signs, 1 positive sign).

[7]A principal component analysis of the variables selected by the stepwise logit procedure indicates that there are typically three to six factors. However, only one of the factors typically contains some type of return measure such as return on assets. This result provides additional evidence that the models are at least partially based on phenomena other than accounting rates of return.

Table 1

Correlation matrix for *PR* indices, excess return measures, unexpected earnings-per-share, and selected 'anomalies' for NYSE, AMEX, and NASDAQ firms over the time period 1978–1988.

(A) *PR indices*

	PR-MAR	*PR-ALPHA*	*PR-SAR*	*PR-EPS*	Notation
PR-MAR	1.000				Prob score for market-adjusted return prediction
PR-ALPHA	0.516[a]	1.000			Prob score for Jensen alpha return prediction
PR-SAR	0.660[a]	0.451[a]	1.000		Prob score for size-adjusted return prediction
PR-EPS	0.225[a]	0.166[a]	0.086[a]	1.000	Prob score for unexpected *EPS* prediction

(B) *Excess returns and unexpected EPS*

	MAR	*ALPHA*	*SAR*	*UN EPS/P*	Notation
MAR	1.000				Market-adjusted return month +4 to month +15
ALPHA	0.819[a]	1.000			Jensen alpha return month +4 to month +15
SAR	0.974[a]	0.789[a]	1.000		Size-adjusted return month +4 to month +15
UN EPS/P	0.089[a]	0.066[a]	0.095[a]	1.000	Unexpected *EPS* associated with annual earnings for year ended on month +12, deflated by price as of the end of month 0

(C) *PR indices and subsequent excess returns and unexpected EPS*

	MAR	*ALPHA*	*SAR*	*UN EPS/P*	Notation Excess return measures and unexpected *EPS* (see panel B for definitions)
PR-MAR	0.097[a]	0.086[a]	0.060[a]	0.008	Prob scores computed from financial ratios for year ended on month 0 (see panel A for definition)
PR-ALPHA	0.076[a]	0.064[a]	0.055[a]	– 0.021[a]	
PR-SAR	0.069[a]	0.050[a]	0.065[a]	– 0.026[a]	
PR-EPS	– 0.018[a]	– 0.004	– 0.009	0.190[a]	

(D) *PR indices and selected 'anomalies'*

	PR-MAR	*PR-ALPHA*	*PR-SAR*	*PR-EPS*	Notation Prob scores computed from financial ratios for year ended on month 0 (see panel A for definition)
E/P	0.008	0.043[a]	0.057[a]	– 0.340[a]	Ratio of earnings-per-share to price-per-share at the end of month 0
B/M	0.114[a]	0.140[a]	0.048[a]	0.158[a]	Ratio of book value of equity to market value of equity at the end of month 0
RMB36	– 0.101[a]	– 0.092[a]	– 0.033[a]	– 0.363[a]	Market-adjusted return from month –35 to month 0
MKT VAL	0.041[a]	0.012	0.148[a]	– 0.239[a]	Natural logarithm of the market value of equity (thousands of dollars) at the end of month +3
UEPS/P	0.031[a]	0.023[a]	0.047[a]	– 0.094[a]	Unexpected *EPS* associated with annual earnings for year ended on month 0, deflated by price as of the end of month 0

[a] Statistically significant ($p < 0.001$, one-tail).

implementation of the Ou and Penman model, which is discussed in more detail in section 4). Panel A indicates that the correlations among the three return prediction models are relatively high (0.45 to 0.66), whereas the correlation between the return prediction models and the model predicting unexpected earnings-per-share are substantially lower (0.086 to 0.225). Thus, as might be expected, predicting the sign of excess returns is quite different than predicting the sign of unexpected *EPS*.

Panel B provides information about the correlation between excess returns and unexpected earnings. The timing of the variables in panel B of table 1 is critical for understanding these correlations. Consider a company with a December 31 fiscal year-end. In this panel, if excess returns are measured over the period 4/1/89 to 3/31/90, then unexpected earnings deflated by price are based on the unexpected earnings reported for the 12/31/89 fiscal year-end, which are assumed to be available as of 3/31/90, deflated by the price as of 12/31/88. Panel B of table 1 indicates that the three excess returns are highly correlated (0.79 to 0.97). However, the correlations between actual unexpected earnings-per-share deflated by price and the contemporaneous excess return measures are relatively low, less than 0.10.

Panel C of table 1 provides a preview of the results which follow. Again, timing here is critical. For a company with a 12/31/88 fiscal year-end, the excess returns are measured over the 4/1/89 to 3/31/90 period, and unexpected earnings deflated by price are based on unexpected earnings for the 12/31/89 fiscal year-end, deflated by the 12/31/88 price. The predictions of the excess returns models and unexpected earnings-per-share models are made using data from 12/31/88, which are assumed to be available as of 3/31/89. As can be seen, the return prediction models are all significantly positively correlated with subsequent excess returns, though the correlations at the individual firm level are not striking. The diagonal indicates the correlation between each excess return prediction model and its corresponding subsequent excess return. These correlations, which are in the range of 0.064 to 0.097, are similar in magnitude to the correlations between one-year returns and actual unexpected earnings-per-share (reported in panel B). Note further in panel C that the model predicting unexpected earnings-per-share, while positively correlated with subsequent unexpected earnings-per-share at 0.190, is not significantly positively correlated with subsequent excess returns.

Panel D provides information about the relation between the various prediction models and other financial information which has been used in some studies to predict subsequent returns. The timing of the variables in this panel is contemporaneous. In other words, for a 12/31/88 company, all of the variables here would be observable as of 3/31/89, the due date of the 10-K report. The post-earnings announcement drift phenomena discussed in the literature is proxied by unexpected earnings-per-share deflated by price. As can be seen the excess return prediction models are weakly positively correlated with unexpected earnings-per-share deflated by price and negatively correlated with the earnings-per-share prediction model. Further, the probability scores from the model which predicts unexpected earnings-per-share exhibit significant negative correlation with earnings/price ratios and the market value of equity (similar to Ou and Penman's findings), whereas the probability scores from the excess return prediction models exhibit weak positive correlation with earnings/price ratios and size. Surprisingly, the probabilities from the size-adjusted return prediction model are most highly correlated with size, perhaps indicating some inadequacy in the size adjustment. The probability scores from all of the prediction models are positively correlated with book-to-market ratios of shareholders equity and are negatively correlated with the market-adjusted returns over the previous 36 months. The latter is evidence that the prediction models appear to be somewhat of a contrarian strategy, though the negative correlation is most pronounced for the earnings prediction model. Regression tests reported in section 3.4 examine the marginal explanatory power of each of these variables to predict subsequent excess returns.

2.2. *Predictive ability of the model*

In order to use an excess return prediction model to form portfolios, we rank in-sample probability scores to determine nine cut-off scores which place each observation into one of ten portfolios. For example, for the 1973–1977 market-adjusted return model, we sort the estimated in-sample probability scores from low to high, and determine the nine cut-off scores which create ten equally-sized groups. Those nine cut-off scores are used when the 1973–1977 model is applied to data from the 1978–1983 period.[8] Portfolio 10 contains the observations with the greatest probability of negative excess returns and portfolio 1 contains observations with the greatest probability of positive excess returns. Since the formation of the actual portfolios used in the trading rule is based on the 1978–1983 data, the actual portfolios formed are not equally sized. This procedure is repeated for each of the 12 models estimated.

Table 2 provides information about the out-of-sample prediction rates for the three different excess return prediction models. Accuracy rates are reported based on predicting positive returns for both portfolios 1 to 5 and 1 to 3, and negative returns for both portfolios 6 to 10 and 8 to 10. In the portfolio trading strategies which follow, observations assigned to portfolios 1 to 3 are considered predictions of positive excess returns (the long portfolio), and observations assigned to portfolios 8 to 10 are considered predictions of negative excess returns (the short portfolio). Portfolios 4 to 7 are excluded because we

[8]This procedure is used because approximately 90% of the probability scores lie in the 0.40 to 0.70 range for the excess return prediction models. However, we use Ou and Penman's cut-off scores (0.1, 0.2, . . . , 0.9) when replicating their strategy in sections 4 and 5.

Table 2

Out-of-sample percentage of correct predictions for logit prediction models of market-adjusted returns, Jensen alphas, and size-adjusted returns for NYSE, AMEX, and NASDAQ firms over the 1978–1988 period.

(A) % *correct predictions for the 1978–1988 period (out-of-sample) by long, short, and hedge portfolios*

	Market-adjusted returns		Jensen alphas		Size-adjusted returns	
	Predictions (portfolios 1–5 & 6–10)[a]	Predictions (portfolios 1–3 & 8–10)[a]	Predictions (portfolios 1–5 & 6–10)[a]	Predictions (portfolios 1–3 & 8–10)[a]	Predictions (portfolios 1–5 & 6–10)[a]	Predictions (portfolios 1–3 & 8–10)[a]
# of observations	36,842	24,063	34,444	22,523	32,218	21,281
% correct predictions	51.4%	52.1%	51.8%	52.5%	53.3%	54.3%
Chi-Squared[b]	23.7	34.9	40.2	50.3	152.3	168.9
% predicted increases correct	43.2%	42.1%	44.8%	43.6%	46.1%	45.9%
% actual increases	41.9%	40.2%	43.1%	41.2%	42.7%	41.6%
% predicted decreases correct	59.3%	61.6%	58.6%	61.1%	60.7%	62.9%
% actual decreases	58.1%	59.8%	56.9%	58.8%	57.3%	58.4%

(B) *% correct predictions for the 1978–1988 period (out-of-sample) by portfolio*

	Market-adjusted returns		Jensen alpha		Size-adjusted returns	
Portfolio[a]	# of observations	% correct predictions	# of observations	% correct predictions	# of observations	% correct predictions
1	4,672	39.0%	4,576	40.2%	4,251	45.0%
2	3,800	43.3%	3,321	44.4%	3,345	47.5%
3	3,302	45.0%	3,208	47.6%	3,228	45.4%
4	3,263	45.7%	2,895	47.0%	2,805	47.5%
5	3.169	44.8%	2,877	47.2%	2,695	45.2%
6	3,170	53.3%	3,030	52.9%	2,707	55.9%
7	3,177	56.2%	3,119	55.0%	2,730	57.4%
8	3,276	56.8%	3,318	56.1%	2,684	59.6%
9	3,676	59.2%	3,446	59.4%	3,321	61.5%
10	5,337	66.3%	4,654	65.8%	4,452	65.9%

[a]Ten portfolios are formed based upon cut-offs that divide the in-sample probability scores into ten equally-sized portfolios. The first (tenth) portfolio contains observations that the models predict to have positive (negative) excess returns.

[b]The 0.001 critical value of the Chi-Squared statistic with one degree of freedom is 10.83.

assume that the middle portfolios would contain more noisy predictions than the extremes. This eliminates approximately 35% of the observations out-of-sample.[9]

For the market-adjusted returns model, panel A of table 2 indicates that based on predictions using portfolios 1 to 5 over the 1978–1988 period, 51.4% of all predictions are correct of which 43.2% (59.3%) of the predictions of positive (negative) excess returns are correct. Since the proportion of positive and negative returns in the sample is 41.9% and 58.1%, the model is predicting positive and negative returns slightly more accurately than their incidence in the population. The Chi-Squared statistic for the resulting classification table is equal to 23.7.[10] The overall prediction rate and the Chi-Squared statistic increase somewhat by using portfolios 1 to 3 and 8 to 10. In this time period, the model would not beat a naive model which was based on predicting only negative excess returns. However, this is a naive model which one would not likely select ex ante.

Evidence on the proportion of correct predictions for each of the ten portfolios over the 1978–1988 period is in panel B. In portfolios 1 to 5, which we use to predict positive excess returns, only portfolio 1 has an accuracy rate below 41.9%, which is the proportion of positive market-adjusted returns in the sample. However, accuracy rates do not increase monotonically from portfolios 5 to 1, as might be expected. Portfolios 6 to 10, which we use to predict negative excess returns, have accuracy rates between 53.3% and 66.3%, and the accuracy rate increases monotonically from portfolio 6 to 10. Results, not presented, indicate that the model predicts slightly more accurately in the first period (1978–1982) than in the second period (1983–1988). Subsequent tests indicate that the profitability of the strategy declines somewhat in the second period where the predictive ability falls. Table 2 indicates that the predictive ability of the Jensen alpha and size-adjusted returns prediction models are similar to the market-adjusted returns prediction model.

The excess return prediction models do not predict returns as well as Ou and Penman's unexpected earnings prediction model predicts unexpected earnings. As reported later in table 5, at least 60% of the unexpected earnings predictions are correct. However, this does not imply that a trading rule based on an unexpected earnings prediction model will be superior to a trading rule based on a model which predicts excess returns, given the weak correlation between unexpected earnings and returns.

[9]As a point of reference, Ou and Penman exclude approximately 44% of their observations by eliminating observations with probability scores between 0.4 and 0.6, their portfolios 5 and 6.

[10]The 0.001 critical value of a Chi-Squared statistic with one degree of freedom is 10.83. Note however, that the observations in the sample are not independent and this statistic is likely to be overstated.

3. Estimation of stock returns associated with the trading strategy

3.1. Procedures used to measure the profitability of the trading strategy

The profitability of each of the three excess return prediction models is judged by calculating 12-month, 24-month, 36-month, and 48-month buy-and-hold returns for each firm and then averaging across all securities available for that holding period. All excess returns are calculated starting at the beginning of the fourth month after the end of the fiscal year-end. Two different weighting schemes are used: (i) equal weighting of all observations pooled cross-sectionally and over time, and (ii) equal weighting of observations within a year (cross-sectionally) and then equal weighting of those averages across years.

A problem associated with measuring the returns to the trading strategy is dealing with firms which delist during the execution of the trading rule. We consider two alternative means for dealing with delisting. The first takes any money available from a delisted security and invests it in one-month U.S. Treasury bills for the duration of the holding period. The second alternative eliminates the firm from the trading strategy if it is not available for the particular holding period return being calculated. Note that this latter approach relies on information which is not available at the time the trade is executed.[11] All reported results eliminate the firm from the sample if it does not trade throughout the designated holding period. However, the results are not sensitive to this choice.

The results of the trading strategy are based on the following steps:

1. Consider initially the trading strategy based on the market-adjusted return prediction model for a 12/31/78 fiscal year-end NYSE or AMEX company. Use the market-adjusted return prediction model estimated on 1973–1977 data for NYSE/AMEX firms to compute a probability score for the 12/31/78 firm-year observation based on accounting data assumed released by 3/31/79.
2. Assign that observation to one of ten portfolios based on the cut-off scores which place the in-sample 1973–1977 probability scores for NYSE/AMEX firms into ten equally-sized portfolios ranked from highest to lowest probability scores. Assign that observation to the long (short) portfolio if it is placed in portfolios 1 to 3 (8 to 10).
3. Calculate buy-and-hold market-adjusted returns starting at the beginning of the fourth month after the fiscal year-end, April 1979, for 12-, 24-, 36-, and 48-month holding periods.

[11] For example, suppose a firm's returns are no longer available 30 months after it entered the long or short portfolio of the trading strategy. That firm's returns would then be included in the 12- and 24-month results reported, but not in the 36- and 48-month results reported.

4. Repeat steps 1 to 3 for all NYSE/AMEX firms with data available between 1978 and 1982.

5. Repeat steps 1 to 4, for observations based on accounting data which become available from 1983 to 1988, using the model estimated with data from 1978 to 1982.

6. Repeat steps 1 to 5 for OTC firms using the appropriate models estimated on OTC observations.

7. Calculate average long, short, and hedge market-adjusted portfolio returns (based on one of two weighting schemes) for 12-, 24-, 36-, and 48-month holding periods.

8. Repeat steps 1 to 7 for the trading strategies based on the prediction of Jensen alphas and size-adjusted returns.

3.2. Profitability of the trading strategy: Observations pooled over time

The average market-adjusted buy-and-hold returns for the ten portfolios for 12-, 24-, 36-, and 48-month holding periods are presented in table 3, panel A. The average return to the long portfolio (portfolios 1 to 3), the short portfolio (portfolios 8 to 10), and the hedge portfolio are also presented. Jensen alpha excess returns are reported in panel B of table 3, and buy-and-hold size-adjusted returns are reported in panel C of table 3.

The averaging in table 3 is pooled cross-sectional and time-series (i.e., it is based on the assignment of firm-year observations to a particular portfolio over the years 1978 to 1988 and, once all observations have been assigned to a portfolio, the mean for the portfolio is based on an equally-weighted average of all observations in that portfolio). As discussed in Holthausen (1983), this does not represent a truly implementable strategy since the portfolio weights are not known until all of the observations have been assigned to a particular portfolio. However, if the returns to the trading strategy are drawn from the same distribution over time, then the weighting scheme used in table 3 is an appropriate estimate of the expected return to the trading strategy.

Examination of panel A indicates that market-adjusted returns are related to the probability scores. Portfolios 1 to 5, generally have higher returns than portfolios 6 to 10. The long portfolio earns 0.03%, on average, for the 12-month holding period, while the short portfolio earns -4.23%, on average. Much of the return to the short portfolio stems from portfolio 10, which earns -9.04% and contains 43% of the firms in the short portfolio. However, since we have no way of knowing that would happen ex ante, we cannot use that information to legitimately increase the returns to the trading strategy. The hedge portfolio earns, on average, 4.26% for the 12-month holding period. Further examination of panel A indicates that the magnitude of the total returns increases with the holding period, though the excess return earned for the strategy in each subsequent year diminishes as the time from portfolio formation increases. Thus, the hedge portfolio earns 4.3% during the first year and 3.3%, 2.7%, and 1.3% in the three following years. This diminishing drift is consistent with an inappropriate risk adjustment. The diminishing drift is also consistent with the market continuing to price the securities closer to their fundamental value, but since the

Table 3

Average returns associated with the excess return prediction models for market-adjusted returns, Jensen alphas, and size-adjusted returns with equally-weighted pooled cross-sectional and time-series observations for NYSE, AMEX, and OTC stocks over the time period 1978–1988.

Portfolio[a]	# of observations (month 12)	Month of holding period			
		12	24	36	48
	(A) *Marked-adjusted returns*				
1	4,672	− 0.0179	− 0.0107	− 0.0012	0.0337
2	3,800	0.0007	0.0313	0.0467	0.0754
3	3,302	0.0260	0.0483	0.0908	0.1259
4	3,263	0.0208	0.0522	0.0973	0.1515
5	3,169	0.0231	0.0513	0.0985	0.1541
6	3,170	0.0181	0.0589	0.1033	0.1538
7	3,177	0.0148	0.0628	0.1020	0.1397
8	3,276	− 0.0007	0.0132	0.0421	0.0707
9	3,676	− 0.0096	− 0.0080	− 0.0159	0.0027
10	5,337	− 0.0904	− 0.1336	− 0.1633	− 0.1520
Long portfolio (portfolios 1 to 3)[a]	11,774	0.0003	0.0200	0.0416	0.0758
Short portfolio (portfolios 8 to 10)[a]	12,289	− 0.0423	− 0.0558	− 0.0616	− 0.0399
Hedge portfolio	24,063	0.0426	0.0758	0.1032	0.1157
	(B) *Jensen alphas*				
1	4,576	0.0118	− 0.0112	− 0.0204	0.0133
2	3,321	0.0486	0.0409	0.0610	0.1014
3	3,208	0.0469	0.0760	0.1086	0.1314
4	2,895	0.0539	0.0667	0.1257	0.2120
5	2,877	0.0370	0.0679	0.1199	0.1634
6	3,030	0.0381	0.0438	0.0811	0.1490
7	3,119	0.0342	0.0441	0.0657	0.0938
8	3,318	0.0121	0.0013	0.0320	0.0649
9	3,446	− 0.0186	− 0.0369	− 0.0266	− 0.0419
10	4,654	− 0.0599	− 0.1417	− 0.1973	− 0.2307
Long portfolio (portfolios 1 to 3)[a]	11,105	0.0329	0.0303	0.0438	0.0779
Short portfolio (portfolios 8 to 10)[a]	11,418	− 0.0265	− 0.0678	− 0.0759	− 0.0798
Hedge portfolio	22,523	0.0594	0.0981	0.1197	0.1577

Table 3 (continued)

Portfolio[a]	# of observations (month 12)	Month of holding period 12	24	36	48
		(C) Size-adjusted returns			
1	4,251	0.0362	0.0726	0.0677	0.0766
2	3,345	0.0354	0.0482	0.0511	0.0656
3	3,228	0.0246	0.0574	0.1098	0.1630
4	2,805	0.0386	0.0838	0.1013	0.1452
5	2,695	0.0316	0.0643	0.1166	0.1568
6	2,707	0.0164	0.0404	0.0769	0.1359
7	2,730	− 0.0007	0.0376	0.0587	0.0848
8	2,684	− 0.0197	0.0078	0.0341	0.0723
9	3,321	− 0.0266	− 0.0075	0.0129	0.0526
10	4,452	− 0.0792	− 0.0942	− 0.0803	− 0.0566
Long portfolio (portfolios 1 to 3)[a]	10,824	0.0325	0.0604	0.0754	0.1006
Short portfolio (portfolios 8 to 10)[a]	10,457	− 0.0472	− 0.0398	− 0.0199	0.0142
Hedge portfolio	21,281	0.0797	0.1002	0.0953	0.0864

[a]Ten portfolios are formed based upon cut-offs that divide the in-sample probability scores into ten equally-sized portfolios. The first (tenth) portfolio contains observations that the models predict to have positive (negative) excess returns.

prediction model is based on predicting only 12-month returns, the latter explanation seems less likely.

The results using Jensen alphas in panel B of table 3 are somewhat more supportive of the profitability of the trading rule than the market-adjusted return results as the hedge portfolio earns 5.94% for the 12-month holding period and the long (short) portfolio earns 3.3% (−2.65%). There is some evidence that the hedge portfolio continues to produce positive returns in the subsequent years, though at a diminished rate (2.9%, 2.1%, and 3.8% for the next three years). The excess returns across the ten portfolios are not perfectly monotonic. The results using Jensen alphas are a less crude risk adjustment than the tests based on market-adjusted returns, though there is ample evidence to suggest that the CAPM is not correctly specified [see, for example, Banz (1981) and Keim (1983) among others].

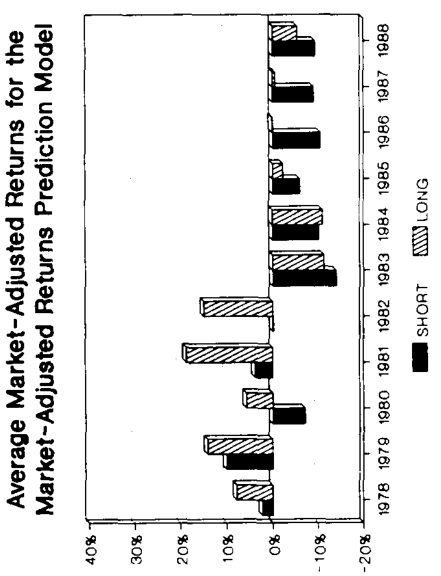
Some of the prior evidence on the misspecification in the CAPM indicates that the misspecification is correlated with firm size, and panel C of table 3 presents results based on size-adjusted returns. The size-adjusted returns to the trading strategy are approximately 8% for the 12-month holding period where the long (short) portfolio earns 3.25% (−4.72%). Again the results are not monotonic across the ten portfolios. For the size-adjusted returns, there is no systematic continuing drift after the first year. Though this does not preclude the possibility that the entire phenomenon is caused by risk shifts occurring in the first 12 months, the results here are not consistent with the model merely detecting a misspecified risk adjustment which persists for multiple years. However, evidence presented in table 4 does indicate that the size adjustment may be somewhat crude.

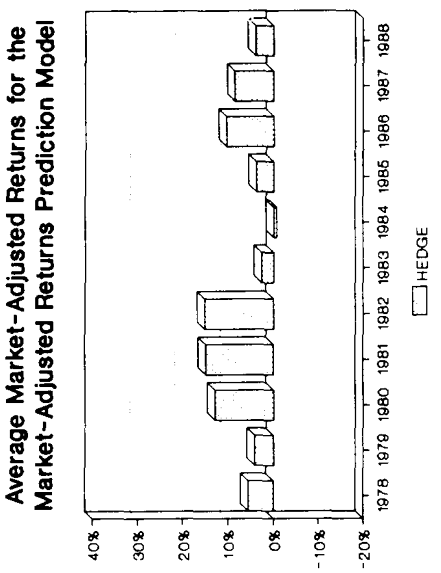
We also examined, but do not report in detail, the sensitivity of the investment strategy to the subperiod examined (1978–1982 and 1983–1988), to exchange listing (NYSE/AMEX and OTC), and to price-per-share (less than or greater than $10). For market-adjusted returns the hedge strategy performs better in the first subperiod but is not sensitive to exchange listing. For example, the 12-month return results for 1978–1982 (10.4% per year) are approximately twice as profitable as for the 1983–1988 period (5.0% per year). Moreover, the returns to the trading strategy over the whole period are similar for NYSE/AMEX firms (6.9% per year) and OTC firms (7.2% per year). The results using Jensen alphas also indicate that the returns to the hedge portfolio at 12 months are more profitable in the first period (14.0% per year) than in the second period (5.6% per year), and the returns to the trading strategy over the whole period are similar for NYSE/AMEX firms (8.2% per year) and for OTC firms (9.0% per year). The results based on size-adjusted returns indicate there is more consistency in the return results over time, but less consistency across exchanges. That is, the returns to the trading strategy for NYSE/AMEX firms (4.5% per year) are smaller than the returns to the OTC firms (11.0% per year), but for a given exchange listing the returns are similar in the two subperiods. Finally, in order to determine whether the returns to the trading strategy are the result of low-priced shares (which have high bid–ask spreads), returns to the trading strategy for shares which sell for at least $10 are estimated. These estimates of the profitability of the trading strategy were uniformly *higher* than the results reported in the paper. As such, we conclude the results are not driven only by very small-priced stocks.

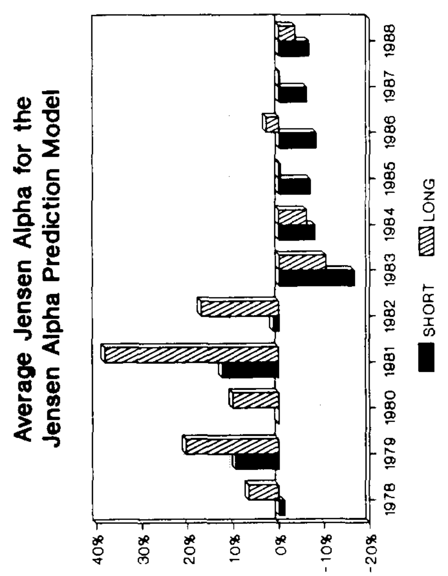
3.3. Profitability of the trading strategy: Year-by-year results

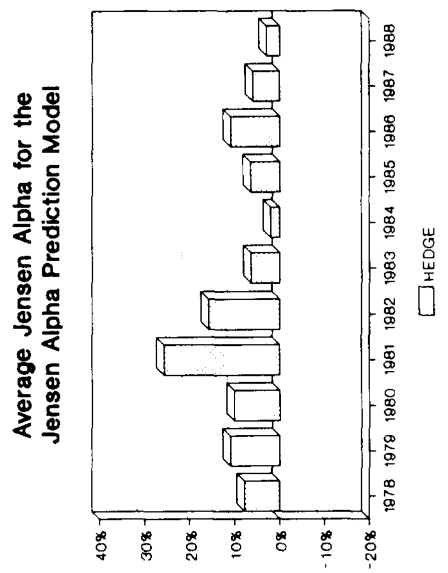
The top graphs of fig. 1 present the year-by-year market-adjusted return results from 1978 to 1988 for the long, short, and hedge positions for 12-month holding periods for NYSE, AMEX, and OTC firms combined.[12] As can be seen, the long portfolio is positive in only five of eleven years, while the short portfolio is negative in all but three years. There is only one year in which the hedge portfolio earns a negative return. The annual arithmetic mean return to the long

[12]To be more precise, year refers to COMPUSTAT year. For example, the 1979 returns refer to companies with fiscal year-ends between 6/79 and 5/80. Excess returns for a 6/79 fiscal year-end observation are calculated from 10/79 to 9/80, while excess returns for a 5/80 fiscal year-end observation are calculated from 9/80 to 8/81. Limiting the analysis to December 31 fiscal year-ends has no substantive impact on the results.


Average Market-Adjusted Returns for the
Market-Adjusted Returns Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
SHORT
LONG


Average Market-Adjusted Returns for the
Market-Adjusted Returns Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
HEDGE


Average Jensen Alpha for the
Jensen Alpha Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
SHORT
LONG


Average Jensen Alpha for the
Jensen Alpha Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
HEDGE

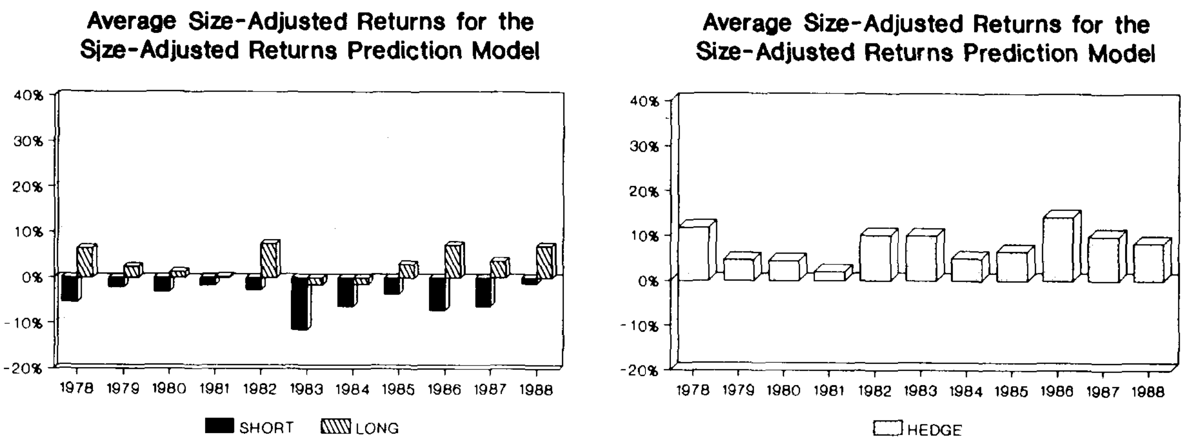


Fig. 1. Mean 12-month market-adjusted returns, Jensen alphas, and size-adjusted returns associated with the excess return prediction models for the long, short, and hedge portfolios for NYSE, AMEX, and OTC firms over the 1978–1988 period.

(short) position is 2.7% (-4.6%) with t-statistics of 0.92 (-2.15).[13] The hedge portfolio has an annual arithmetic mean return of 7.3% with a t-statistic of 4.77.[14] Note that the profitability of the trading strategy using this weighting method results in a higher point estimate that obtained in table 3 where observations are equally-weighted.

The middle graphs of fig. 1 present the year-by-year results for the trading strategy based on Jensen alphas. In this case, the short position is negative in seven of eleven years and the long position is positive in six of eleven years. The hedge position is positive in every year between 1978 and 1988. Annual arithmetic mean returns for the long (short) portfolios are 6.7% (-2.9%) with associated t-statistics of 1.65 (-1.19). The hedge portfolio has an annual arithmetic mean return of 9.5% with a t-statistic of 4.98. Again, the point estimate of the return to the hedge portfolio based on this weighting scheme is higher than appears in table 3.

The bottom graphs of fig. 1 present the year-by-year results for the size-adjusted returns. The short portfolio earns negative returns in every year, the long portfolio is positive in all but two years, and the hedge portfolio is always positive. Annual arithmetic mean returns (t-statistics) for the long, short, and hedge portfolios are 3.2% (3.27), -4.7% (-5.35), and 7.9% (7.34), respectively. These results are very similar to those obtained in table 3.

3.4. Relationship of the trading strategy to other known anomalies

The results in table 3 and fig. 1 indicate that trading rules based on excess return logit prediction models are able to generate returns in excess of common benchmarks used for expected returns. A natural question to address is to what extent the abnormal returns associated with the logit models are simply manifestations of other previously documented 'anomalies'. Financial data which have been shown to be correlated with subsequent excess returns include earnings/price ratios [Basu (1983) and Reinganum (1981)], market-to-book ratios [Reinganum (1988)], prior returns of the stock [the so-called contrarian strategy examined by Debondt and Thaler (1985)], the firm size anomaly [Banz (1981) and Keim (1983)], and the most recently observed unexpected earnings [the post-earnings announcement drift examined by Watts (1978) and Bernard and Thomas (1989) among others].

[13]The average returns to the trading strategy reported here are different from those reported in table 3 because here the averaging takes place across firms within a year and then across years, whereas in table 3 the averaging takes place across firm-year observations. Thus, the weighting scheme here represents a truly implementable strategy. The reported t-statistics, which are based on the standard deviation of the annual returns between 1978 and 1988, assume independence in the returns over time and have ten degrees of freedom. The 5% (1%) two-tailed critical value for the t-distribution with ten degrees of freedom is 2.228 (2.764).

[14]We also calculated annual geometric mean returns to the trading strategies discussed in the paper. The annual geometric mean estimates are so close to the annual arithmetic mean estimates that we do not report them.

Table 4 reports three different regressions, one for each excess return measure used, to address the issue of whether the prediction models are just capturing other well-known phenomena that are correlated with subsequent excess returns. The dependent variable in each regression is a particular subsequent excess return measure. One of the independent variables is a dummy variable which indicates whether the return prediction model (for the particular excess return metric serving as the dependent variable) classifies the observations as belonging to the long portfolio (coded as a one) or short portfolio (coded as a zero). Observations which fall into portfolios 4 to 7 are not classified into either the long or short portfolio, and are dropped from the analysis. Other independent variables are the earnings/price ratio, the ratio of book value of equity to market value of equity, the firm's market-adjusted buy-and-hold return over the previous 36 months (the contrarian strategy),[15] the most recently observed unexpected earnings deflated by price (post-earnings announcement drift), and the market value of equity. The independent variables are all measured contemporaneously, at the end of the third month following the most recent fiscal year-end. The excess return metric being used as the dependent variable is measured over the subsequent 12 months.

The form of the regression is

$$EXRET_{it} = b_{0t} + b_{1t}\, PRDUMMY_{it} + b_{2t}\, UEPS/P_{it} + b_{3t}\, E/P_{it} + b_{4t}\, B/M_{it} + b_{5t}\, RMB36_{it} + b_{6t}\, MKTVAL_{it},$$

where

$EXRET_{it}$	=	particular excess return measure MAR_{im}, α_{im}, or SAR_{im} with $m = 12$,
$PRDUMMY_{it}$	=	dummy variable equal to one if the appropriate return prediction model classifies an observation in the long portfolio, zero otherwise,
$UEPS/P_{it}$	=	most recently observed unexpected earnings-per-share (judged by a random walk with drift model) deflated by price-per-share at the fiscal year-end,
E/P_{it}	=	earnings/price ratio based on most recently observed annual earnings deflated by price at the fiscal year-end,
B/M_{it}	=	book value of equity based on most recently observed annual report deflated by market value of equity at the fiscal year-end,

[15]The test we report is not similar to the contrarian strategy tests by DeBondt and Thaler (1985), since their strategy is based on using a very limited number of observations in each year with the most extreme positive and negative returns. Our sample is based on a large proportion of NYSE, AMEX, and OTC firms and is not conditioned on having had extreme returns.

Table 4

Mean yearly coefficients and t-statistics based on time-series standard errors of estimated yearly regression models of 12-month market-adjusted, Jensen alpha, and size-adjusted excess returns (beginning four months after the fiscal year-end) regressed on a long or short portfolio assignment variable (based on an excess return prediction model) and variables used to proxy for selected 'anomalies' for NYSE, AMEX, and OTC firms over the 1978–1988 period.[a]

	b_0	*PRDUMMY* b_1	*UEPS/P* b_2	*E/P* b_3	*B/M* b_4	*RMB36* b_5	*MKTVAL* b_6
(A) *Market-adjusted returns*							
Average yearly coefficient estimate	− 0.036	0.060	0.018	0.043	0.023	0.014	− 0.006
t-statistic computed using the time-series standard error from the 11 individual yearly regressions[b]	− 1.431	12.479	1.721	1.714	1.661	1.354	− 1.225
(B) *Jensen alpha*							
Average yearly coefficient estimate	− 0.005	0.064	0.044	0.021	0.009	0.005	− 0.019
t-statistic computed using the time-series standard error from the 11 individual yearly regressions[b]	− 0.204	5.386	1.813	0.804	0.763	0.427	− 1.736

(C) *Size-adjusted returns*							
Average yearly coefficient estimate	− 0.041	0.079	0.024	0.038	0.025	0.011	− 0.011
t-statistic computed using the time-series standard error from the 11 individual yearly regressions[b]	− 4.036	5.072	1.407	1.467	1.428	1.064	− 3.196

[a] $EXRET_{it} = b_{0t} + b_{1t}\ PRDUMMY_{it} + b_{2t}\ UEPS/P_{it} + b_{3t}\ E/P_{it} + b_{4t}\ B/M_{it} + b_{5t}\ RMB36_{it} + b_{6t}\ MKTVAL_{it}$,

where $EXRET_{it}$ = particular excess return measure MAR_{im}, α_{im}, or SAR_{im} with $m = 12$; $PRDUMMY_{it}$ = dummy variable equal to 1 if the appropriate return prediction model classifies an observation in the long portfolio, 0 otherwise; $UEPS/P_{it}$ = most recently observed unexpected earnings-per-share (judged by a random walk with drift model) deflated by price-per-share at the fiscal year-end; E/P_{it} = earnings/price ratio based on most recently observed annual earnings deflated by price at the fiscal year-end; B/M_{it} = book value of equity based on most recently observed annual report deflated by market value of equity at the fiscal year-end; $RMB36_{it}$ = market-adjusted return to the common equity over the previous 36 months (a proxy for the contrarian strategy); $MKTVAL_{it}$ = natural logarithm of the market value of the equity (thousands of dollars) at the fiscal year-end; t = subscript for years from 1978 to 1988.

[b] The t-statistic has ten degrees of freedom under the assumption that the yearly coefficient estimates are independent through time.

$RMB36_{it}$ = market-adjusted return to the common equity over the previous 36 months,

$MKT\,VAL_{it}$ = natural logarithm of the market value of the equity (thousands of dollars) at the fiscal year-end,

t = subscript for years from 1978 to 1988.

A separate regression is estimated for *each year t*. In each yearly regression, all of the independent variables except the dummy variable for the return prediction models are mean-adjusted. Given the mean adjustment, the coefficient on the dummy variable for the portfolio assignment can be interpreted as the return to the hedge portfolio, after controlling for the effect of all the other 'anomaly' variables. The intercept of the regression is the return to the short portfolio and the sum of b_0 and b_1 is the return to the long portfolio, after controlling for the effect of all the other 'anomaly' variables. The mean of each coefficient across the 11 years is reported, as well as the t-statistic based on the time-series standard error of that coefficient, which assumes the coefficients are independent through time. Thus, the t-statistic has 10 degrees of freedom.[16]

The regressions which use the market-adjusted buy-and-hold return as the dependent variable indicate that, given the other variables, the return to the hedge strategy based on the market-adjusted return prediction model is 6.0% per year (t-statistic of 12.48), which is reasonably close to the estimate of the hedge return (7.3%) reported for the year-by-year results. None of the other coefficients in the regression is significant at even the 10% level.

The regression based on Jensen alphas indicates that, given the other variables, the 12-month return to the hedge portfolio based on the Jensen alpha prediction model is 6.4% per year (t-statistic of 5.39), which is less than the 9.5% reported for the year-by-year results. The only other variable which is significant at even the 10% level is unexpected earnings deflated by price, which, as might be expected, has a positive sign.

The regression based on size-adjusted returns indicates that the return to the hedge portfolio based on the size-adjusted return prediction model is 7.9% per year (t-statistic of 5.07), which is identical to the 7.9% reported for the year-by-year results. The only other variable which is significant at conventional levels is the market value of the equity which has a negative sign. The significance of the market value of the equity is surprising since we did not anticipate that firm size would enter the regression significantly when we used size-

[16]We also estimated the model by pooling all of the observations together. The results are similar except the magnitude of the coefficient on the dummy variable is very close to the returns reported in table 3 since the weighting schemes are similar. Moreover, there is some variation as to which of the variables representing the 'anomalies' are significant (e.g., the market-to-book ratio is typically highly significant). This arises because the pooled model allows variation over time in the variables (such as market-to-book ratios) to predict excess returns, whereas the year-by-year regressions effectively suppress the ability of the time-series variation to predict excess returns.

adjusted returns. This result may be indicative of the crude size adjustment that is obtained when size deciles are used, as it does not eliminate within-portfolio size variation.

To the extent that the anomaly variables proxy for previously documented asset pricing misspecification problems, these tests address whether the profitability of the return prediction models is diminished by including those proxy variables. Fama and French (1992) indicate that size and the market-to-book ratio capture all of the cross-sectional variation in stock returns associated with market beta, size, leverage, market-to-book ratios, and earnings/price ratio. Interestingly, the estimates of the profitability of the trading strategies are not diminished greatly by conditioning on these proxy variables. These results suggest that either (i) asset pricing misspecifications are not driving the results or (ii) the return prediction models capture elements of asset pricing misspecification that are distinct from those associated with the proxy variables.[17]

The results of this section suggest that a trading strategy, based on a model which predicts excess returns with relatively modest predictive power, is capable of earning excess returns judged relative to typical benchmarks. The annual excess return measures, assuming no transactions costs, vary between 4.3% and 9.5% depending on the benchmark used, the weighting scheme employed, and whether controls for other potential 'anomalies' are included in the analysis. In the next section we contrast our results with those we obtain by estimating the profitability of Ou and Penman's trading strategy with our data.

4. Estimation and predictive ability of the unexpected earnings logit prediction model

4.1. Estimation of the unexpected earnings logit prediction models

Ou and Penman estimate their multivariate logit model using only those ratios which are significant at the 10% level in univariate predictions of unexpected *EPS*. From their 68 ratios, 18 different variables are used in their various logit models. One potential problem with this approach is that it may eliminate financial statement items which provide significant marginal explanatory power in the presence of other variables. Since our sample includes Over-the-Counter firms, extends to a new time period, and has only 60 of the original 68 ratios used by Ou and Penman, we estimate new logit models for predicting unexpected earnings using the BMDPLR stepwise logit procedure.

[17]The lack of significance of the variables proxying for the anomalies may be driven by (i) multicollinearity among the anomaly variables, (ii) the use of year-by-year regressions which severely limits the assumed degrees of freedom, and (iii) the elimination of observations based on probability scores from the return prediction models which may eliminate variation in the 'anomaly' variables, thus limiting the power of the tests to detect significant effects associated with the anomalies.

Table 5

Out-of-sample percentage of correct predictions for logit prediction models of unexpected earnings-per-share by subperiod for NYSE, AMEX, and OTC firms over the 1978–1988 period.

	(A) *Prediction of unexpected earnings-per-share*					
	Predictions 1978–1982		Predictions 1983–1988		Predictions 1978–1988	
	Cut-offs of		Cut-offs of		Cut-offs of	
	0.5	0.4 & 0.6	0.5	0.4 & 0.6	0.5	0.4 & 0.6
# of observations	14,711	7,960	15,747	8,430	30,458	16,390
% correct predictions	60.2%	65.0%	60.1%	65.0%	60.1%	65.0%
Chi-Squared[a]	673.5	744.8	645.7	762.2	1307.4	1508.4
% predicted *EPS* increases correct	56.3%	62.3%	59.0%	63.4%	57.6%	62.8%
% actual increases	46.9%	49.4%	49.6%	51.1%	48.3%	50.3%
% predicted *EPS* decreases correct	65.3%	68.8%	61.3%	67.3%	63.2%	68.0%
% actual decreases	53.1%	50.6%	50.4%	48.9%	51.7%	49.7%

(B) *% correct predictions (out-of-sample) by PR portfolio*

	1978–1982		1983–1988		1978–1988	
PR portfolio[b]	# of observations	% correct predictions	# of observations	% correct predictions	# of observations	% correct predictions
1	614	73.8%	1,292	72.4%	1,906	72.9%
2	507	67.5%	790	65.6%	1,297	66.3%
3	1,079	65.0%	1,094	60.3%	2,173	62.6%
4	2,472	57.2%	1,875	58.0%	4.347	57.5%
5	3,647	48.6%	3,462	52.6%	7,109	50.5%
6	3,104	61.6%	3,855	56.1%	6,959	58.5%
7	1,840	66.1%	2,040	64.7%	3,880	65.3%
8	834	71.6%	818	69.7%	1,652	70.6%
9	359	74.7%	325	74.5%	684	74.6%
10	255	71.0%	196	73.0%	451	71.8%

[a]The 0.001 critical value of the Chi-Squared statistic with one degree of freedom is 10.83.

[b]Ten portfolios are formed based on Ou and Penman's (1989) cut-offs (0.1, 0.2, . . . , 0.9). The first (tenth) portfolio contains observations that the models predict to have positive (negative) unexpected earnings-per-share.

Separate models are estimated for NYSE/AMEX firms and OTC firms. The logit models estimated with accounting data from 1973–1977 are used to form portfolios based on accounting data that become available between 1978 and 1982 and the models estimated with accounting data from 1978–1982 are used to form portfolios based on accounting data that become available between 1983 and 1988. The exact timing of the trading strategy is identical to the approach discussed in sections 2 and 3.

We estimate four different models (two exchanges and two time periods). The typical logit model retains 15 ratios.[18] Table 1 contains the previously discussed correlations, between the estimated probabilities of the earnings prediction model with the three return prediction models, the three excess return measures, subsequent unexpected earnings, and selected 'anomaly' variables which have been used to predict subsequent excess returns. The earnings prediction models exhibit considerable intertemporal stability. The correlation in the probability scores between the 1973–1977 model and the 1978–1982 model estimated from data available between 1983 and 1988 for NYSE/AMEX (OTC) firms is 0.70 (0.58).

4.2. Predictive ability of the unexpected earnings logit models

Table 5 provides information about the predictive ability of the model. Panel A indicates that over the 1978–1988 period, using a cut-off of 0.5 to determine predicted increases and decreases, the overall accuracy is 60.1%, with 57.6% of the predicted increases correct and 63.2% of the predicted decreases correct where 48.3% of the unexpected earnings are positive and 51.7% are negative. Using cut-offs of 0.4 and 0.6 to predict the sign of unexpected earnings increases the overall predictive accuracy to 65.0%. The overall predictive accuracy is not sensitive to the choice of subperiod as the overall accuracy rates in the two subperiods are very similar. Ou and Penman (their table 4) report an overall accuracy rate of 60% for the 1978–1983 period using a cut-off of 0.5 and an accuracy rate of 67% using cut-offs of 0.4 and 0.6. Thus, our results are qualitatively similar.

Panel B of table 5 indicates the percentage of predictions which are correct by *PR* portfolio, where *PR* portfolios are based on the estimated probability scores from the logit model. Similar to the approach of Ou and Penman, the first

[18]Thirty-three different variables enter the four models. Three variables enter four times (current ratios, quick ratio, and inventory/total assets) and four variables enter three times (depreciation/plant assets, percentage change in depreciation/plant assets, cash flow/total debt, and stockholders equity/fixed assets). All of these variables always enter with the same sign. Increases in current ratios, inventory/total assets, depreciation/plant assets always signify a reduction in the probability of a subsequent earnings increase, while increases in the quick ratio, percentage change in depreciation divided by plant assets, cash flow to total debt, and shareholders' equity to fixed assets indicate an increase in the probability of a subsequent earnings increase.

portfolio contains all observations with *PR* scores greater than 0.9 and the last portfolio contains all observations with *PR* scores less than 0.1. In general, accuracy rates increase monotonically from portfolio 5 to portfolio 1 and from portfolio 6 to portfolio 10. Thus, portfolio 5 has an accuracy rate of only 50.5%, whereas portfolios 1 and 10 have accuracy rates of 72.9% and 71.8%, respectively. These results are also similar to those reported by Ou and Penman (1989).

5. The profitability of the Ou and Penman trading strategy

5.1. Profitability of the trading strategy: Observations pooled over time

We report returns for the long, short, and hedge positions of the trading strategy measured as of 12, 24, 36, and 48 months after the start of the strategy. We estimate buy-and-hold market-adjusted returns, Jensen alphas, and buy-and-hold size-adjusted return measures to judge the profitability of the trading strategy.[19] As in Ou and Penman, the long portfolio is comprised of firm-observations with probability scores ranging from 0.6 to 1.0, and the short portfolio is based on probability scores ranging from 0.0 to 0.4. Consistent with Ou and Penman as well as table 3 of this paper, the long and short portfolio returns are based on equally-weighting pooled cross-sectional and time-series data. The profitability of the trading strategy based on the unexpected earnings prediction model for NYSE, AMEX, and OTC firms over the 1978–1988 period is presented in table 6.

As can be seen in table 6, our implementation of the trading strategy based on predicting unexpected earnings does not yield results as strong as those reported by Ou and Penman. For example, at 24 months, the holding period that Ou and Penman select for testing their trading rule, the market-adjusted return to the hedge portfolio is 2.23% whereas Ou and Penman report a market-adjusted return to the hedge portfolio of 14.5%. The return to the hedge portfolio as measured by the Jensen alpha is 3.4% at 24 months and for size-adjusted returns it is 3.74%.

There is also evidence of substantial increases in the returns to the Ou and Penman strategy beyond 12 months in table 6. Regardless of the return metric used, the returns using a model which predicts subsequent unexpected earnings one year ahead, are very modest at 12 months. Moreover, the increase in the returns from months 37 to 48 is greater than the 12-month return from months 25 to 36, which is greater than the 12-month return from month 13 to month 24, and that is greater than the first 12-month return. This pattern of abnormal

[19]Ou and Penman use the average cumulative mean market-adjusted return metric to judge the profitability of their trading rule, which implies monthly rebalancing of the portfolio, and thus is very expensive to implement. While we do not report results using this measure, the results are not particularly sensitive to alternative measures for computing cumulative returns.

Table 6

Average returns associated with the unexpected *EPS* prediction models for market-adjusted returns, Jensen alphas, and size-adjusted returns with equally-weighted pooled cross-sectional and time-series observations for NYSE, AMEX, and OTC stocks over the time period 1978–1988.

	# of observations (month 12)	Month of holding period 12	24	36	48
		(A) Market-adjusted returns			
Long portfolio (portfolios 1 to 4)[a]	8,986	– 0.0062	0.0183	0.0592	0.1137
Short portfolio (portfolios 6 to 10)[a]	6,287	– 0.0061	– 0.0040	– 0.0152	– 0.0160
Hedge portfolio	15,273	– 0.0001	0.0223	0.0744	0.1297
		(B) Jensen alpha			
Long portfolio (portfolios 1 to 4)[a]	8,946	0.0227	0.0166	0.0614	0.1136
Short portfolio (portfolios 6 to 10)[a]	6,269	0.0065	– 0.0174	– 0.0291	– 0.0446
Hedge portfolio	15,215	0.0162	0.0340	0.0905	0.1582
		(C) Size-adjusted returns			
Long portfolio (portfolios 1 to 4)[a]	8,917	– 0.0042	0.0206	0.0607	0.1166
Short portfolio (portfolios 6 to 10)[a]	6,190	– 0.0104	– 0.0168	– 0.0358	– 0.0430
Hedge portfolio	15,107	0.0062	0.0374	0.0965	0.1596

[a]Ten portfolios are formed based on Ou and Penman's (1989) cut-offs (0.1, 0.2, . . . , 0.9). The first (tenth) portfolio contains observations that the models predict to have positive (negative) unexpected earnings-per-share.

returns is especially troubling given that the model is based on predicting one year's unexpected earnings. These results are similar to those of Stober (1992), who documents that the returns to the Ou and Penman strategy increase for six years when he replicates their study. This suggests that the Ou and Penman trading strategy may be sorting firms into portfolios according to some asset pricing misspecification problem. For example, Greig (1992) suggests that Ou and Penman's results arise, in part, because their model is just a proxy for expected returns associated with differences in relative size.

We examine, but do not report in detail, the sensitivity of the Ou and Penman trading strategy to the subperiod examined (1978–1982 and 1983–1988) as well as the exchange status (NYSE and AMEX, OTC only, and NYSE, AMEX and OTC). The conclusions drawn from examining these subsets depend upon whether one examines the 12-month returns (the focus of our study) or the

24-month returns (the focus of Ou and Penman). Examination of the returns at 24 months indicates that the Ou and Penman strategy works well in the 1978–1982 period regardless of exchange, but does not work at all in the 1983–1988 period. For example, 24-month returns to the hedge portfolio for NYSE/AMEX firms in the 1978–1982 period vary from 6.9% to 10.3% depending on the excess return metric, while the strategy earns between 8.0% and 11.4% on OTC firms. In the 1983–1988 period, returns to the hedge portfolio at 24 months are negative (with one exception where the hedge portfolio earns 0.58%), regardless of the exchange or excess return metric used. Moreover, in this period the hedge portfolio generally earns approximately −4% to −5%.

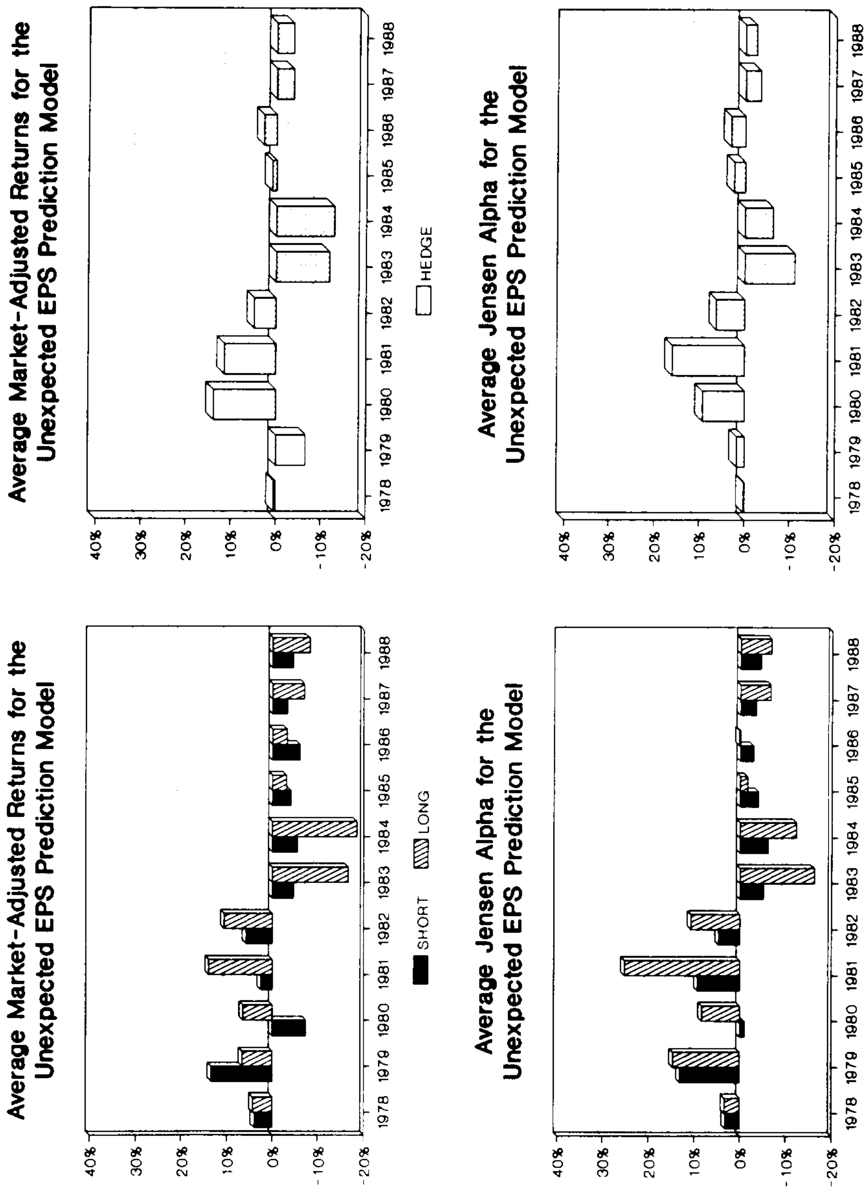
Examination of the 12-month returns, the focus of our study, indicates again that the Ou and Penman strategy only works in the first subperiod (all of the returns to the hedge portfolio at 12 months are negative in the 1983–1988 period regardless of exchange or excess return metric used). Moreover, the results suggest that overall the strategy is more successful on NYSE/AMEX firms than OTC firms. Over the 1978–1988 period, the trading strategy earns (depending on the excess return metric used) between 2.0% and 5.6% for NYSE/AMEX firms, while it earns between −0.8% and −2.2% for OTC firms.

5.2. Profitability of the trading strategy: Year-by-year results

Fig. 2 reports the year-by-year 12-month excess returns for the trading strategy based on the unexpected earnings prediction model for the long, short, and hedge portfolios for each of the excess return measures. The top graphs of fig. 2 present the 12-month market-adjusted portfolio returns. Returns to the hedge portfolio are not consistent, as the returns are negative in five of the eleven years reported. The short portfolio performs reasonably well, as it is negative in seven of the eleven years. However, the long portfolio does not perform nearly as well, in that it earns a negative return more often than not. The annual arithmetic mean return to the long (short) portfolio is −1.35% (−0.90%) with associated t-statistics of −0.44 (−0.49).[20] The hedge portfolio has an annual arithmetic mean return of −0.45% with a t-statistic of −0.18.

The middle graphs of fig. 2 present the Jensen alpha portfolio returns. The 12-month hedge portfolio returns are negative in four of the eleven years. The short portfolio earns negative returns in seven of the eleven years, while the long portfolio earns a positive return in six of the eleven years. The annual arithmetic mean return to the long (short) portfolio is 1.72% (0.31%) with associated t-statistics of 0.49 (0.17). The hedge portfolio has an annual arithmetic mean return of 1.41% with a t-statistic of 0.66.

[20]As before, the t-statistic is based on the standard deviation of the annual returns between 1978 and 1988 and has ten degrees of freedom.


Average Market-Adjusted Returns for the Unexpected EPS Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
SHORT
LONG
Average Market-Adjusted Returns for the Unexpected EPS Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
HEDGE
Average Jensen Alpha for the Unexpected EPS Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
SHORT
LONG
Average Jensen Alpha for the Unexpected EPS Prediction Model
40%
30%
20%
10%
0%
-10%
-20%
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
HEDGE

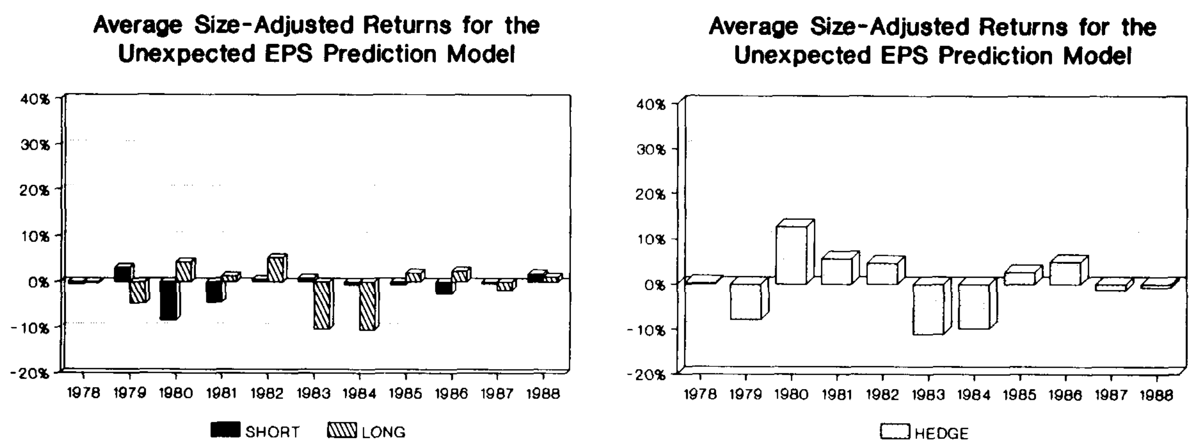


Fig. 2. Mean 12-month market-adjusted returns, Jensen alphas, and size-adjusted returns associated with the unexpected earnings-per-share prediction models for the long, short, and hedge portfolios for NYSE, AMEX, and OTC firms over the 1978–1988 period.

The bottom graphs of fig. 2 are based on size-adjusted returns. Annual returns to the hedge portfolio are negative in five of the eleven years reported. The short portfolio earns negative returns in seven of the eleven years, while the long portfolio earns a positive return in six of the eleven years. The annual arithmetic mean return to the long (short) portfolio is -1.10% (-1.09%) with associated t-statistics of -0.71 (-1.20). The hedge portfolio has an annual arithmetic mean return of -0.01% with a t-statistic of -0.01.[21]

6. Conclusions

In this paper, we have investigated the ability of purely statistical models, which are based exclusively on historical cost accounting information, to predict excess returns in a subsequent period. Our work is similar to that of Ou and Penman (1989), but rather than basing our trading strategy on a model which predicts unexpected earnings, our trading strategy is based on the prediction of excess return measures directly. The results suggest that a trading strategy based on a model which predicts excess returns directly is able to earn significant abnormal returns in the 1978–1988 period. Our overall results support the contention of Ou and Penman that financial statement items can be combined into one summary measure to yield insights into the subsequent movement of stock prices.

In comparing the returns of our trading strategy with Ou and Penman's trading strategy, we find that, given our time period and data, our implementation of the trading strategy based on a returns prediction model appears to earn returns which exceed the returns to our implementation of the trading strategy based on an earnings prediction model. Moreover, we conclude that Ou and Penman's trading strategy does not work in the 1983–1988 period. As such, we believe the profitability of the Ou and Penman trading strategy is more fragile than their tests of the 1973–1983 period suggest. Of course, it is entirely conceivable, that the excess returns we document over the 1978–1988 period for the trading strategies based on excess return prediction models will not be robust to new time periods as well.

The reported profitability of the trading strategy investigated in this paper may be exaggerated relative to 'true' excess returns for at least four reasons:

1. Our results do not include transactions costs. In particular, the estimates of the returns to the trading rule do not incorporate transactions costs, the

[21] We also estimated the regressions reported in table 4 where the *PR DUMMY* indicates whether the trading strategy based on the earnings prediction model assigns an observation to the long or short portfolio. Unlike the results reported in table 4, the *PR DUMMY* is not statistically significant at conventional levels, indicating the earnings prediction model has no explanatory power given the presence of the other known anomalies. In general, the regression indicated that unexpected earnings deflated by price and book-to-market ratios were positive and statistically significant at conventional levels. Market value of equity was again significant in the size-adjusted returns.

effect of bid–ask spreads,[22] and other trading restrictions (e.g., restrictions on short sales and the possibility that holding a short position for a year without being made to cover the position is not always feasible). Hence, the returns are overstated relative to the true profitability of the trading rule after consideration of those costs. However, given the magnitude of the excess returns, we do not think that incorporation of these execution costs would eliminate the apparent profit opportunities which the tests suggest are available from the trading strategy based on the prediction of excess returns. Moreover, the profitability of the trading rule is not diminished by eliminating low-priced shares.

2. Our benchmarks for normal returns may be misspecified. To mitigate that possibility we used several excess return benchmarks. Regression tests also indicated that the return prediction models had significant explanatory power to predict returns in the presence of other well-known anomalies, such as firm size, post-earnings announcement drift, the contrarian strategy, market-to-book ratios, and earnings/price ratios, which may proxy for omitted risk factors in typical risk adjustments. Finally, the pattern of excess returns over the 48 months following the start of the trading strategy seems to suggest that permanent differences in expected returns, which are not captured by our asset pricing models, may be more of an explanation for the profitability of the trading strategy based on predicting unexpected earnings than the trading strategy based on predicting excess returns.

3. There may be temporary risk shifts which our methods do not adequately consider.[23]

4. The accounting data for all firms may not be available at the end of the third month following the fiscal year-end. To the extent that some firms file their 10-K's late, particularly firms in financial distress, some of the firms in the trading rule will not have released their financial information by the end of the third month following the fiscal year-end.

[22]Prices used in computing these returns will reflect the average of the bid and ask prices for these securities (we assume there are no patterns in normal investor buying and selling which would be correlated with the execution of the trading strategy). However, in executing this strategy, one will typically execute purchases at the ask and sales at the bid. Hence, the returns to a trading strategy estimated from CRSP data are likely to be overstated by the bid–ask spread of the securities that enter into the trading strategy. See Holthausen, Leftwich, and Mayers (1990) and Keim (1989) for discussions.

[23]The Jensen alpha tests are appropriate for estimating the profitability of a trading rule where temporary shifts in risk are likely, as long as the CAPM is an appropriate specification of asset pricing. The advantage of the Jensen alpha tests relative to a market model specification (where the market model is estimated in a period outside the holding period of the trading strategy) is that Jensen alpha tests estimate risk in the same period the asset is being held. As such, it avoids the problem of measuring the profitability of a trading strategy in the presence of shifts in risk, but it depends on the assumption that the CAPM is an appropriate model of asset pricing.

Given the competitive environment in which securities are traded in the New York, American, and Over-the-Counter markets, we find it surprising that a statistical model, derived without consideration of any economic foundations, can earn excess returns of the magnitude documented here. Had our trading strategy been based on some new economic insight that others had never considered, or if it had been based upon hours of diligent investigation of annual reports of the firm, its suppliers, customers, the industry, and/or government documents, we would be more convinced that the trading strategy was earning 'true' excess returns. As such, we view the results of our paper as something of a puzzle, similar in spirit to other evidence which is inconsistent with joint tests of market efficiency and asset pricing [see, for example, results in Watts (1978) and Bernard and Thomas (1989, 1990), as well as reviews by Ball (1978, 1990)].

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