Portfolio Manager Behavior and Arbitrage Pricing Theory

1. Introduction

Professional equity portfolio managers have long sought classification schemes for characterizing the similarities and differences among individual firms. Some procedures classify stocks on the basis of financial variables such as dividend yield, earnings growth and volatility, leverage, and market capitalization. Other schemes involve looking for patterns in the comovements among security returns – the identification of market sectors or groups whose constituent firms have returns that tend to move together but with no necessarily close relations among security returns across groups. A familiar example is the five sector breakdown into growth, cyclical, stable, interest-sensitive, and oil stocks. These two classification strategies are related: high and low dividend yield, high earnings growth and volatility, and small market capitalization firms tend to be growth stocks, highly levered firms tend to have interest-sensitive returns, and stable stocks tend to have large market values.

Why are portfolio managers interested in such classifications? The ability to group similar stocks together simplifies the control of portfolio risk, the implementation of active portfolio strategies, and the evaluation of portfolio performance. This follows in part from the traditional breakdown of management skills into stock selection and market or sector timing ability. The performance of stock pickers can be measured by comparing the returns on their picks with those of a passive portfolio of similar stocks and their picks can be incorporated into an overall sector portfolio. Sector timers can then take these sector portfolios and invest more or less in each sector according to their timing predictions. The portfolio manager can keep the scorecard[1].

Financial economists care about characterizing the similarities and differences among firms as well. Their motivation is different – money managers seek high returns for given risk levels, and financial economists seek to understand the structure of security prices. One of the most enduring concepts among economists is that goods and services that are close substitutes (that is, that are similar in the eyes of consumers) should sell for almost the same price. By this logic, similar equity securities should sell for nearly the same price as well. The basic problem is quantifying what is meant by similar stocks.

In fact, there is a prominent theory of asset pricing which unites both the financial economist's and portfolio manager's notion of similar securities – the *Arbitrage Pricing Theory (APT)* of Ross (1976, 1977). The APT assumes that the portfolio manager's quantification of similar stocks is correct and presumes that there are clusters of stocks whose returns tend to move together. The theory goes beyond this model of stock returns in considering its implications for security pricing in a market whose prices reflect the absence of particular arbitrage opportunities. The basic idea is that stocks with similar risk characteristics should sell for similar prices. The basic problem is quantifying what is meant by risk.

What is particularly interesting about the APT is the relation between the theory and the model of portfolio management sketched above. Hence, the APT is a theory that should be easily understood und intuitively appealing to portfolio managers. One of the goals in this paper is to present the APT in exactly this fashion.

Of course, no theory can be accepted solely on the basis of its logical appeal or of the compelling nature of its underlying intuition. Mod-

els are made and broken on the basis of their ability to 'explain the facts'. Financial economists have invented many models beside the APT that can potentially account for stock price movements. Chief among these is the *Capital Asset Pricing Model (CAPM)* that has dominated financial theory for much of the last two decades. Another goal of this paper is to examine the degree to which the APT explains facts that are not accounted for by the CAPM.

As a consequence, this paper has two major goals – explaining the APT as the outcome of typical portfolio management strategies and assessing the degree to which it is an empirical success, particularly relative to the CAPM[2]. The next section describes the stylized model of portfolio manager behavior sketched above in more detail. The third section discusses the implications of the APT for securities prices and links this discussion to the stylized model of managerial behavior. The fourth section provides some empirical evidence from U.S. equity markets on the validity of the theory, and the final section contains concluding remarks.

2. Active and Passive Portfolio Management

Institutional investors such as pension funds often hire a number of portfolio managers. Portfolio managers tend to be classified according to two criteria: their management style and the universe of assets (i.e., the sectors) in which they specialize. Management styles are either active or passive. Active managers think that they can 'beat the market' either by superior stock selection ability (i.e., picking stocks) or through the ability to predict the ups and downs of broad market sectors (i.e., market timing). Passive managers do not attempt to outperform the market and instead try to tailor portfolios to minimize transactions costs while closely tracking the returns of some market or sector index. So-called index funds, whose returns typically track the returns of the Standard and Poor's 500 index, are the ultimate expression of the belief that the market is efficient and that managerial skill does not yield superior returns.

Consider the following sketch of the management of a hypothetical institutional portfolio. This picture does not reflect the management strategies of most institutional portfolios but is probably a reasonable characterization of a substantial fraction of them. The sponsor of a pension fund, after consultation with a team of experts, has decided to break down the U.S. equity market and its investments in that market into the five sectors mentioned earlier: growth, cyclical, stable, interest-sensitive, and oil stocks. A passive portfolio manager for each sector is hired to construct and manage a passive portfolio whose returns are almost identical to those of given broad-based indices of the stocks in each sector.

The pension fund also hires active managers. An active manager who purports to have stock selection ability is hired to alter the composition of these passive sector portfolios by purchasing more shares of the stocks that they anticipate will perform well and to sell anticipated 'losers'. These active managers actually trade with the relevant passive manager, which serves to minimize transactions costs. Finally, market timing experts are hired to determine the fraction of funds (perhaps within established guidelines) to be allocated to each sector portfolio in accordance with their expectations regarding the future relative market values of these sectors.

From an analytical perspective, there are three key features of this characterization. The first aspect, emphasized in the introduction, is that this portfolio management strategy breaks securities into groups that are similar in some dimensions. The second facet is the disciplined search within sectors for particular stocks that are expected to exhibit abnormally poor or superior performance. The third feature is that cross-sector comparisons involve only the prospects of the resulting sector portfolios and not of the individual securities across sectors. In short, this mixed passive and active portfolio management strategy involves the determination of similar stocks and the evaluation of how similar they are in prospective performance by comparison with other stocks in the sector but not across sectors.

3. The Arbitrage Pricing Theory and Portfolio Management Style

The basic premise underlying the APT is that the U.S. stock market can be broken down into sectors in a similar fashion. For expositional

simplicity, we can attach the same labels to the market sectors that we used in the previous section (that is, growth, cyclical, stable, interest-sensitive, and oil stocks), although this identification is not a necessary feature of the APT. What is a necessary feature of the APT is that the returns on sector portfolios (which are often referred to as factor, mimicking, or basis portfolios in the APT literature) are the dominant source of covariation among equity returns.

Of course, security returns fluctuate for many other reasons as well, reflecting changes in prices that follow from firm or industry specific events. The theory assumes that such idiosyncratic risk is not an important source of covariation among security returns. In particular, the APT requires that well-diversified portfolios consisting of many securities contain negligible idiosyncratic risk. Note that this means that the returns of large, well-diversified portfolios are not affected by firm specific fortunes because they 'average out' by assumption[3].

This model of the structure of stock returns can be captured succinctly by the following equation:

$$R_{it} = a_i + \sum_{k=1}^{K} b_{ik}R_{kt} + e_{it} \qquad (1)$$

where K is the number of sectors (five in our example), R_{it} is the percentage return on the ith security in month t (that is, the dividend yield in month t plus the percentage capital gain), R_{kt} is the percentage return on the kth sector portfolio, the terms b_{ik} reflect the degree to which the ith security's return typically respond to the returns on the kth sector portfolio, and e_{it} is the idiosyncratic (that is, security specific) portion of the ith security's return. It is worth emphasizing that it is always possible to decompose the returns on a security into these components in this fashion so that there are no assumptions whatsoever about market prices implicit in equation (1).

The only assumption about market prices made in this model of stock prices is that it is possible to diversify away the security specific portion of each security's return (that is, idiosyncratic risk) in large portfolios. Hence the actual return on a large, well-diversified portfolio p is simply:

$$R_{pt} = a_p + \sum_{k=1}^{K} b_{pk}R_{kt} \qquad (2)$$

since it is not exposed to idiosyncratic risk. In the next section, we will examine some evidence regarding the ability to diversify away idiosyncratic risk in large portfolios.

Consider the task confronting a passive portfolio manager who constructs a portfolio to track the returns of the first sector when security returns follow the model (1). This means that the job of this sector portfolio manager is to construct a portfolio that goes up ten points when index one rises by ten points and declines by ten points when the converse occurs. It seems obvious that the manager can accomplish this goal by simply buying all of the securities in index one.

This is not actually feasible in practice because of transactions costs. For example, an index fund manager attempting to perfectly track the S&P 500 stock index will hold many fewer stocks than the 500 stocks in that index because the manager must engage in transactions in each stock in the index fund every time there are inflows or outflows from the fund (that is, when its investors add or withdraw funds). In addition, this passive sector portfolio manager must trade even more actively than an index fund manager because of the requirement of trading with the other active managers as well. Actual index fund managers are able to track broad-based indices of common stocks with only a small fraction of a percentage point of tracking error (usually less than 0.25%) with portfolios consisting of a relatively small number of securities.

Therefore, as a practical matter, the passive sector portfolio manager must construct a portfolio which is different from the first index and which nearly perfectly tracks the index. Clearly, the manager must choose a well-diversified portfolio: if not, the resulting impact of idiosyncratic risk on the sector portfolio returns will show up as tracking error and, hence, will result in the dismissal of the manager. Similarly, the manager must eliminate exposure to the other sector portfolios (that is, $b_{p2} = b_{p3} = b_{p4} = b_{p5} = 0$) to prevent their uncertain returns from creating tracking error as well. Finally, it must perfectly track the first sector portfolio (that is, $b_{p1} = 1$). These are just algebraic translations of the mandate of the passive sector portfolio managers discussed in the previous section.

What are the returns R_{it}^* earned by this portfolio manager? Since the passive manager chooses a well-diversified portfolio with no ex-

posure to the other sector portfolios and unit exposure to the first such portfolio, its returns are given by:

$$R_{1t}^* = a_1^* + R_{1t} \qquad (3)$$

which follows directly from equation (2). If a_1^* is not zero, this passive portfolio manager can earn abnormal profits without working hard at all. For example, if a_1^* is positive, the manager can earn extra profits by taking this position, giving the pension fund the return R_{1t} on the first sector portfolio (which after all is what it asked for), and pocketing a_1^* every month. All managers in this position would do this until they drove market prices to the point where a_1^* is zero. This is precisely one algebraic implication of the APT.

The basic premise of passive portfolio management is that it is not possible to make abnormal profits in equity markets, at least not in the absence of special information. It takes no special knowledge about the future prospects of particular firms or sectors to construct a portfolio which nearly perfectly tracks a given index. It takes only detailed knowledge of historical patterns of return comovement coupled with the disciplined minimization of transactions costs. The APT, like passive portfolio managers, assumes that such managers cannot earn profits by mechanically tracking some broad-based market or sector index.

The APT has somewhat stronger implications than this because any well-diversified portfolio contains negligible idiosyncratic risk. What does this mean in words? In the introduction, I suggested that there are at least two concepts that require quantification in any asset pricing theory including the APT: what is meant by 'risk' and by 'similar stocks'. The risk of a stock in any well-diversified portfolio is measured by its exposure (that is, the coefficients b_{ik}) to the uncertain returns of the sector portfolios. Similar stocks are those with similar risk exposure. The APT says that stocks with the same risk exposures are perfect substitutes in well-diversified equity portfolios and, hence, should earn the same expected excess returns in well-functioning capital markets.

The APT can be understood by considering the following simple portfolio strategy:

Portfolio Position	Initial Cost	Payoff
Long Portfolio p	\$1	$\left\{ a_p + \sum_{k=1}^{K} b_{pk}R_{kt} \right\}$
Short \$$b_{pk}$ of Portfolio k, k = 1,...,K	$\$ -\left\{ \sum_{k=1}^{K} b_{pk} \right\}$	$\left\{ \sum_{k=1}^{K} b_{pk}R_{kt} \right\}$
Totals	$\$ \left\{ 1 - \sum_{k=1}^{K} b_{pk} \right\}$	a_p

This is a very complicated way of saying a very simple thing. A portfolio strategy that involves going long portfolio p and short the K sector portfolios in the amount of the exposure of portfolio p to each sector risk is *riskless* because the payoff to this strategy is a_p no matter what profits or losses are earned on the sector portfolios. Hence, the portfolio strategy should earn the riskless rate.

What this implies is that a_p can take on only one value in a well-functioning capital market under these assumptions:

$$a_p = \left\{ 1 - \sum_{k=1}^{K} b_{pk} \right\} R_f \qquad (4)$$

where R_f is the return on a riskless asset such as a one-month Treasury bill. If a_p were larger than the right-hand side of (4), investors could earn riskless profits by following this strategy. Conversely, if a_p were smaller than the right-hand side of (4), investors could earn riskless profits by taking a short position in this strategy. Since the APT presumes that it is not possible to earn such riskless *arbitrage* profits, it is called the *Arbitrage* Pricing Theory.

Note that this relation must hold for every possible well-diversified portfolio (that is, portfolio p was simply an arbitrary well-diversified portfolio) if this kind of arbitrage opportunity is absent from stock prices. If this relation is true for any well-diversified portfolio, it must be approximately true for individual securities. We usually assume that it is exactly true for individual securities. This yields the APT pricing relation:

$$R_{it} = R_f + \sum_{k=1}^{K} b_{ik}[R_{kt} - R_f] + e_{it} \qquad (5)$$

which implicitly restricts the value of a_i in equation (1). Alternatively, we often think in terms of expected (that is, the long run average) security returns. The expected return on the ith equity security R_i implied by the APT is:

$$R_i = R_f \sum_{k=1}^{K} b_{ik}[R_k - R_f] \qquad (6)$$

which provides the link between expected re-

turns R_i and risk exposure b_{ik}. This is simply the algebraic embodiment of the notion that similar stocks are those with similar risk exposures (that is, with similar coefficients b_{ik}) and similar stocks should have similar prices or risk-adjusted expected excess returns in well-functioning capital markets.

What is equally interesting is what the APT does *not* say about security prices. Anybody with even cursory knowledge of financial economic theory knows that it is common to assume that financial markets are efficient in that security prices reflect all of the information that is publicly available about individual firms. This theory – the efficient markets hypothesis – implies that it is typically not possible to earn profits trading on publicly available information. Of course, many investors have made enormous sums of money in security markets, purportedly on the basis of superior use of public information. The efficient markets hypothesis suggests that such millionaires are just lucky, a fact that we would clearly see if big losers were to write books, to give public lectures, and to retain their jobs in money management. In terms of the portfolio management model presented in the previous section, the efficient markets hypothesis implies that the pension fund is wasting its money by hiring active managers who claim to be able to beat the market.

The APT is consistent with the efficient markets hypothesis but does not require that it be true. All that is necessary for the APT to be true is that the returns on sector portfolios are the dominant source of covariation among individual equity returns, that idiosyncratic risk can be diversified away in large portfolios, and that passive managers cannot earn profits by mechanically tracking some broad-based market or sector index. In these circumstances, the APT implies that long run average security returns are related to their exposure to sector portfolio risk. Stock pickers can, in principle, successfully predict firm specific price fluctuations and sector timers can time movements in market sectors in the short run so long as their actions (and those of their competitors) do not upset the three assumptions underlying the APT. This occurs because the APT assumes the absence of one particular type of arbitrage opportunity in equity markets without making assumptions about other possible arbitrage opportunities or particular aspects of investor behavior[4].

Most portfolio managers do not believe that the efficient markets hypothesis is true while many academicians do. The APT represents a middle ground between these extreme positions which unites some of the beliefs that these two groups share concerning the similarities and differences among securities. As such, the theory can potentially help portfolio managers control risk and implement and evaluate active portfolio strategies. However, the demonstration of its practical usefulness requires hard empirical evidence, to which we now turn.

4. Some Evidence on the Arbitrage Pricing Theory

The analysis of the preceding section might lead one to believe that the APT must be true and, hence, that it is not necessary to examine evidence. After all, if portfolio managers and academicians both agree that idiosyncratic risk can be diversified away in large portfolios and that passive managers cannot earn profits by mechanically tracking some broad-based market or sector index, where can we possibly go wrong? In fact, these are the two places that the APT can go wrong – just because some people believe that security returns satisfy these assumptions does not make them true. This section is devoted to the examination of some evidence on these propositions.

There are three ingredients that are necessary for evaluating the empirical implications of the APT. The first choice is the selection of the appropriate portfolios to use in testing the implications of the theory. The second element is the procedure for implementing the CAPM so that there is some basis for comparison with an alternative model. The third requirement is the determination of the appropriate sector portfolios. This may seem a bit peculiar given the earlier discussion which suggested broad agreement on the view that sector portfolios are the dominant source of covariation among security returns. While there is much agreement about the existence of such sector portfolios, there remains considerable disagreement about the identity of the sector portfolios.

Fifteen portfolios will be used to test the APT – three groups of five portfolios of New York

and American Stock Exchange stocks sorted on the magnitudes of three characteristics: market capitalization, dividend yield, and return variance. The first portfolio contains those securities with the smallest values of the sorting characteristic while the securities with the largest values comprise the fifth portfolio[5]. Portfolios two, three, and four contain stocks with the intermediate values of these characteristics arranged in increasing order. The large differences in average portfolio returns represent a formidable challenge to any asset pricing theory and the inclusion of between 200 and 275 securities in each portfolio renders them reasonably well-diversified.

The CAPM is not the subject of this paper so that only a cursory description will be provided here. The CAPM implies that the portfolio consisting of all marketable wealth perfectly explains expected security returns. In terms of the analysis in the previous section, this is the only 'sector portfolio' that is relevant for asset pricing; that is, there is only one portfolio in equations (5) and (6). Note that this theory does not imply that the idiosyncratic risk computed with respect to this portfolio can be diversified away. The difficulty with implementing this model is the measurement of the market portfolio of all risky assets. We will follow conventional (but not necessarily correct) practice and pretend that either a value-weighted (termed VW below) or equally-weighted (termed EW below) index of New York Stock Exchange stocks are adequate proxies for the market portfolio[6]. These portfolios at least provide some basis for comparison.

The use of the equally-weighted (EW) index as a proxy for the market portfolio in the CAPM imparts one additional advantage. Since the equally-weighted index is a well-diversified portfolio (with less than one-tenth of one cent invested in each stock) and so it is a reasonable candidate for *the* sector portfolio if there were only one sector or dominant source of covariation among stock returns that is relevant for asset pricing. Hence, the results shed light on the advantages of moving from a single sector to a multisector model.

There are many procedures that could be employed to select candidates for sector portfolios. Portfolios can be selected on the basis of firm characteristics, an approach that would not be appropriate here since portfolios based on firm characteristics are being employed to test the theory. Many portfolio managers use different statistical procedures to identify clusters or sectors. The five portfolios employed as postulated sector portfolios in this paper were constructed on the basis of a statistical procedure called maximum likelihood factor analysis. The details of this procedure may be found in LEHMANN and MODEST (1986, 1987) and comparisons with some other methods are contained in LEHMANN and MODEST (1987).

The first question addressed here is whether well-diversified portfolios actually contain negligible idiosyncratic risk. If well-diversified portfolios contained no idiosyncratic risk, their returns simply reflect the returns of the sector portfolios. Regression analysis provides a measure of the degree to which the characteristics portfolios contain negligible idiosyncratic risk called the coefficient of determination or R^2. This number represents the percentage of variation in the returns of the characteristics portfolios that is successfully accounted for by the sector portfolios and, hence, will be between zero and one. If these fifteen portfolios are well-diversified and the five sector portfolios are adequate choices, the R^2 should be one. For the purposes of this paper, I will take a value of R^2 in excess of 0.96 to reflect 'negligible' idiosyncratic risk (that is, the constructed sector portfolios account for 96% or more of the variation in the returns of the characteristics portfolios).

Table 1: Fraction of Portfolio Regressions for which R^2 exceeded 0.96

Model	Sorting Characteristic		
	Market Value	Dividend Yield	Own Variance
APT	17/20	17/20	17/20
CAPM–VW	2/20	0/20	0/20
CAPM–EW	10/20	6/20	7/20

Table 1 provides some evidence on this question obtained from the regression of the weekly returns of the fifteen characteristics portfolio on those of the five sector portfolios for four five-year periods – 1963–1967, 1968–1972, 1973–1977, and 1978–1982. This yields a total of twenty regression results for each sorting characteristic. The table reports the number of regressions over the four time periods for which the R^2 of the fifteen characteristics portfolios

exceeded 0.96 for the APT as well as the corresponding fraction for the two CAPM market proxies to provide a basis of comparison. Note that the CAPM does not imply that the R^2 should be near one so this comparison is illustrative.

As is readily apparent, a very large fraction (85%) of the APT regressions yielded R^2 values in excess of 0.96 and the smallest such value was 0.90. As is equally apparent, the corresponding fractions are between 30% and 50% for the equally-weighted (EW) index (with a smallest R^2 value of 0.74 across the three characteristics) and 0% to 10% for the value-weighted (VW) index (with a smallest R^2 value of 0.60 across the three characteristics). This appears to reflect the presence of 'negligible' idiosyncratic risk, especially relative to the two CAPM indices. This latter observation is interesting since it serves to remind us that it actually does take more than one sector portfolio to account for covariance patterns among security returns.

While these observations suggest that the assumptions underlying the APT are probably reasonable .approximations, they leave unanswered the question of the validity of the theory. Tables 2 through 4 address this question. They report the annualized weekly mean excess returns over the one-month Treasury bill rate of the three sets of characteristics portfolios for the twenty years between 1963 and 1982 as well as the values implied by the APT and the two CAPM implementations. Of course, the averaging implicit in these tables might obscure important model failures. As a consequence, Table 5 reports the average difference between the annualized weekly mean excess characteristics portfolio returns and the values implied by the models across the four five-year periods 1963–1967, 1968–1972, 1973–1977, and 1978–1982[7].

Table 2: Statistics for Market Capitalization Portfolios (1963–1982)*

Portfolio	Sample Mean	APT	CAPM–VW	CAPM–EW
1	17.90%	12.64%	4.19%	11.66%
2	10.63%	10.73%	3.88%	10.72%
3	8.42%	9.06%	3.33%	9.39%
4	5.89%	7.76%	3.04%	8.70%
5	3.30%	5.38%	2.49%	7.28%

* Annualized weekly mean returns and implied weekly mean model returns.

Table 3: Statistics for Dividend Yield Portfolios (1963–1982)*

Portfolio	Sample Mean	APT	CAPM–VW	CAPM–EW
1	15.00%	13.21%	4.59%	13.08%
2	7.71%	9.63%	3.37%	10.12%
3	7.58%	7.98%	2.92%	9.62%
4	7.70%	7.88%	2.85%	8.19%
5	7.72%	6.72%	2.96%	7.40%

* Annualized weekly mean returns and implied weekly mean model returns.

Table 4: Statistics for Own Variance Portfolios (1963–1982)*

Portfolio	Sample Mean	APT	CAPM–VW	CAPM–EW
1	4.27%	4.62%	2.04%	5.91%
2	6.23%	7.07%	2.60%	7.62%
3	8.71%	9.19%	3.36%	9.66%
4	11.34%	11.51%	4.26%	11.62%
5	15.52%	13.23%	4.59%	12.98%

* Annualized weekly mean returns and implied weekly mean model returns.

Table 5: Statistics for Extreme Characteristics Portfolios (1963–1982)*

		APT	CAPM–VW	CAPM–EW
Panel A: Market Capitalization Portfolios	1	5.26%	13.71%	6.33%
	5	2.08%	1.33%	4.19%
Panel B: Dividend Yield Portfolios	1	1.79%	12.67%	4.44%
	5	1.00%	4.76%	1.17%
Panel C: Own Variance Portfolios	1	1.01%	2.23%	2.74%
	5	2.50%	13.00%	4.87%

* Average difference between annualized weekly mean returns and implied weekly mean model returns across four five-year periods.

There are two facts that emerge from these tables that seem especially important for any theory of security prices. The major challenge implicit in these tables is the large difference between the average returns of the portfolios with the lowest and highest values of the sorting characteristics displayed in the 'Sample Mean' column. On the other hand, these differences appear to be systematic: the average own variance portfolio returns are strictly increasing while those based on firm size or dividend yield are decreasing. The systematic nature of this behavior suggests the possibility of a risk-based

explanation where firm characteristics are related to the underlying riskiness of their securities.

There is little good news for asset pricing theory in the results for the market capitalization portfolios provided in Table 2 and in Panel A of Table 5. Success would involve a close relationship between sample mean and implied model mean returns. None of the models comes close to successfully accounting for the average returns of size portfolios. The value-weighted index fails in a particularly miserable fashion while the equally-weighted index and the APT provide somewhat better (but still inadequate characterizations) of the mean returns on the market capitalization portfolios. The evidence in Table 2 and in Panel A of Table 5 does suggest that the APT comes somewhat closer to success in this regard but the overall message is one of failure.

The results involving the dividend yield portfolios in Table 3 and in Panel B of Table 5 are somewhat more encouraging for the APT. The CAPM implemented with the value-weighted index as a proxy for the unobservable market portfolio yields implied mean returns that differ substantially from the corresponding sample values, a recurring theme in these tables. The equally-weighted index version of the CAPM comes somewhat closer but proves less successful than the APT, particularly since the evidence in Panel B of Table 5 suggests that averaging does obscure the magnitude of the failure in matching the lowest dividend yield portfolio. The performance of the APT is by no means perfect, particularly for the two smallest dividend yield portfolios. It is worth noting that the smallest dividend yield portfolios (and the largest dividend yield portfolio as well) have a large number of small market capitalization firms so that the bulk of the failure can be reasonably attributed to the size effect documented in Table 2.

Finally, the results in Table 4 and in Panel C of Table 5 for the own variance portfolios paint a similar picture. The APT implied mean portfolio returns closely match the sample mean portfolio returns for all but the largest variance portfolio, which (once again) is very closely related to the smallest market capitalization portfolio. The comparative performance of the equally-weighted index is somewhat worse and Panel C of Table 5 once again suggests that the mean returns of the smallest and largest own

variance portfolios were less closely matched by the model than Table 4 would suggest. The mean returns implied by the value-weighted implementation of the CAPM differed markedly from the sample mean portfolio returns.

What is the bottom line on this comparison? No asset pricing model comes close to fully accounting for the differences in the mean returns of the characteristics portfolios. In general, the APT comes closer to success than the usual implementations of the CAPM in this regard, but there is plenty of room for improvement. Probably the most encouraging feature of these results is in the source of the failure of the APT – the evidence against the APT comes primarily from the smallest market capitalization portfolio and from the small market capitalization firms in the relevant dividend yield and own variance portfolios. Since many portfolio managers prefer not to trade in the riskier and less liquid 'small cap' universe of securities, it seems reasonable to suggest that the APT constitutes an empirically successful model of expected returns for most securities traded by portfolio managers.

5. Conclusion

The APT has a lot going for it both from the perspective of portfolio managers and financial economists. Practical investors and theoretical academicians are both interested in quantifying the riskiness of stocks and the similarities among firms. The APT provides one such characterization by suggesting that risk represents exposure to the uncertain fluctuations in major sectors of the stock market and that similar firms have similar risk exposures. This yields a simple asset pricing model since firms with similar risk exposures should have similar expected returns. This model of expected returns can aid passive portfolio managers in the quantification and control of portfolio risk.

The empirical scorecard is somewhat less heartening although the record is by no means one of total failure. In fact, the average returns of portfolios formed on the basis of characteristics such as market capitalization, dividend yield, and return volatility are not fully accounted for by their exposures to the uncertain returns of portfolios constructed to represent broad market sectors. This sobering observa-

tion is mitigated somewhat by two observations: the APT proves more successful than the usual CAPM implementations in this regard and the empirical failure of the APT is primarily concentrated in the smallest market capitalization firms. Many portfolio managers do not trade in small market capitalization firms so that the APT is reasonably successful in explaining the prices of many of the equity securities in their trading universe.

The APT is a young theory and there remains considerable controversy among academicians regarding its role in financial theory and the appropriate procedures for its empirical implementation. It seems reasonable to expect some resolution on both fronts in the coming years. It also seems reasonable to suggest that a theory that captures intuitions shared by both portfolio managers and financial economists will prove to be an attractive framework for further analysis.

Footnotes

[1] This is actually easier said than done. For some of the intricacies, see GRINBLATT (1986/87). The job confronting the portfolio manager is somewhat easier than that confronting an outside evaluator because the portfolio manager can measure the performance of active managers transaction by transaction while outside evaluators (such as academicians) typically must rely on total measured returns to determine superior performance.

[2] Practitioner-oriented papers which address similar questions include ARNOTT (1980), ESTEP, HANSON and JOHNSON (1985), FARRELL (1974), ROLL and ROSS (1983, 1984), and SHARPE (1982, 1985).

[3] This may seem to be somewhat surprising but is easily understood with a familiar example. Suppose that one repeatedly tosses a coin in a game where one earns one dollar when it comes up heads and loses a dollar when it comes up tails. After twenty-five or fifty coin tosses, one can be pretty certain that the *average* gain per coin toss will be very close to its *expected* value of zero (try it, if you like). A well-diversified portfolio averages out idiosyncratic risk in a similar fashion although it probably takes many more securities than coin tosses.

[4] In other words, the APT can be further refined by particular models of the manner in which stock pickers search within sectors for particularly undervalued or overvalued stocks and market timers evaluate relative sector prospects. This can yield an explicit model of short-run variation in expected returns which also captures some of the beliefs of investment professionals. None of this detracts from the potential usefulness of the basic model discussed in the text.

[5] The mechanics of portfolio formation are as follows. On four dates – December 31st of 1962, 1967, 1972 and 1977 – all firms that were continuously listed on the New York or American Stock Exchanges for the subsequent five years were sorted on the basis of the magnitude of the values of the three sorting characteristics. The securities were then grouped into one of five portfolios based on their ranking. The securities were given equal weight in each of the five portfolios and neither the securities nor the weights were changed for five years.

[6] The use of the value-weighted index is on somewhat firmer logical ground than those involving the equally-weighted index since the market portfolio is value-weighted and the value-weighted index of NYSE stocks probably accounts for a large fraction of the variation in aggregate U.S. wealth. The omission of American Stock Exchange stocks has virtually no effect on the returns of the value-weighted index and tilts the equally-weighted index too much toward small firms to successfully account for differences in expected returns.

[7] Those familiar with the conventions of statistical inference will note that I make no attempt here to ascertain whether the differences between the implied model and sample mean characteristics portfolio returns are statistically significant. This omission reflects my attempt to simplify an already technical paper. All of the 'failures' discussed below are, in fact, statistically significant at conventional levels. See LEHMANN and MODEST (1986, 1987) for a detailed statistical examination of the evidence.

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