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Sources of Predictability in Portfolio Returns

Despite the random walk hypothesis, which asserts that asset returns should be completely unpredictable, it is well known that returns are predictable to some extent. Does this predictability reflect inefficiencies such as market fads, or is it more systematic?

A multi-beta asset pricing model using risk factors related to the stock market, unexpected inflation, consumer expenditures and interest rates indicates that most of the predictable variation in asset returns can be explained by shifts in the assets' risk exposures (betas) and by shifts in the market's compensations for holding these exposures (risk premiums). Little variation remains to be explained by market inefficiency.

Both betas and risk premiums change predictably over time, although changes in risk premiums are far more important than changes in betas, at least at the portfolio level. The evidence suggests that investors rationally update their assessments of expected return. It also suggests that the relative contributions of different risk factors to predictable return will differ across assets.

IT IS WELL established that bond and stock portfolio returns are to some extent predictable. The source of the predictability, however, is controversial. In the 1960s and 1970s, academic studies focused on models that assumed that required rates of return were constant over time. In the 1980s, academic research shifted focus, allowing the required returns for exposure to economic risk to vary over time.

The controversy over predictability in returns continues. Some attribute predictability to market inefficiencies. Others believe that **predictability** reflects the rational updating of investors' assessment of the required rate of return.

In complex securities markets, we might expect to find that part of return predictability reflects changes in required returns, while part results from less-than-perfect efficiency. This article attempts to calibrate the relative importance of these two sources.

Methodology

We express the predictable changes in portfolio returns as follows:

$$\text{Predictable Return} = \text{Return Predicted by Model} + \text{"Inefficiency"}. \quad (1)$$

The model we use is a multiple-beta, APT-type model (described below); this model is supported by academic research and is representative of contemporary practice. If the multiple-beta model is the "true" model for required returns, then it should capture all predictable changes in return that are not due to market inefficiencies. Of course, no model is perfect; our model may miss some important sources of variation in required returns, hence we place quotation marks around inefficiency.

We focus on three questions. First, how much of the predictability of portfolio returns can be explained using a representative **multiple-beta model**? We find that the multiple-beta model does a good job of capturing the predictability of the portfolio returns. This means that the portion of predictability due to market inefficiency is relatively small. Second, how much of the

Glossary

Predictability: The degree to which information today can be used to forecast a future rate of return. An asset whose price follows a random walk exhibits no predictability.

Multiple-Beta Model: An asset pricing model that assumes that several risk factors affect asset prices. Portfolio expected returns are determined by portfolios' exposures to changes in these variables and by market-wide compensations for the risk exposures.

State Variables: Variables that describe the state of the economy. Changes in these variables are the risk factors in the multiple-beta model. Each asset has an exposure or degree of sensitivity to changes in these variables.

Beta: A measure of the percentage return that would be expected in response to an unanticipated 1 per cent change in the value of a variable, holding all else constant. A high beta value means that the asset is very sensitive to changes in a particular variable.

Risk Premium: The economy-wide expected compensation for exposure to a particular economic risk in the multiple-beta model; measured as an increment to the expected return per unit of beta.

Excess Return: The rate of return of an asset, net of the return of a short-term Treasury security.

Predictable Variation: The portion of a return's variance that is due to predictability. The ratio of the variance of the forecast return to the variance of the actual return is known as the R^2. A high R^2 implies that a large portion of the changes in the asset returns can be predicted on the basis of previous information.

Market Inefficiencies: A systematic departure of market prices or rates of return from the values implied by investment fundamentals. Examples of market inefficiencies might include investors' overreaction to news, or an investment fad that causes a large deviation between the market value of an asset and its rational investment value.

predictability is due to changes in betas and how much is due to changes in the required return for a given beta? Finally, which sources of economic risk are the most important for explaining predictability in portfolio returns?

A Representative Model

Theories of security pricing imply that the expected returns of securities and portfolios are related to their sensitivities to changes in the state of the economy. Theory assumes that economic changes can be captured by a set of variables (**state variables**) and that a security's or portfolio's sensitivities to these variables can be measured in the form of **betas**. Furthermore, for each unit of beta, the market offers compensation in the form of an increment to the expected return (a **risk premium**).

Betas and risk premiums are combined to obtain the required or expected rate of return:

$$E(R_i) = P_o + b_{i1}P_1 + b_{i2}P_2 + \ldots + b_{iK}P_K. \quad (2)$$

Here $E(R_i)$ is the required or expected rate of return of a security or portfolio i. The b_is are security i's beta coefficients, where b_{i1} is the security's sensitivity to the first source of economic risk, and b_{iK} the sensitivity to the Kth source of risk. The P_j are economy-wide expected risk premiums, or the expected compensations for exposures to the K economic risks. Arbitrage Pricing Theory (APT) and the Capital Asset Pricing Model (CAPM) are two examples of this type of model.[1] The CAPM, however, posits only one risk premium, that of the market as a whole, and only one beta for each security, the market beta.

Multiple-beta models are increasingly used in portfolio management and other fields and have been studied extensively. Research and current practice suggest that five or six risk factors associated with the stock market, inflation, aggregate economic output and interest rates can be used to measure risk premiums. Table I summarizes the risk factors we used in Equation (2).

These variables have been shown to be useful in explaining *differences* across portfolio returns, on average.[2] Of course, we are concerned here with the ability of the multiple-beta model to predict *changes* in portfolio returns. If the model can be used to predict returns, it follows that either the betas or the expected risk premiums (or both) move over time in a predictable way.

Return Data

We examined both common stock and fixed income portfolios. We formed 10 stock portfolios by ranking and then grouping New York Stock Exchange (NYSE) stocks according to market value of equity capital at the beginning of each year. These 10 "size" portfolios were val-

1. Footnotes appear at end of article.

ue-weighted averages of the stocks in each group. (Value weighting approximates a "buy-and-hold" investment strategy.) We also formed 12 NYSE industry portfolios based on two-digit SIC numbers. In addition, we studied portfolios of long-term government bonds, long-term corporate bonds and six-month Treasury bills.[3]

We looked at monthly data over the 1959–86 period. We used the first five years of data for initial beta estimates, so the reported results refer to analyses of the 1964–86 period.

All the returns are measured net of the one-month Treasury bill rate. We study these **excess returns** because the Treasury bill rate is known at the beginning of each month, hence perfectly predictable. It makes sense to focus on predictions of excess returns.

Predicting Returns

Previous research has shown that certain variables can be used to predict the future returns of portfolios. We use as predictor variables the past excess returns of the equally weighted NYSE stock index, the excess return on the three-month Treasury bill, the past year's dividend yield on the Standard & Poor's 500, the yield spread between Baa and Aaa corporate bonds, the one-month Treasury bill rate and a dummy variable for the month of January. Table II shows how well these variables predicted future portfolio returns.

A simple regression model using these variables was able to predict between 4 and 20 per cent of the fluctuation in the next month's return. Use of the dummy variable for January helped a lot with the smaller firms. This is not surprising; it is well known that small-stock returns are typically higher in January. The January dummy made little difference in the predictions for the other portfolios.

Table I Risk Factors

Symbol	*Definition*	*Source*
XVW	Value-weighted NYSE index return less one-month Treasury bill return	CRSP
CGNON	Monthly real per capita growth of personal consumption expenditures, nondurable goods	Commerce Department
PREM	Monthly return of corporate bonds rated Baa by Moody's Investor Services, less long-term U.S. government bond return	Ibbotson Corporate Bond Module
ΔSLOPE	Change in the yield spread between 10-year Treasury bonds and three-month Treasury bills	Federal Reserve
UI	Unexpected inflation rate, the difference between the actual and the forecast inflation rate from a time-series model.	CRSP
REALTB	One-month Treasury bill return less inflation	CRSP

Table II Predicting Monthly Portfolio Returns, 1964–1986

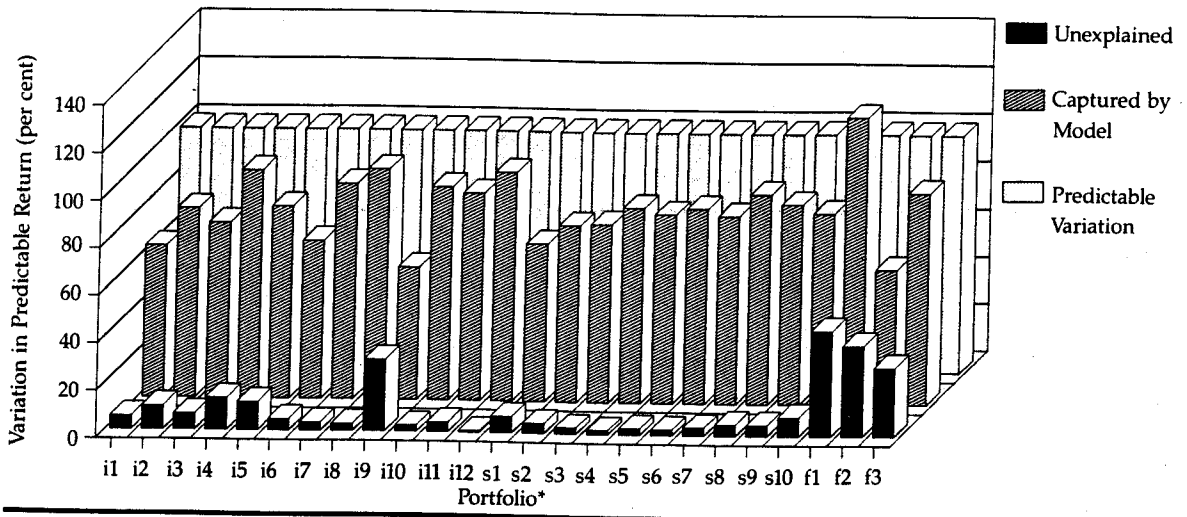
	Portfolio	*Proportion of Variance Predicted (adjusted R-squares)* With January Dummy	Without January Dummy
	Industry Groups		
i1	Petroleum	.058	.059
i2	Finance/Real Estate	.086	.089
i3	Consumer Durables	.130	.129
i4	Basic Industries	.093	.094
i5	Food/Tobacco	.091	.093
i6	Construction	.137	.132
i7	Capital Goods	.113	.114
i8	Transportation	.104	.096
i9	Utilities	.098	.092
i10	Textiles/Trade	.095	.094
i11	Services	.110	.107
i12	Leisure	.102	.103
	Market-Capitalization Groups		
s1	Smallest Decile	.196	.079
s5	Fifth Decile	.153	.122
s10	Largest Decile	.105	.109
	Fixed Income		
f1	Treasury Bonds	.040	.038
f2	Corporate Bonds	.055	.059
f3	Treasury Bills	.092	.094

Required Returns and Predictability

The data in Table II define for our purposes the predictable part of the variation in portfolio returns. We now want to find out what part of that **predictable variation** can be explained by the multiple-beta model; the remaining portion is unexplained predictability. If the model captures most of the predictable behavior—through movements in either the betas or the expected risk premiums—then we assume that **market inefficiencies** explain only a small portion of the predictability of portfolio returns.

Figure A decomposes the predictable variation, from Table II, into that part captured by the model and the residual part, which should be zero if the model describes expected returns in an efficient capital market.[4] The model cap-

Figure A Decomposing Predictability of Monthly Returns



*See Table II for portfolio descriptions.

tures most of the predictability of the returns; the part not explained by the model is a tiny fraction of the total in most cases.[5]

The model captures a smaller portion of the predictable variation in smaller-firm returns than in larger-firm returns. The divergence in performance is primarily due to the use of the January dummy in the forecasting regressions. Without the January dummy, the predictable variation in the smaller-firm returns is lower, but the fraction of the predictability captured by the model is higher—at least as large as it is for the larger firms.

The model does a better job of capturing predictability for some industries than for others. For the utilities portfolio, the model explains only 55.9 per cent of the predictability, its worst performance. It fares slightly better with the construction industry, capturing 66.7 per cent of variability. But the model explains over 95 per cent of the predictability in transportation, leisure and the basic industries.

Changing Betas

Beta coefficients are not fixed over time. Recent studies show that changes in market-beta coefficients can explain much of the mean-reversion phenomenon observed in individual common stocks that are recent "winners" or "losers."[6] Individual firms' market betas commonly halve or double after a period of unusually large price rises or declines.

Of course, portfolio betas are more stable than individual common stock betas.[7] Much of the variation in individual firms' betas cancels out in large portfolios. Portfolio betas can nevertheless fluctuate substantially over time.

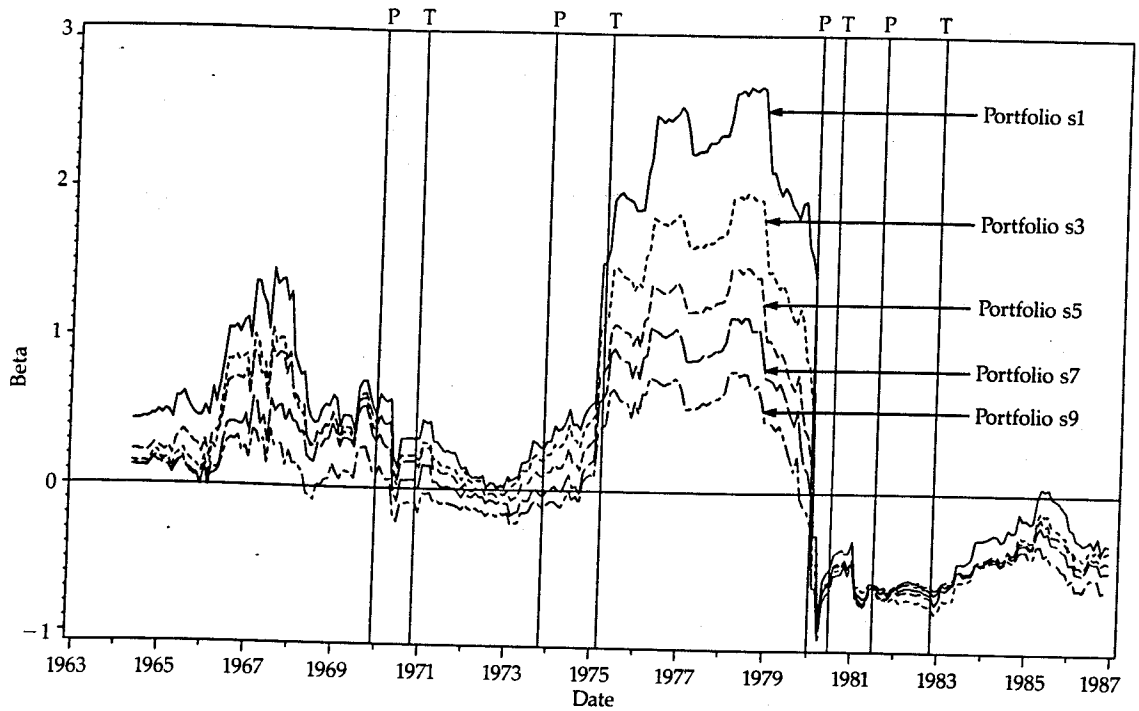
Figure B illustrates for a subset of the size portfolios the behavior of beta relative to the default premium (PREM) variable.[8] Both the differences across the portfolio betas and the overall level of the betas fluctuate over time. Variation in the betas is highly predictable. Regressing the betas in Figure B on our predetermined variables produces adjusted R-squares in excess of 40 per cent. It would seem that changes in beta could be an important source of predictability in the portfolio returns. As we will see below, however, this is not the case.

Changing Risk Premiums

Figure C plots estimates of the expected risk premium per unit of market beta. The dashed line represents the premiums in January and the solid line the premiums for the remaining 11 months of the year. The vertical lines denote business cycle peaks and troughs, as determined by the National Bureau of Economic Research (NBER).

Of course, market expectations of economic conditions may differ from the NBER's *ex post* determination of business cycles. Nevertheless, the figure shows that the risk premium for a unit of market beta increases during economic contractions and peaks near business cycle troughs. The stock market premium tends to

Figure B Cyclical Movements of Portfolio Betas*



*Sensitivity of monthly betas to changes in default premium (PREM).

decline over the life of the economic expansion, reaching its lowest levels near the business cycle peak. The economic rationale for this pattern is that risk capital is relatively expensive during recessions. High expected returns are required to induce investors to forgo current consumption in favor of investment.[9]

Figure C shows that the expected market risk premium is higher in January than in the other 11 months, although its time-series behavior appears similar. Studies have noted that average stock market premiums are higher in January than in the other months. The average level of the dashed line in the figure reflects this "January effect." The observation that expected risk premiums in January behave like premiums in the other months does not explain the January effect, but it does suggest that the same economic forces that produce cyclical variation in the other months are also at work in January.

The risk premiums corresponding to real interest rates, consumer expenditures and term structure risks have countercyclical patterns similar to the pattern in Figure C. The expected premium for exposure to inflation risk has roughly the opposite pattern; it is procyclical and, on average, negative.

Sources of Predictability

To the extent that predictability in portfolio returns is the result of rational changes in required returns, the multiple-beta model identifies two channels through which the predictability can operate. The betas measuring the exposure to economic risk may shift over time, and the expected risk premium for a given beta may change with economic conditions. The multiple-beta model allows us to break out these two channels:

Predictability Captured by the Model

= Changing Betas Effect

+ Changing Premiums Effect

+ Interaction Effect. (3)

The interaction effect arises because fluctuations in the betas and the risk premiums may be correlated with each other.

Figure C Expected Compensation for Stock Market Risk

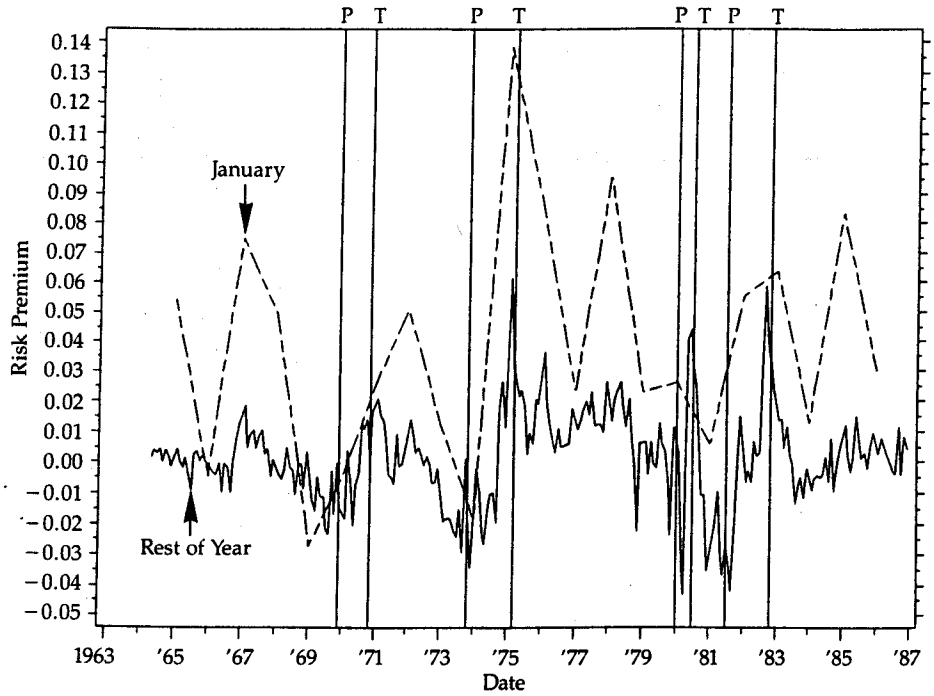
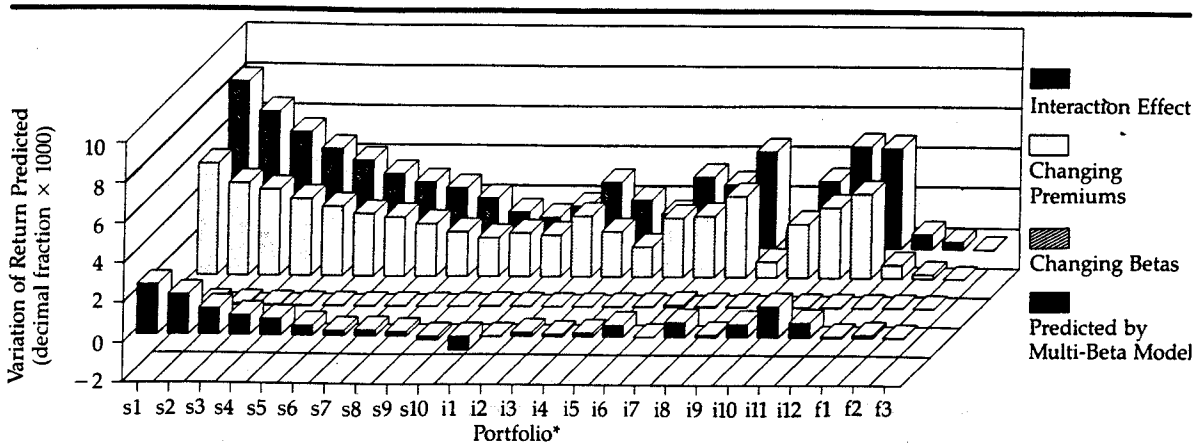


Figure D breaks the variation of each portfolio's expected excess return down into the components given by Equation (3). By far the largest component of the variation in expected returns is the part associated with changes in the expected risk premiums. Very little is attributable to changing betas.

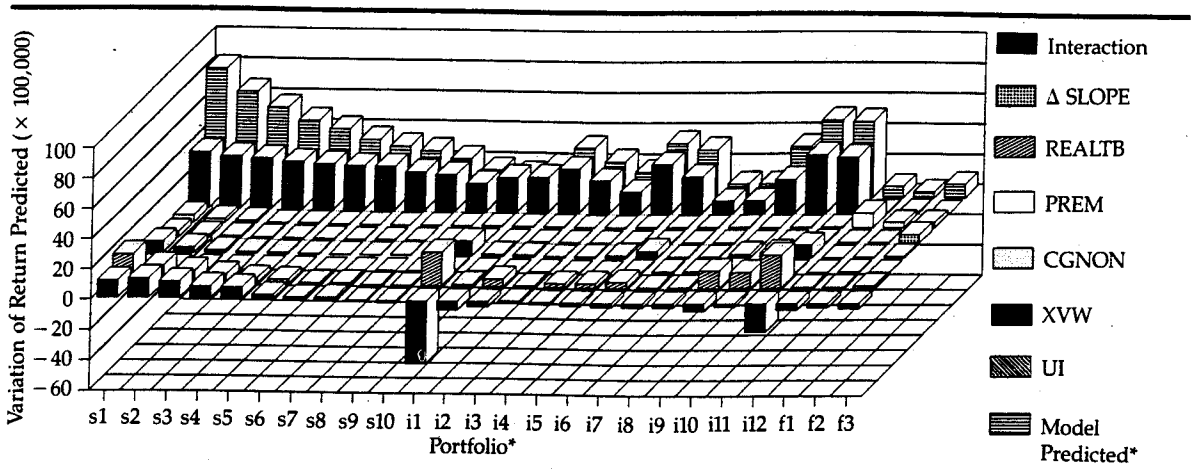
The interaction effect between changes in betas and changes in premiums accounts for some of the predictable variation in returns to the smaller firms, some of the industries, and the six-month Treasury bill portfolio.[10] The interaction effect declines smoothly as the size of the firms increases; it is negative for the largest firms. This suggests that small-firm betas tend to be relatively high during recessions, when

Figure D Decomposing Predictability of Monthly Returns Captured by Multi-Beta Model



*See Table II for portfolio descriptions.

Figure E Contribution of Various Risk Factors to Predictability of Portfolio Returns



*Variance of fitted expected excess returns for each asset explained by multi-beta model.

expected premiums are high, while the large-firm betas tend to be relatively low at such times.

Why is so little of the predictability of portfolio returns attributable to variations in betas? The answer is basically a function of the structure of the multi-beta model. Variations in beta over time are captured by beta variance (the square of beta standard deviation). The model thus multiplies beta variance by the average risk premium. The largest average risk premium in our sample is less than 0.007. The square of this number is very small, hence the impact of beta variance on the portfolio is very small. By contrast, the impact of a changing risk premium is scaled by the square of the beta—a number close to 1.0 in magnitude. It is thus not surprising that most of the predictable variation in returns is attributable to time-varying risk premiums, as opposed to time-varying betas. What does seem surprising, given this evidence, is that so much research effort has been directed at modeling betas and so little at modeling the risk premiums associated with those betas.

Economic Risks

It is interesting to isolate the contributions of individual economic variables to the predictability of portfolio returns. For each portfolio, variations in expected returns can be broken down into parts attributable to each of the six variables, plus an interaction term reflecting correlations between the economic variables. Figure E illustrates the decomposition.

The variation associated with the expected stock market premium is by far the most important single factor for equity returns. Real interest rate risk comes in a distant second, followed by unanticipated inflation and the interaction term. The market premium accounts for most of the predicted variation in large-firm returns. Real interest rate and inflation risks are more important for smaller firms. The effects of real interest rate risk are largest in the petroleum industry, where they are nearly as great as stock market effects. Real interest rate effects are also fairly strong in the textiles/trade, services and leisure groups.

The transportation and utilities portfolios have similar exposures to the various risk variables and, as shown in Figure D, exhibit similar variations in these risk exposures over time. These industries appear to be the most sensitive to the risk of changes in consumer non-durable-goods expenditures. This single source of risk accounts for about 13 per cent of the expected return variation in these two portfolios.

For the fixed income portfolios, the portion of predictable variation attributable to the market factor is small to negligible. A large share of the predictable variation in corporate bond returns is attributable to the PREM variable, which measures default-related yield spreads in the corporate bond market relative to the government bond market. PREM is also important to government bond and Treasury bill returns. The premium for the term-structure variable ΔSLOPE is the most important source of predictable variation in six-month Treasury bill monthly returns.

Interaction effects are negative for all three fixed income portfolios. This suggests that changes in risk sensitivities are negatively related to changes in the expected compensation for those risks; that is, the most important betas for the fixed income portfolios are procyclical.

Conclusion

Changes in portfolios' exposures to risks (betas) and changes in the premiums the market offers investors for accepting risks account for the bulk of the predictable variation in security and portfolio returns. Changes in the risk premiums, however, are far more important than changes in the betas. The risk premiums change with the business cycle. Compensations for bearing market risk, real interest rate risk and consumption risk are highest near business cycle troughs, while the inflation risk premium is highest at cyclical peaks. This evidence suggests that investors rationally update their assessments of expected return.

The evidence also indicates that the market premium is by far the most important factor in predicting equity portfolio returns, whereas interest rate and inflation premiums are the most important factors in predicting bond portfolio returns. These results are important for portfolio managers and for those who must calculate a firm's cost of capital. Some applications of multiple-beta models, for example, assume that the market-wide compensation for beta risks is constant over time and across market sectors. Our research shows that this assumption is too simplistic. ■

Footnotes

1. The CAPM was first published by W. Sharpe, "Capital Asset Prices, a Theory of Market Equilibrium Under Risk," *Journal of Finance* 19 (1964). The APT was developed by S. Ross, "The Arbitrage Pricing Theory of Capital Asset Pricing," *Journal of Economic Theory* 13 (1976), pp. 341–360.
2. See E. Burmeister and M. McElroy, "Arbitrage Pricing Theory as a Restricted Nonlinear Multivariate Regression Model," *Journal of Business and Economic Statistics* 6 (1988), pp. 29–42, for a recent example. Earlier frequently cited studies are those of Nai-fu Chen, R. Roll and S. Ross, "Economic Forces and the Stock Market," *Journal of Business* 59 (1986), pp. 383–403, and K. C. Chan, N. Chen and D. Hsieh, "An Exploratory Investigation of the Firm Size Effect," *Journal of Financial Economics* 14 (1985), pp. 451–472. See also Roll and Ross, "The Arbitrage Pricing Theory Approach to Strategic Portfolio Planning," *Financial Analysts Journal*, May/June 1984.
3. The data were provided by the Center for Research in Security Prices (CRSP) at the University of Chicago.
4. We do not include a time-varying "zero-beta" return because all returns are calculated in excess of a Treasury bill return.
5. The sum of the two components is not necessarily 100 per cent because the regression method we used does not force the two components to be uncorrelated over time. The difference between the sum of the two foreground columns in Figure A for a given portfolio and 100 per cent reflects the correlation between our estimates of the predictable part of the returns attributable to the model and the part attributable to model misspecification or market inefficiency.
6. See K. C. Chan, "On the Contrarian Investment Strategy," *Journal of Business*, April 1988, and R. Ball and S. Kothari, "Nonstationary Expected Returns: Implications for Tests of Market Efficiency and Serial Correlation in Returns," *Journal of Financial Economics* 25 (1989), pp. 51–74.
7. For evidence using size portfolios, see K. C. Chan and N. Chen, "An Unconditional Asset Pricing Test and the Role of Firm Size as an Instrumental Variable for Risk," *Journal of Finance* 43 (1988), pp. 309–326, G. Huberman and S. Kandel, "Mean-variance Spanning," *Journal of Finance* 42 (1987), and Ball and Kothari, "Nonstationary Expected Returns," *op. cit.*
8. These are ordinary regression betas using the most recent five years of monthly data. The methodology is described in more detail in W. Ferson and C. R. Harvey, "The Variation of Economic Risk Premiums," *Journal of Political Economy* 99 (1991), pp. 385–415. The findings summarized here are replicated in that paper using five alternative methods of estimating beta. The results are robust to the alternative methodologies.
9. Similar patterns are observed by R. Arnott, C. Kelso, S. Kiscadden and R. Macedo, "Forecasting Factor Returns: An Intriguing Possibility," *Journal of Portfolio Management* 16 (1989), pp. 28–37, S. Kandel and R. Stambaugh, "Expectations and Volatility of Consumption and Asset Returns," *Review of Financial Studies* 3 (1990), pp. 207–232, and E. Fama and K. French, "Business Conditions and Expected Stock Returns," *Journal of Financial Economics* 25 (1989), pp. 23–50.
10. The scale of the figure makes the breakdown difficult to see for the six-month bill; 46 per cent of the predicted variation is attributable to changing premiums, 53 per cent to changing betas and 1.2 per cent to the interaction effect.