Market Pricing of Economic Risks and Stock Returns*

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ABSTRACT

We estimate the market prices of economic risks from the stock market, while overcoming the challenges faced by existing studies. First, we use two dynamic factors, one real and the other nominal, to summarize the systematic information and to suppress the noise in a large array of economic indicators. Second, in linking systematic economic risks to stock returns, we carefully separate the cash flow effect from the pricing kernel effect. We first estimate the economic risk exposures for each individual stock, and then investigate how the expected return on each stock varies with its economic risk exposures. The different risk exposure estimates for different stocks capture the cash flow effect. How the expected stock return varies with the economic risk exposure reveals how the market prices the economic risks. Our estimation shows that the market charges a positive price for the real output growth risk, but a negative price for the inflation risk. We explore the economic implications of the market price estimates.

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KEY WORDS: Economic risks, stock returns, inflation, real output, pricing kernel, cash flow.

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Fundamentally, financial security valuation should be linked to the systematic states of the aggregate economy. On the one hand, real output growth directly governs the aggregate consumption growth in an economy, a key determinant of the real pricing kernel in classic asset pricing models (Merton (1973)[1], Ross (1976)[2], Lucas (1978)[3], and Breeden (1979)[4]). Moreover, inflation not only directly affects the nominal pricing kernel, but it can also enter the real side of the pricing kernel via its dynamic interactions with the real production (Piazzesi and Schenider (2006)[5]). Quantifying these linkages has paramount importance in understanding and developing economic and asset pricing theories. Yet, despite several decades of empirical effort in measuring the relation between economic risks and stock returns, empirical support from the literature has been far and few. Researchers who have tried to link the pricing of macroeconomic risks to stock returns have been facing several significant challenges.

First, many macroeconomic indicators are available. Each indicator contains some information, but also a tremendous amount of noise, about the systematic state of the economy. Directly incorporating a noisy economic indicator as a regressor suffers from the well-known errors-in-variable problem. Including too many highly correlated indicators into a regression can also lead to stability and multicollinearity issues. Therefore, how to extract the systematic movements in an economy from the many noisy series poses the first challenge.

Second, the systematic states of the aggregate economy influence the valuation of a stock not only through their linkages to the aggregate pricing kernel, but also through their impacts on the cash flows entitled to the equity owners of the company. The cash flow effect varies with the nature of the company's business. A pro-cyclical company tends to have higher earnings during booming economies than during recessions. A counter-cyclical company tends to show the opposite effect. By contrast, the pricing kernel effect is a market-wide effect that affects all financial security valuations. To exclude arbitrage, one pricing kernel should apply to the valuation of all financial securities. Therefore, how to separate the company-specific cash flow effect from the market's equilibrium pricing of economic risks presents the second challenge.

[1] Merton, Robert C., 1973, An intertemporal asset pricing model, Econometrica 41, 867 - 887.

[2] Ross, Stephen A., 1976, The arbitrage theory of capital asset pricing, Journal of Economic Theory 13, 341 - 360.

[3] Lucas, Robert, 1978, Asset prices in an exchange economy, Econometrica 46, 1429 - 1445.

[4] Breeden, Douglas T., 1979, An intertemporal asset pricing model with stochastic consumption and investment opportunities, Journal of Financial Economics 7, 265 - 296.

[5] Piazzesi, Monika, and Martin Schneider, 2006, Equilibrium yield curves, NBER Working Paper 12609 University of Chicago and New York University.

In this paper, we address the first challenge by using a dynamic factor model approach. We use two dynamic economic factors to summarize the fundamental information about the real and nominal states of the economy from the numerous noisy macroeconomic indicators. The dynamic factor model provides an effective way of suppressing noise and highlighting the information content in the many noisy series. We use maximum likelihood estimation joint with Kalman (1960) [6] filter to identify the dynamic factors from a large array of macroeconomic indicators.

To address the second challenge, we propose a two-step procedure. In the first step, we regress returns on each stock on innovations in the two economic factors. The relative difference of the regression coefficients across different stocks reveals the difference in their respective cash flow exposures to the two economic factors. In the second step, we study how the expected return on a stock or a stock portfolio varies with its exposures to the economic risks. The variation reveals how the market prices the economic risk exposures. If investors do not price an economic risk, the expected stock returns will not vary with the stock's exposure to the economic risk. On the other hand, a positive coefficient estimate would suggest that investors dislike positive exposures to the economic risk and ask for a higher expected return for bearing the risk. A negative coefficient would suggest that investors are willing to accept a lower expected return to gain positive exposure to the risk, possibly because the exposure generates some beneficial effects on one's utility.

The first-stage regression generates risk exposure estimates that vary greatly across stocks. A one standard deviation positive shock on the inflation (output growth) risk can move some stocks up by 14.76% (16.55%) per month while moving some other stocks down by 12.13% (34.26%) per month. By contrast, if we regress the market portfolio return on the two economic risks, as sometimes done in the literature, the average market response is merely -0.48% (-0.26%) per month per one standard deviation shock on the inflation (output growth) risk. The latter estimate is not statistically significant. These statistics suggest that exploiting the cross-sectional variation in risk exposures is important not only for controlling for the cash flow effect, but also for enhancing the statistical power of the market price identification.

To estimate the market prices of the two economic risks, we analyze the relation between the expected stock returns and the economic risk exposure estimates using three approaches. First, we form 100 stock portfolios based on their ranking in risk exposures to the two economic risk factors. We compare the

[6] Kalman, Rudolph Emil, 1960, A new approach to linear filtering and prediction problems, Transactions of the ASMEJournal of Basic Engineering 82, 35 - 45.

average returns for the ranked portfolios, and find that portfolios with high positive exposure to inflation (output growth) factor have lower (higher) average returns. The average return spread between the highest and the lowest inflation (output growth) beta portfolios is -0.30% (0.19%) per month with a Newey and West (1987) [7] t-value of 1.96 (1.63).

In the second approach, we apply the Fama and MacBeth (1973) [8] procedure and perform cross-sectional regressions at each period between the next period's stock returns and the corresponding economic risk exposure estimates. We average the cross-sectional regression coefficients over time to determine the average risk premium induced by exposure to each economic risk. We find that the average coefficient on the inflation risk is negative, but that on the real output growth risk is positive. Thus, stocks that have negative exposure to the inflation risk and positive exposure to the real output growth risk have higher expected returns on average. One standard deviation cross-sectional variation in the inflation (output growth) risk exposure leads to an expected return difference of -0.19% (0.27%) per month (see Table I).

In the third approach, we estimate the market price on the two sources of economic risks conditionally based on a panel regression with cross-sectional constraints. First, we apply a multi-variate GARCH framework to estimate the conditional covariances between the two economic risks and the 100 stock portfolios formed based on the exposure rankings to two economic risk factors. Then, we estimate a panel regression of the portfolio returns on their conditional covariances, while constraining the slope coefficients to be the same across the 100 portfolios. The slope estimates can be regarded as the market prices on the two sources of economic risks. Internal consistency requires that the market charges the same price per unit economic risk across all stocks. The estimation generates negative market price estimates on the inflation risk and positive market price estimates on the real output growth risk. On average, one standard deviation intertemporal movement in the conditional covariance with the inflation (output growth) risk varies the portfolio's expected excess return by -0.66% (1.05%) per month (see Table II).

The results from the three approaches are consistent with one another. The positive market price for the real output growth risk provides empirical support for classic asset pricing theories that argue for consumption smoothing. Intuitively, payoffs from a cyclical company work against real consumption smoothing

[7] Newey, Whitney K, and Kenneth D. West, 1987, A simple positive-definite heteroskedasticity and autocorrelation consistent covariance matrix, Econometrica 55, 703 - 708.

[8] Fama, Eugene F., and James D. MacBeth, 1973, Risk return, and equilibrium: Empirical tests, Journal of Political Economy 81, 607 - 636.

and hence generate lower valuation and higher expected returns. The opposite is true for counter-cyclical companies.

On the other hand, the negative market price on the inflation risk suggests that inflation not only affects the nominal stock return, but also enters the real side of the pricing kernel, potentially due to dynamic interactions between inflation and real output growth. Our estimated economic factor dynamics suggest that inflation and real output growth not only show negative contemporaneous correlations, but they can also dynamically predict each other. In particular, high inflation predicts future slowing down in real output growth, whereas high real growth can generate high future inflation. As a result, stocks with high positive correlations with the inflation factor can play a hedging role against future real consumption risks. Investors are willing to accept a lower expected return for the hedging benefit.

Compared to the long list of studies that attempt to understand how economic risks are priced in stock returns, we make two major contributions. First, rather than picking one or a few noisy economic indicators to proxy inflation or output growth, or interpreting each series in a stand-alone basis, we employ a dynamic factor model approach and use two dynamic factors to summarize the systematic information and to suppress the idiosyncratic noise in a large array of macroeconomic indicators. The high information content in the two dynamic economic factors enables us to identify the risk exposures in stock returns more accurately and reduces our chance of misidentification and misinterpretation induced by the large noisy content in a single series and the potential multi-collinearity issue when multiple economic series are included in a regression.

Our second contribution lies in our careful separation of the pricing kernel effect from the cash flow effect by exploiting the large cross section of individual stocks. Existing studies often focus on the market portfolio return and analyze its relation with economic variables. Depending on the nature of a company, its cash flow can either move positively or negatively with the economic conditions. Different cash flow dependence leads to different relations between stock returns and the economic shocks. Narrowly focusing on the market portfolio return amounts to averaging these different relations. Thus, it is not surprising that such exercises often generate results that are either insignificant or difficult to interpret. In this paper, by first estimating the risk exposure at the firm level and then form portfolios based on their exposure ranks, we can exploit the cross-sectional information to control for the cash flow effect and to highlight how the expected returns vary with the estimated economic risk exposures.

Table I
Risk premium estimates from Fama-MacBeth regressions

Entries report the average slope estimates and the Newey-West t-statistics from the Fama-MacBeth regressions for both the full sample and two subsamples.

Sample period	Inflation risk premium (α_π)		Output risk premium (α_g)	
01/1963 - 12/2005	-0.0546	(1.89)	—	—
01/1963 - 12/2005	—	—	0.0397	(1.74)
01/1963 - 12/2005	-0.0673	(2.22)	0.0555	(2.43)
01/1963 - 12/1985	-0.0892	(2.09)	—	—
01/1963 - 12/1985	—	—	0.0682	(1.72)
01/1963 - 12/1985	-0.1106	(2.37)	0.0934	(2.34)
01/1986 - 12/2005	-0.0148	(0.42)	—	—
01/1986 - 12/2005	—	—	0.0069	(0.42)
01/1986 - 12/2005	-0.0174	(0.51)	0.0120	(0.78)

Table II
Market prices of economic risks: Estimates from panel regressions

Entries report the common slope estimates and the absolute value of the t-statistics (in parentheses) on the following system of equations,

$$R_{i,t+1} = C_i + A_\pi \omega_{i\pi,t} + A_g \omega_{ig,t} + e_{i,t+1}, \quad i = 1, 2, \cdots, 100,$$

where $R_{i,t+1}$ denotes excess returns on portfolio i, $\omega_{i\pi,t}$ and $\omega_{ig,t}$ denote the conditional covariances between the excess return on portfolio i and the two economic risk factors, respectively. We constrain the slope coefficients (A_π, A_g) to be the same across all portfolios for cross-sectional consistency. We perform the estimation on restricted and unrestricted versions of the equation for both the full sample and two subsamples.

Sample Period	A_π		A_g	
01/1963 - 12/2005	-0.9089	(5.89)	—	—
01/1963 - 12/2005	—	—	1.9692	(5.85)
01/1963 - 12/2005	-0.7054	(4.00)	1.1313	(3.03)
01/1963 - 12/1985	-0.8151	(5.12)	—	—
01/1963 - 12/1985			4.5487	(11.19)
01/1963 - 12/1985	-0.4394	(2.24)	4.2213	(9.01)
01/1986 - 12/2005	-2.8077	(10.94)	—	—
01/1986 - 12/2005	—	—	10.9837	(12.87)
01/1986 - 12/2005	-1.5841	(5.13)	7.2475	(7.45)