Monetary Policy and Pricing of Cash-Flow and Discount-Rate Risk

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In this paper I examine the pricing of cash-flow and discount-rate risk in the framework of Campbell and Vuolteenaho (2004), conditional on Federal Reserve monetary policy. I find that monetary policy significantly influences the pricing of cash-flow and discount-rate risk. The model can be used to calibrate the relative importance of cash-flow and discount-rate news in transmitting monetary policy effects on stock returns. The well-documented size and value premiums in stock returns also are affected by monetary policy—these are observed mainly in expansive monetary policy environments. The two-factor model successfully explains size and value anomalies when risk prices are allowed to vary in different monetary environments.

Introduction

For the past several decades the Sharpe-Lintner capital asset pricing model (CAPM) has been one of the cornerstones of modern financial theory. Empirical research, however, has uncovered anomalies that cast doubts about the single-factor CAPM. Two notable failures of the CAPM have been the model's inability to explain higher average returns on small stocks and value stocks.[1] Several authors also report that the market beta is not priced in empirical tests of the CAPM (see Fama and French, 1992 and 1996). Thus, empirical findings seem to indicate that the single-factor CAPM is misspecified.

Campbell and Vuolteenaho (2004) split the market beta of the CAPM into two components: a cash-flow beta and a discount-rate beta. The sum of the two betas is equal to the market beta. They examine two different time periods—January 1929 to June 1963 (early sample), and July 1963 to December 2001 (modern sample). In the

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[1]See Banz (1981), Reinganum (1981), Basu (1983), Rosenberg, Reid and Lanstein (1985), Bhandari (1988), Chan, Jegadeesh, and Lakonishok (1995), Fama and French (1992, 1995, and 1996), Jagannathan and Wang (1996), and Skinner and Sloan (2002).

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early sample, value stocks and small stocks have higher cash-flow and discount-rate betas than growth stocks and large stocks. Thus, the value premium and the size premium in the early sample are compensation for higher levels of risk. In the modern sample, value stocks have higher cash-flow betas than growth stocks, whereas growth stocks have higher discount rate betas. Campbell and Vuolteenaho (2004) report that the prices of cash-flow risk are significantly higher than the prices of discount-rate risk in both samples. Therefore, higher return on value stocks in the modern sample can be attributed to their higher cash-flow betas. Higher return on small stocks in the modern sample can be attributed to their greater exposure to discount-rate risk. Cash-flow betas for small stocks and large stocks in the modern sample are about equal. Thus size premium in the modern sample is explained by higher discount-rate risk for small stocks. Campbell and Vuolteenaho's model demonstrates that value and size premiums in equity returns are compensation for higher levels of risk. The CAPM thus is resurrected as a two-factor model. The single-factor model's inability to explain anomalies apparently is due to aggregation of the two betas into a single market beta.

In this paper I examine pricing of cash-flow and discount-rate betas in different Fed monetary policy environments. There is ample evidence in the literature that monetary policy influences contemporaneous and ex ante stock returns. In two early studies Rozeff (1974 and 1975) reports that monetary developments influence a large fraction of stock return variation. Rozeff concludes that changes in Fed monetary policy strongly influence contemporaneous stock returns. [See Ewing (2001) and Bomfim (2003) for more recent evidence on the effects of monetary policy on stock return volatility.] In another widely cited early paper Fama (1981) examines the relation between inflation and stock returns. He finds evidence of negative correlation and argues that stock returns and inflation are driven in opposite directions by anticipated real activity. Geske and Roll (1983), James, Koreisha, and Partch (1985), and Kaul (1987) argue that countercyclical Fed monetary policy explains this Fama hypothesis. The Fed pursues restrictive policy to curb inflation, which leads to lower stock returns. Zweig (1986) argues that the monetary climate is the dominant factor in determining the stock market's major direction. Smirlock and Yawitz (1985) contend that changes in monetary policy affect stock returns by influencing interest rate forecasts, the cost of capital, and investors' expectations of corporate profitability. Jensen, Mercer, and Johnson (1996) provide evidence that stock and bond returns are significantly higher in expansive monetary policy periods than in restrictive periods. [Also see Conover, Jensen, Johnson, and Mercer (2005) for more recent evidence.] Stock returns are negative during restrictive monetary policy periods. They conclude that monetary stringency affects investors' required returns. Patelis (1997) presents evidence that restrictive monetary policy shocks predict lower expected stock returns in the short run and higher expected returns in the long run.

How does central bank monetary policy influence corporate profits and stock prices? In two widely cited papers Bernanke and Gertler (1989 and 1995) argue that monetary policy affects corporate profitability through two different channels: a balance sheet channel (or net worth channel) and a bank lending channel.

Interest rate hikes by the Fed worsen firms' balance sheets by increasing interest expenses, reducing net cash flows and profits, and reducing the value of assets that the firm may have used as collateral for external financing. If monetary tightening reduces spending by the firm's customers, then revenues also can be impacted adversely. Short-term borrowing (working capital financing) also rises following monetary tightening (Bernanke and Gertler, 1995; Gertler and Gilchrist, 1994; and Friedman and Kuttner, 1993). This increased need for external financing arises (internal financing may be inadequate due to low corporate profits) precisely at times when such financing is more expensive.

Monetary tightening also works through the bank lending channel—by draining reserves and deposits from the banking system, the supply of bank loans is reduced, and agency costs of lending are magnified. The effect of corporate cash flow squeeze and reduced supply of (costlier) bank loans places more financial burden on small firms than large firms. Large firms may be better collateralized (and in better overall financial condition) and have recourse to commercial paper and other sources of short-term credit. Since stock prices are weighted averages of expected future cash flows, in an efficient market, stock prices quickly should incorporate the real effects of monetary policy. Fed monetary tightening, therefore, predicts lower expected stock returns in the short run, especially for small firms.

Thorbecke (1997) finds that expansive (restrictive) monetary policy increases (decreases) contemporaneous stock returns. He also reports that monetary policy affects stocks returns of small firms significantly more than those of large firms, validating Bernanke and Gertler's (1989 and 1995) hypothesis. Thorbecke (1997) also finds evidence that monetary policy is a systematic factor that affects ex-ante stock returns within the framework of a multi-factor asset pricing model (with prespecified risk factors). Thorbecke and Alami (1992) report similar results. Park and Ratti (2000) present empirical evidence that positive output shocks (growth in industrial production) lead to higher inflation and to monetary tightening. Monetary tightening, in turn, causes an immediate decline in expected real stock return. Thus, Park and Ratti (2000) establish empirical cause and effect relationships among real economic activity, inflation, monetary policy, and expected stock return.

Rigobon and Sack (2003) discuss a simultaneity problem in disentangling the cause-and-effect relationship between monetary policy and stock market returns. They find that while stock returns are affected by monetary policy, monetary policy is also influenced by equity returns. Rigobon and Sack (2003) estimate that a 5 percent rise (fall) in the S&P 500 index increases the likelihood of a 25 basis point tightening (easing) by about half. They conclude, however, that the Fed responds to stock price movements only to the extent that is warranted by their implications for the economy. In another paper, Rigobon and Sack (2004) examine equity market reactions on days of the FOMC meetings and on days of the semi-annual monetary policy testimony (Humphrey-Hawkins testimony) of the Fed chairman to the Congress. They argue that market commentary on these days is likely to be dominated by news about monetary policy—so monetary policy news must be the primary determinant of equity price movements on such days. They find that an unanticipated 25 basis point increase in the short-term interest rate results in a 1.7 percent decrease in the S&P 500 index and a 2.4 percent decrease in the Nasdaq index. They argue that the Nasdaq index reacts more because the cash flows on Nasdaq stocks are farther in the future, which makes the prices of those stocks more sensitive to changes in the discount rate. Crowder (2006) provides evidence that inflation leads to monetary tightening, which results in an immediate decline in the S&P 500 index. He also finds that stock price movements do not influence monetary policy immediately, but eventually lead to a change in short-term interest rates in the same direction. He interprets this as evidence that the Fed uses information about equity markets in formulating monetary policy. He (2006) provides evidence that the relationship between stock returns and monetary policy (indicated by the discount rate and the federal funds rate) has varied over the past four decades, depending on the specific goals and targets that were followed by the Fed. The relationship is found to be statistically significant only when the funds rate (or the discount rate) "effectively serves as an indicator of money market conditions" and as an indicator of the overall strength of the economy. A significant relationship between the two is found when "investors understand or share the Federal Reserve's assessment on the strength of the economy." For example, no significant relation was found between January 1962 and December 1969 because the Fed targeted free reserves (excess reserves minus borrowed reserves) during this time period, and the funds rate or the discount rate were not perceived to be good indicators of future changes in economic activity. He (2006) argues that if equity investors do not understand or share the Fed's assessment of the strength of the economy or about financial market conditions in general, then stock returns may not be sensitive to changes in the federal funds rate or the discount rate. There is also some evidence in the extant literature that size and value premiums in stock returns are influenced by monetary conditions (see Conover, Jensen, Johnson, and Mercer, 2005).

The general conclusion emerging from this literature is that monetary policy shocks have real economic effects on the business environment, which are transmitted to the stock market. Further, monetary shocks have greater impact on small and value firms, which may not have adequate financial resources to weather a restrictive shock. In this paper, I pull these related ideas together to examine whether prices of cash-flow and discount-rate risk vary with Fed monetary policy, within the intertemporal asset pricing framework of Campbell and Vuolteenaho (2004). If monetary policy has real economic effects that alter stock return expectations, then it should have significant effects on equity risk premiums. The goal of the paper is to demonstrate that monetary policy significantly influences risk premiums,[2] a fact that suggests that the monetary environment should be incorporated into asset pricing models. I also find that Campbell and Vuolteenaho's (2004) two-factor model can explain the size and book-to-market equity (be/me) anomalies only when monetary policy is incorporated into the model. The two-factor model also is used to calibrate the relative importance of changes in market cash-flow and discount-rate news in transmitting monetary policy effects on stock returns.

Like Campbell and Vuolteenaho (2004), I find that cash-flow risk is priced significantly higher than discount-rate risk. I also find that both risk premiums are significantly higher when the Fed pursues expansive monetary policy than when it pursues restrictive policy. During restrictive policy months, the risk premiums are much smaller and often have the wrong sign. These results suggest that asset pricing models should incorporate the influence of the monetary sector. I also find that size- and be/me-sorted portfolio returns are much higher during expansive monetary policy periods. Small size and value premiums are realized mainly in expansive policy environments. The two-factor model is able to explain these return anomalies in different monetary environments only when risk prices are allowed to vary in different environments.

Cash-Flow and Discount-Rate Risk

This paper is closely related to Campbell and Vuolteenaho's (2004) paper. A brief description of their methodology and empirical results may be useful. Campbell and Vuolteenaho (2004) split the market beta of the CAPM into two components: a cash-flow and a discount-rate beta. The sum of the two betas is equal to the market beta.[3] They argue that two separate and distinct factors can cause the value of a stock to decline. The value of a stock may decline because bad news is revealed about expected cash flows. The value can also decline if investors increase the discount rate (expected return) at which the expected cash flows is capitalized, even if there is

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[2]This result is probably not surprising, given the extensive evidence in the literature that monetary policy shocks in restrictive environments worsen firm balance sheets (especially for small and value firms) and lower contemporaneous and expected stock returns.

[3]Campbell and Vuolteenaho (2004) split the unexpected market return into a cash-flow component and a discount-rate component: $r^e_{M,t} - E_{t-1}r^e_{M,t} = N_{CF,t} - N_{DR,t}$, where $r^e_{M,t}$ is log of excess market return in month t, E_{t-1} denotes expectations formed in month t-1, and $N_{CF,t}$ and $N_{DR,t}$ are the cash-flow and discount-rate components of market return. The above equation is an accounting identity, which says that an unexpected positive market return can result only from either an increase in expected future cash flows or a decrease in the discount rate. The sum of portfolio i's cash-flow beta and discount-rate beta equals the portfolio's beta on unexpected market return (see appendix to Campbell and Vuolteenaho's paper):

$$\begin{aligned}\beta_{i,CF} + \beta_{i,DR} &= Cov(r_{i,t},N_{CF,t})/Var(r^e_{M,t}-E_{t-1}r^e_{M,t}) + Cov(r_{i,t},-N_{DR,t})/Var(r^e_{M,t}-E_{t-1}r^e_{M,t})\\ &= Cov(r_{i,t},r^e_{M,t}-E_{t-1}r^e_{M,t})/Var(r^e_{M,t}-E_{t-1}r^e_{M,t})\end{aligned}$$

no change in the expected cash flows. The concept can easily be generalized to the overall market. "The value of the market portfolio may fall because investors receive bad news about future cash flows; but it may also fall because investors increase the discount rate or cost of capital that they apply to these cash flows. In the first case, wealth decreases and investment opportunities are unchanged, while in the second case, wealth decreases but future investment opportunities improve" (Campbell and Vuolteenaho, 2004). If the market declines due to a rise in the discount rate, then the decline in current wealth is at least partially compensated by higher expected returns. Risk-averse stock investors, therefore, will require higher compensation for holding one unit of cash-flow risk than for holding one unit of discount-rate risk. Campbell and Vuolteenaho (2004) formulate an inter-temporal CAPM (ICAPM) to suggest that risk-averse investors require higher risk premium for bearing cash-flow risk than discount-rate risk.

Campbell and Vuolteenaho (2004) use a vector autoregressive (VAR) model to estimate cash-flow news and discount-rate news. Their data are available from the website of The American Economic Review (www.aeaweb.org/aer). Their test assets are excess returns on 45 equity portfolios—25 portfolios sorted by size and be/me and another 20 sorted by past risk loadings with their VAR state variables (risk-sorted portfolios). Cash-flow and discount-rate betas are estimated separately for two time periods: January 1929–June 1963 (early sample) and July 1963–December 2001 (modern sample).[4] Their results for the early sample are that value stocks and small stocks have both higher cash-flow and discount-rate betas compared to growth stocks and large stocks. The average cash-flow betas for the value and the growth portfolios are 0.462 and 0.306 respectively. Average discount-rate betas for the two portfolios are 1.266 and 1.048. For small stocks, average cash-flow and discount-rate betas are 0.46 and 1.328, respectively, in the early sample. The corresponding betas are 0.28 and 0.962 for large stocks. Thus value premium and small size premium in the early sample are simply compensation for higher cash-flow and discount-rate risks.

The pattern is somewhat different in the modern sample. Value stocks seem to have higher cash-flow betas than growth stocks, whereas growth stocks have significantly higher discount-rate betas than value stocks. Average cash-flow betas for the value and the growth portfolios in this sample are 0.124 and 0.038 respectively. The corresponding discount-rate betas for value and growth stocks are 0.928 and 1.376 respectively. Since the sum of the two betas is equal to the market beta, growth stocks have higher market beta than value stocks in the modern sample. This

[4]Campbell and Vuolteenaho (2004) split the sample in July 1963 because Compustat data become available at that time, and most of the academic evidence on the be/me anomaly is from the post-1963 time period. They suggest that the early sample, therefore, provides an opportunity to perform out-of-sample tests on the be/me effect. They also find dramatic differences in the beta estimates between the two sample periods. Because my paper is an extension of Campbell and Vuolteenaho's work, I also split the sample in July 1963 in order to facilitate comparison with their results.

explains the failure of the CAPM market beta to account for higher return on value stocks in this sample. Risk premiums are estimated from cross-sectional regressions. Risk prices of cash-flow betas are much larger than prices of discount-rate betas (in both time periods). In the modern sample, the price of cash-flow risk is between 20 and 70 times larger than the price of discount-rate risk. Thus, the value premium in this sample is explained by the higher cash-flow betas of value stocks. Small stocks have significantly higher discount-rate betas (average beta of 1.29) than large stocks (0.784 on average). Cash-flow betas for the two groups are about equal (0.088 for small stocks and 0.084 for large stocks). Thus size premium in the modern sample is explained in terms of higher discount-rate risk for small stocks.

Campbell and Vuolteenaho's (2004) results show very different pattern of cash-flow and discount-rate betas in the two time periods examined. The early sample (January 1929–June 1963) includes the time period of the Great Depression. They argue that value stocks in the 1930s were probably "fallen angels" with high leverage. Distressed firms probably had to borrow money during the Great Depression just to survive. Falling stock prices and rising levels of debt combined to increase the financial leverage of these firms. Higher cash-flow and discount-rate betas for these firms in the early sample are a direct result of higher leverage of these firms. They argue that discount-rate betas for growth firms increased in the modern sample (July 1963–December 2001) due to several new economic developments in the modern time period. Among these, they list the initial-public-offering (IPO) wave among young growth firms in the 1960s, appearance of Nasdaq stocks in the sample since the 1970s, and the wave of growth company IPOs in the high technology industries in the 1990s. Newly-minted growth firms tend to be less profitable than other firms and may be more dependent on external financing. These firms also tend to generate cash flows in the more distant future. Thus value of their equity may be more sensitive to changes in market discount rates.

Campbell and Vuolteenaho (2004) also perform several different robustness checks of their results. They report that their main results hold even when continuous time-variation is allowed in the portfolio betas. Their results also hold when the representative investor's coefficient of relative risk aversion parameter is allowed to vary within reasonable limits. They repeat the analysis using quarterly and annual data. The results from quarterly and annual data are similar to their reported results, which use monthly data. Their results are also robust to the inclusion of several other variables that are known to predict stock returns in their VAR model. Campbell and Vuolteenaho (2004) also acknowledge several limitations of their analysis. They report that their estimation methodology can result in biased estimates of the betas and the risk premiums in small samples. Their analysis is also subject to the well-known survivorship bias in Compustat data. They also assume a constant variance of the market portfolio's return in their model derivation. They speculate that their results will be insensitive to changes in this assumption—but modeling this is left for future research. Another limiting assumption in their model is that long-term risk-averse investors do not try to time the market, but always hold a constant fraction of their wealth in the value-weighted market index. If this assumption is relaxed, then long-term investors may have an incentive to over-weight small and value stocks in their portfolios, as higher return on small and value stocks in such a model may not be simply compensation for higher investment risks. This is also left for future research.

In spite of these limitations of their analysis, Campbell and Vuolteenaho's (2004) paper furthers our understanding in several important areas. Their two-beta model shows that required return on risky assets must be determined using risk premiums for two uncorrelated sources of risk. Their statistical tests show that the single-factor CAPM fails miserably to explain the cross-sectional return variation in the modern sample (July 1963–December 2001). This has obvious implications for calculating the cost of capital for project evaluation in corporate finance. The cash-flow beta of a project is more relevant than a project's market beta in determining the cost of capital that may be used to evaluate the project. Campbell and Vuolteenaho's model also sheds light on the investing behavior of a representative long-term conservative investor who does not attempt to time the market. Such an investor will hold all stocks, including value stocks, small stocks, and stocks with low past betas, in his or her portfolio at market weights. Even though the single-factor CAPM fails to explain higher risk-adjusted return on value and small stocks (compared to return on growth and large stocks), Campbell and Vuolteenaho (2004) demonstrate that these higher returns are simply compensation for higher levels of risk. Thus, the failure of the CAPM is due to mis-measurement of risk—the aggregation of two separate sources of risk into one market risk.

Empirical Results

In this paper I test the hypothesis that monetary policy has a significant impact on the prices of cash-flow and discount-rate risks.[5] I use excess return on the 45 test assets (data available at www.aeaweb.org/aer**)** and estimate Campbell and Vuolteenaho's (2004) unrestricted two-beta model with unrestricted zero-beta rate. Because the same data and methodology are used, my beta estimates are virtually identical to those reported by Campbell and Vuolteenaho (2004) in Tables 4 and 5. Therefore, the betas are not reported separately in this paper.

[5]The literature on monetary policy (reviewed earlier) suggests that monetary policy shocks directly affect stock returns via changes in the value of private portfolios, changes in expectations about future interest rates, the cost of capital, corporate cash flows and future profitability (see Smirlock and Yawitz, 1985, Bernanke and Gertler, 1989 and 1995, Thorbecke, 1997, Patelis, 1997, Park and Ratti, 2000, and Crowder, 2006). Fed tightening lowers expectations about future cash flows, and simultaneously increases the discount rate for the expected stream of cash flows. Both of these factors indicate lower stock prices.

Classification of Monetary Policy

I use changes in the Fed discount rate to characterize monetary policy as either restrictive or expansive. Discount rate data are available from the St. Louis Federal Reserve Bank's website. Jensen, Mercer, and Johnson (1996) provide compelling evidence that classifying monetary policy using discount rate changes effectively measures the degree of monetary stringency. They demonstrate that money supply, the monetary base, Fed credit, and excess reserves are all significantly greater at times when the Fed lowers the discount rate than when it increases the discount rate. Hence, they argue that decreasing (increasing) discount rates characterize expansive (restrictive) monetary environments.

According to Jensen, Mercer, and Johnson (1996), discount rate changes are a good indicator of monetary policy because: (a) rate changes are perceived to be exogenous signals of Fed actions that are easily interpreted by market participants; (b) rate changes are widely reported and are made only at substantial intervals (there were only 150 rate changes in the 73 years in our sample); and (c) rate changes are interpreted as signals confirming monetary and real output developments. An increase (decrease) in the discount rate initiates a period of restrictive (expansive) monetary policy. The same policy stance is assumed to continue until the discount rate is changed in the opposite direction. Thus, consecutive rate changes in the same direction indicate a continuation of the same monetary policy.

Table 1 summarizes changes in the discount rate over the sample period (January 1929 to December 2001). I exclude months that mark the beginning of a new monetary environment (i.e., months when the discount rate is changed in an opposite direction compared to previous changes for the first time). It is not clear whether these months should be classified as the last month of the previous policy stance or the first month of a new policy environment, especially because rate changes are likely to occur sometime in the middle of the month. This procedure also avoids using ex-post information in establishing return intervals. An investor at the beginning of a month cannot know with certainty whether a rate change will occur in that month. A total of 33 months were thus excluded from the full sample of 876 months, 11 from the early sample (January 1929 to June 1963), and 22 from the modern sample (July 1963 to December 2001).[6] The full sample thus is reduced to 843 months. Over the 73 year (876 months) sample period, there were 69 rate increases and 81 rate decreases. There were only 33 rate changes, however, that marked the beginning of a new monetary policy era (i.e., a rate change in an opposite

[6]The empirical results and conclusions of this paper are not changed if these 33 months are classified either as the last month of the prior policy stance or as the first month of a new policy stance.

Table 1—Consecutive, Same-Direction Changes in the Federal Reserve Discount Rate between January 1929 and December 2001

Series	Month/Year of First Rate Change	Rate Increase (I) or Decrease (D)	Number of Rate Changes in Series
1	01/29	I	1
2	11/29	D	8
3	10/31	I	2
4	02/32	D	2
5	03/33	I	1
6	04/33	D	6
7	04/46	I	5
8	02/54	D	2
9	04/55	I	7
10	11/57	D	4
11	09/58	I	5
12	06/60	D	2
13	07/63	I	3
14	04/67	D	1
15	11/67	I	3
16	08/68	D	1
17	12/68	I	2
18	11/70	D	5
19	07/71	I	1
20	11/71	D	2
21	01/73	I	8
22	12/74	D	7
23	08/77	I	14
24	05/80	D	3
25	09/80	I	4
26	11/81	D	9
27	04/84	I	1
28	11/84	D	7
29	09/87	I	3
30	12/90	D	7
31	05/94	I	4
32	01/96	D	3
33	08/99	I	5
34	01/01	D	12

Note: There were a total of 69 rate increases and 81 rate decreases over the sample period (1/29-12/01). Consecutive rate increases (decreases) define restrictive (expansive) Fed monetary policy environments

direction compared to previous changes). The sample consists of 379 months in restrictive periods and 464 months in expansive periods.

Cash-Flow and Discount-Rate Risk Premiums

Risk premiums for cash-flow and discount-rate risks are estimated from the following cross-sectional regression [equation 10 in Campbell and Vuolteenaho's (2004) paper]:

$$\bar{R}_i = \alpha + \gamma_1(\beta_{i,CF}) + \gamma_2(\beta_{i,DR}) + e_i \tag{1}$$

where, $\bar{R}_i$ is the sample average excess return on test asset i, and $\beta_{i,CF}$ and $\beta_{i,DR}$ are estimated cash-flow and discount-rate betas, respectively. The zero-beta rate (R_{zb}) in this model is allowed to differ from the Treasury-bill rate. The intercept is interpreted as the difference between R_{zb} and the Treasury-bill rate. The γ's are estimated prices of cash-flow and discount-rate risk.

Table 2 reports results for the early sample (January 1929 to June 1963), the modern sample (July 1963 to December 2001), and for the full sample (January 1929 to December 2001).[7] Regression (1) is estimated separately in restrictive and expansive monetary environments. The adjusted R^2 statistics measure the explanatory power of the model. The results reported in the top panel of the table are similar to results reported by Campbell and Vuolteenaho (2004). Specifically, the price of cash-flow risk is found to be much larger than the price of discount-rate risk, especially in the modern sample. The model explains between 45 percent and 58 percent of the cross-sectional variation in average returns across the test assets.

Table 2 also reports risk premiums estimated during restrictive and expansive monetary policy months. In the early sample, the risk premiums are not statistically different from zero in the restrictive policy periods. During expansive monetary policy periods, by comparison, the estimated risk price of cash-flow beta is high at nearly 39 percent per year. The price of discount-rate risk is insignificant. Results for the modern sample show that the price of cash-flow risk is high in both monetary policy environments. The price of cash-flow risk, however, is nearly three times as large during expansive policy months as during restrictive months. The discount-rate risk premium has the wrong sign in restrictive monetary environment. Discount-rate risk is priced during expansive policy months. The risk premium is only about 6 percent of the cash-flow risk premium during expansive months. The adjusted R^2 statistics are 47 percent and 56 percent in restrictive and expansive policy periods, respectively. The full sample results show that cash-flow risk is significantly priced in both monetary environments. The cash-flow risk premium in expansive monetary policy environments is more than twice as large as during restrictive environments. The price of discount-rate risk has the wrong sign again, which makes drawing inferences difficult.[8]

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[7]I thank a journal referee for suggesting examining the full sample results. Campbell and Vuolteenaho (2004) do not report results for the full sample period. Therefore, the full sample results reported in Table 2 cannot be compared with their results.

[8]As mentioned before, Campbell and Vuolteenaho (2004) do not report results for the full sample period. Their point estimates of the risk premiums are fairly close to those that are reported in Table 2 for the early and the modern samples. While the negative price of discount-rate risk in the full sample is problematic, we do not have anything in Campbell and Vuolteenaho's paper for comparison. They do mention in their paper that the "estimated discount-rate betas are noisy" (p. 1266), which may lead to somewhat unreliable estimates of the discount-rate risk premium. Furthermore, their betas are estimated with the assumption of constant variance of unexpected market return (see formulas 4 and 5 in p. 1257 of their paper). This assumption becomes more tenuous as the estimation period lengthens. Also, as discussed

Table 2—Price of Cash-Flow and Discount-Rate Risk in Expansive and Restrictive Monetary Policy Environments (T-Ratios in Parentheses)

	Early Sample (1/29 – 6/63)		Modern Sample (7/63 – 12/01)		Full Sample (1/29 – 12/01)	
		% per annum		% per annum		% per annum
R_{zb} less R_{rf}	0.004*	4.968%	0.001	0.649%	0.005*	5.796%
	(2.72)		(0.41)		(5.05)	
β_{CF} Premium	0.012***	14.916%	0.053*	63.060%	0.027*	32.868%
	(1.90)		(6.66)		(6.75)	
β_{DR} Premium	0.001	1.170%	0.001	1.101%	-0.003	-3.72%
	(0.32)		(1.10)		(-1.43)	
Adjusted R^2	44.77%		50.39%		57.84%	
Restrictive Monetary Policy						
R_{zb} less R_{rf}	0.009*	10.704%	-0.001	-0.756%	0.006*	7.08%
	(4.34)		(-0.46)		(6.90)	
β_{CF} Premium	-0.008	-9.636%	0.031*	36.828%	0.016*	19.272%
	(-0.91)		(3.67)		(4.43)	
β_{DR} Premium	-0.004	-4.344%	-0.003*	-3.732%	-0.009*	-10.884%
	(-0.87)		(-3.51)		(-3.29)	
Adjusted R^2	33.17%		47.43%		55.70%	
Expansive Monetary Policy						
R_{zb} less R_{rf}	0.001	1.452%	0.001	1.512%	0.003**	4.116%
	(0.61)		(0.67)		(2.53)	
β_{CF} Premium	0.032*	38.52%	0.085*	102.24%	0.038*	46.176%
	(3.79)		(7.50)		(6.68)	
β_{DR} Premium	-0.000	-0.579%	0.005*	6.300%	-0.000	-0.373%
	(-0.12)		(4.37)		(-0.16)	
Adjusted R^2	70.15%		56.42%		71.21%	

Note: Slopes, t-statistics and adjusted R^2-s are estimated from the following cross-sectional regression:

$$\bar{R}_i = \alpha + \gamma_1(\beta_{i,CF}) + \gamma_2(\beta_{i,DR}) + e_i$$

where $\bar{R}_i$ denotes sample average excess return on asset i, and $\beta_{i,CF}$ and $\beta_{i,DR}$ are Campbell and Vuolteenaho's (2004) cash-flow and discount-rate betas respectively. The dependent variable is sample average excess return on 25 size- and book-to-market-equity-sorted portfolios and 20 risk-sorted portfolios from Campbell and Vuolteenaho (2004)

* Significant at 1 percent
** Significant at 5 percent
*** Significant at 10 percent

An Extended Model

The results presented in Table 2 show substantial differences in the estimated risk premiums across the two monetary environments. The monetary environment seems to significantly influence the relation between the two pricing variables and

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earlier, Campbell and Vuolteenaho report that the betas in the two sample periods are quite different. They attribute the differences in the betas between the two samples to major structural changes that occurred in the U.S. financial markets during the modern period. I do not know if it is even meaningful to aggregate the disparate betas from the two sample periods into one set of betas for the full sample period. This may be a reason that Campbell and Vuolteenaho have not reported the full sample results in their paper.

cross-sectional return. To formally test for differences in the cross-sectional regression slopes across the monetary environments, I use a monetary policy dummy variable (D) that has a value of 1 (0) during restrictive (expansive) policy months. The following cross-sectional regression is estimated:

$$\bar{R}_i = \alpha + \alpha_1 D + \gamma_1(\beta_{i,CF}) + \lambda_1(D\beta_{i,CF}) + \gamma_2(\beta_{i,DR}) + \lambda_2(D\beta_{i,DR}) + e_i \tag{2}$$

$\bar{R}_i$ is the sample average excess return on test asset i, and $\beta_{i,CF}$ and $\beta_{i,DR}$ are estimated cash-flow and discount-rate betas, respectively. The γ's are estimated risk premiums in expansive policy months, whereas the λ's measure differences between the risk premiums in restrictive and expansive policy months. The results for the three time periods are reported in Table 3.

Table 3—Price of Cash Flow and Discount Rate Risk Estimated from Cross-Sectional Regressions Including a Monetary Policy Dummy Variable with Interaction Terms (T-Ratios in Parentheses)

	Early Sample (1/29 – 6/63)		Modern Sample (7/63 – 12/01)		Full Sample (1/29 – 12/01)	
		% per annum		% per annum		% per annum
Intercept	0.001	1.452%	0.001	1.512%	0.003*	4.116%
	(0.60)		(0.76)		(3.02)	
D	0.008*	9.264%	-0.002	-2.268%	0.002	2.964%
	(2.71)		(-0.81)		(1.54)	
β_{CF} Premium	0.032*	38.520%	0.085*	102.240%	0.038*	46.176%
	(3.70)		(8.55)		(8.00)	
D*(β_{CF}	-0.040*	-48.168%	-0.055*	-65.412%	-0.022*	-26.904%
Premium)	(-3.27)		(-3.87)		(-3.30)	
β_{DR} Premium	-0.000	-0.579%	0.005*	6.300%	-0.000	-0.373%
	(-0.12)		(4.98)		(-0.19)	
D*(β_{DR}	-0.003	-3.756%	-0.008*	-10.032%	-0.009*	-10.512%
Premium)	(-0.55)		(-5.60)		(-3.75)	
Adjusted R^2	84.24%		95.26%		94.79%	

Note: Slopes, t-statistics and adjusted R^2-s are estimated from the following cross-sectional regression:

$$\bar{R}_i = \alpha + \alpha_1 D + \gamma_1(\beta_{i,CF}) + \lambda_1(D\beta_{i,CF}) + \gamma_2(\beta_{i,DR}) + \lambda_2(D\beta_{i,DR}) + e_i$$

where $\bar{R}_i$ denotes sample average excess return on asset i, D is a monetary policy dummy variable that takes a value of 1 (0) in restrictive (expansive) policy months, $\beta_{i,CF}$ and $\beta_{i,DR}$ are Campbell and Vuolteenaho's (2004) cash-flow and discount-rate betas. The dependent variable is sample average excess return on 25 size- and book-to-market-equity- sorted portfolios and 20 risk-sorted portfolios from Campbell and Vuolteenaho (2004). The γ-s are estimates of risk premiums in expansive policy months whereas the λ-s measure differences between the risk premiums in restrictive and expansive monetary policy months. Similarly, α is the excess of the zero-beta rate (R_{zb}) over the risk-free rate (R_{rf}) in expansive policy months, whereas α_1 is the difference in (R_{zb} - R_{rf}) between restrictive and expansive policy months

* Significant at 1 percent

Table 3 shows that cash-flow risk is highly priced in expansive policy months in all three time periods. The significance (and negative sign) of the interaction dummies indicate that the price of cash-flow risk is significantly lower in restrictive monetary environments in all three time periods examined. For example, the cash-flow risk premium in the modern sample in expansive policy periods is 0.085 (102.24 percent per year), whereas it is significantly lower in restrictive periods at 0.031 (0.085-0.055). As in Table 2, discount-rate risk in not priced in the early sample. Discount-rate risk is significantly priced in the modern sample at 0.005 (0.5 percent monthly or 6.3 percent per year) during expansive monetary policy. The discount-rate risk premium is significantly lower during restrictive policy months. As in Table 2, the discount-rate risk premium has the wrong sign in the full sample period. The general conclusion that can be reached from Table 3 is that the risk premiums appear to be linked to monetary policy stringency. The R^2 statistics are impressive: between 84 percent and 95 percent in the three time periods examined. A comparison with the results reported in Table 2 shows that the R^2 statistics increase substantially as a result of adding the monetary policy dummy (from a range of 45 percent to 58 percent without the monetary policy dummy to a higher range between 84 percent and 95 percent with the dummy). Therefore, the explanatory power of the model increases substantially with the inclusion of monetary conditions.

Channels of Monetary Policy Transmission

Thorbecke (1997) and Crowder (2006) argue that since stock prices are present values of expected future cash flows, expansive monetary policy increases contemporaneous stock returns either by increasing expected cash flows or by decreasing the discount rate at which the future cash flows are capitalized. Monetary policy can alter expected future cash flows of firms by influencing the overall level of economic activity. Expansive policy increases aggregate economic activity and increases expected earnings and cash flows of firms in the economy. Monetary policy also can alter the discount rates that are used by equity investors. Discount rates used by equity investors generally are tied to market interest rates. Thus, the Fed's ability to change discount rates is linked to its ability to alter other market interest rates. Forward-looking equity markets quickly incorporate the implications of monetary policy shocks for future cash flows and discount rates. Campbell and Vuolteenaho's (2004) two-factor asset pricing model allows one to examine the differential impact of expansive versus restrictive monetary policy on stock returns, in terms of differential policy impact on returns that are related to the two risk factors.

Table 4 reports average annualized monthly excess returns (stock return minus the Treasury-bill rate) on the 45 size-, be/me-, and risk-sorted Campbell and Vuolteenaho (2004) portfolios in expansive and restrictive monetary policy conditions. The table also reports the components of excess returns that are related to the market cash-flow factor and the discount-rate factor. The component of a stock portfolio's return that is related to a particular risk factor is computed as the product of the portfolio's beta vis-à-vis the risk factor ($\beta_{i,CF}$ or $\beta_{i,DR}$) and the factor risk premium (γ_{CF} or γ_{DR}). The factor risk premiums in restrictive and expansive policy periods are reported in Table 2. Table 4 shows that average annualized excess returns during expansive policy periods exceed those during restrictive policy months by 11.11 percent in the early period and by 18.32 percent in the modern period. The monetary policy premium is 14.98 percent in the full sample. The differences are economically large and statistically significant. These results are consistent with the evidence in the extant literature that monetary policy has an economically large impact on stock returns. Furthermore, in both the modern sample and the full sample, the smallest of the 45-portfolio average excess return in expansive policy months exceeds the largest excess return in restrictive months—by 7.8 percent (= 11.25 percent - 3.45 percent) and 5.66 percent (= 9.00 percent -3.34 percent), respectively.

Table 4—Average Monthly Annualized Excess Returns (Percent per Month*12) on Size-, be/me-, and Risk-sorted Portfolios in Expansive (Exp.) and Restrictive (Rest.) Monetary Policy Environments

	Early Sample (1/29-6/63)			Modern Sample (7/63-12/01)			Full Sample (1/29-12/01)		
	Exp.	Rest.	Diff.	Exp.	Rest.	Diff.	Exp.	Rest.	Diff.
$\bar{R}$	13.84	2.73	11.11*	16.91	-1.41	18.32*	15.28	0.30	14.98*
			(6.66)			(19.31)			(16.17)
Minimum	6.93	-10.1		11.25	-6.28		9.00	-7.73	
Maximum	27.31	9.21		27.07	3.45		27.20	3.34	
$\gamma_{CF}\beta_{CF}$	13.02	-3.26	16.28*	8.88	3.20	5.68*	11.56	4.82	6.73*
			(24.30)			(12.17)			(11.48)
$\gamma_{DR}\beta_{DR}$	-0.63	-4.72	4.09*	6.51	-3.86	10.36*	-0.40	-11.61	11.22*
			(25.90)			(34.88)			(30.12)

Note: The reported numbers are average annualized monthly excess returns on 45 size, be/me-, and risk-sorted portfolios ($\bar{R}$) from Campbell and Voulteenaho (2004), and excess returns related to the market cash-flow factor ($\gamma_{CF}\beta_{CF}$) and market discount factor ($\gamma_{DR}\beta_{DR}$) in expansive (Exp.) and restrictive (Rest.) monetary policy regimes. Diff. equals difference between expansive regime returns and restrictive policy-period returns. T-ratios are reported in parentheses for Diff

*Significant at 1 percent.

Table 4 also shows that monetary policy effects are transmitted to the stock market through its impact on both the market cash-flow factor and the discount-rate factor. Campbell and Vuolteenaho's (2004) model allows one to calibrate the relative importance of the two factors as monetary policy effects are transmitted to the stock market. In the early sample, policy effects are channeled primarily through their impact on the cash-flow factor. The discount-rate factor explains a relatively modest 37 percent (= 4.09/11.11) of the difference in excess return between expansive and restrictive policy periods. In the modern sample, the discount-rate factor accounts for 57 percent (= 10.36/18.32) of the monetary policy effect, whereas the cash-flow factor explains about 31 percent (= 5.68/18.32) of the excess return differential between the two policy regimes. In the full sample, the discount-rate factor explains about 75 percent (= 11.22/14.98) of the monetary policy effect on excess stock returns, with the remainder left to be explained by the cash-flow factor. Interestingly, Campbell and Vuolteenaho (2004) observe that the "discount-rate news is the dominant component of the market return" for the full sample (on p. 1255 of their paper). The numbers do not add to 100 percent because the two-factor model explicitly allows for a non-zero excess zero-beta rate, which can differ between the two monetary policy regimes (Table 2).[9] To summarize, Table 4 shows that monetary policy is transmitted through its impact on both the cash-flow factor and the discount-rate factor. The relative importance varies from the early sample to the modern sample, with the discount-rate factor being the dominant transmission channel for the full sample.

Economic Explanations

What explains the relative prominence of the cash-flow factor in the early sample and the discount-rate factor in the modern sample? A clue can be found in Campbell and Vuolteenaho's (2004) paper. As Campbell and Vuolteenaho observe, the early sample results are dominated by data from the time of the Great Depression. Many firms during that time period (especially small and value firms) were highly leveraged, as their stock prices declined and burden of debt increased. Deflation's impact tends to be particularly severe on sectors of the economy that are leveraged—for example, sectors that regularly use loans to finance activities (such as agriculture). Deflation erodes prices of assets and commodities, while increasing the real value of debt. Campbell and Vuolteenaho suggest that higher leverage and poorer financial condition make firms more sensitive to news about changes in future cash flows. Bernanke and Gertler (1989 and 1995) argue that monetary policy shocks can alter expectations about corporate profits and future cash flows through a balance sheet channel and a bank lending channel. Thus high leverage and weak financial condition of firms during the Great Depression period probably explain the relative importance of the cash-flow factor in the early sample.[10]

To understand the diminished role of the discount-rate factor during the Great Depression period (1929-1933), one needs to examine the Fed's pro-cyclical monetary policy during this time period (Du, 2006). Ben Bernanke, speaking at a conference at the University of Chicago in 2002 on Milton Friedman's 90th birthday (www.federalreserve.gov/boarddocs/speeches/2002/20021108), argues that Fed monetary policy during the Great Depression was driven largely by exogenous factors that were unrelated to economic fundamentals in the United States. The Fed

[9]Residual return can also account for some of the differences. The full sample results for $\gamma_{CF}\beta_{CF}$ and $\gamma_{DR}\beta_{DR}$ are based on the full sample (January 1929 to December 2001) estimates of the β's and the γ's, so the reported full-sample numbers need not be between the corresponding numbers for the early and the modern samples.

[10]To verify this, I re-estimate the model's parameters for the early sample after excluding data for 1930 to 1933. The ability of the discount-rate factor to explain the transmission of monetary policy increases to over 50 percent, while that of the cash-flow factor drops to below 50 percent. There may be a valid concern that excluding any data from empirical analysis is an attempt at data mining.

tightened money supply between 1928 and 1933 (while output and prices declined) to curb bank lending for stock speculation, to slow the outflow of U.S. gold reserves to France, to defend the dollar against speculative foreign attacks (in the aftermath of the sterling crisis of September 1931), and to relieve pressures on the gold reserves of the Fed in early 1933 (as rumors circulated about the economic policies of then President-elect Franklin D. Roosevelt). As the Fed tightened money supply, output and prices fell in response, and a severe banking crisis ensued. The public lost confidence in the Fed's policies and in the banking system in general, draining bank deposits and hoarding cash. This reduced money supply even further. Tight money supply (and higher interest rates) surely had the predictable adverse impact on corporate cash flows, which helps explain the importance of the cash-flow factor in the early sample. As the Fed kept raising interest rates in the face of falling output and prices, however, it is possible that stock investors did not increase the discount rate that they use to discount expected future cash flows. As Campbell and Vuolteenaho (2004) point out, if the discount rate (expected return) increases, *ceteris paribus*, contemporaneous stock prices decline but future investment opportunities improve. Perhaps, in the height of the Great Depression, investors did not raise the discount rate (as the Fed tightened money supply) because they did not believe that future investment opportunities and expected returns would improve. As the public lost faith in the Fed's counter-cyclical monetary policy [according to Friedman and Schwartz (1963), the Fed was pursuing the wrong set of policies], they probably believed that the higher interest rates would not prevail for long, and the Fed would be forced to reverse course. He (2006) argues that if monetary policy deviates from its traditional path, it can cause significant confusion among investors. Perhaps that is what happened as a result of the Fed's ambiguous monetary policy during the Great Depression.

In the modern sample, Campbell and Vuolteenaho (2004) hypothesize that several new economic developments increased sensitivities to changes in discount-rate news: the IPO wave in the 1960s among newly minted growth companies, the appearance of Nasdaq stocks in the modern sample since the 1970s, and IPOs of young growth firms in the high technology industries in the 1990s. Younger firms tend to be less profitable than more established firms and may be more dependent on external financing. These firms also tend to generate cash flows in the more distant future. Thus, the value of their equity may be more sensitive to changes in market discount rate news conveyed by monetary policy shocks. Rigobon and Sack (2004) also note that Nasdaq stocks are especially sensitive to the discount-rate factor because cash flows on many of these securities are farther in the future (long-duration cash flows). These economic developments since the 1960s may help explain why the discount–rate factor has grown in importance as the primary channel of transmission of monetary policy shocks to the stock market.

Size and BE/ME Portfolios

I also examine the ability of the two risk-factors to explain the monetary policy premiums (difference between expansive policy period return and restrictive policy period return) for the size portfolios and the be/me portfolios. The results (not reported here because of space constraints, but available upon request) are consistent with the overall conclusions drawn from Table 4. The monetary policy premiums for small firms and value firms range from 18 percent a year to 25 percent a year, depending on the time period examined. The monetary policy premiums for large firms and growth firms are comparatively muted, but economically significant. (The range is from 6 percent a year to 17 percent a year). These results are consistent with the results reported by Conover, Jensen, Johnson, and Mercer (2005). Consistent with the results reported in Table 4, the cash-flow factor is the dominant factor in the early sample, whereas the discount-rate factor becomes more important over time. In the modern sample, the two factors jointly transmit the effects of monetary policy on stock excess returns, with the discount-rate factor being relatively more important than the cash-flow factor.

Thorbecke (1997) and Crowder (2006) postulate that the real effects of monetary policy shocks must be transmitted through changes in expected cash-flows or changes in discount rates. Campbell and Vuolteenaho's (2004) model allows one roughly to gauge the relative importance of the two. To get a clearer picture of the transmission mechanism, one needs to estimate effects of monetary policy on expected cash flows and discount rates at the firm level. Campbell and Vuolteenaho's two-factor market model only allows one to estimate policy effects on aggregate market-wide cash-flow and discount-rate factors. Estimating these at the individual firm level is a more daunting task, but seems like a fruitful avenue for future research.

Monetary Policy and Size and Value Premiums: A Closer Look

Table 5 presents average raw monthly returns on size- and be/me-sorted portfolios in different monetary conditions for the early sample, the modern sample, and the full sample periods. Monthly returns for any given size portfolio are computed by averaging returns across the five be/me portfolios for that size category. Similarly, return on any be/me portfolio, in any given month, is the average return across the five size categories for that particular be/me portfolio. The well-known size and be/me effects are clearly present in average returns in expansive monetary environments in all the samples. During expansionary periods, the average annualized size effects are 10.40 percent (0.866 percent per month multiplied by 12 months), 6.86 percent, and 8.74 percent in the early sample, the modern sample, and

Table 5—Size- and be/me-sorted Portfolio Returns (percent per month) in Expansive and Restrictive Policy Months (1/1929-12/2001) (t-ratios in parentheses)

Size Sort	All Months	Expansive	Restrictive	BE/ME Sort	All Months	Expansive	Restrictive
Early Sample (1/29 – 6/63)							
	N=403	N=247	N=156		N=403	N=247	N=156
Small	1.109***	1.887**	-0.123	Growth	0.742***	1.157***	0.084
	(1.82)	(1.98)	(-0.28)		(1.75)	(1.79)	(0.22)
2	1.080**	1.593**	0.268	2	0.874**	1.229***	0.311
	(2.32)	(2.22)	(0.71)		(2.11)	(1.93)	(0.90)
3	1.015**	1.422**	0.371	3	1.016**	1.398**	0.410
	(2.37)	(2.16)	(1.02)		(2.45)	(2.19)	(1.17)
4	0.927**	1.246**	0.422	4	1.069**	1.549**	0.309
	(2.28)	(2.00)	(1.16)		(2.34)	(2.20)	(0.82)
Large	0.861**	1.020***	0.609***	Value	1.291**	1.834**	0.431
	(2.32)	(1.82)	(1.69)		(2.31)	(2.11)	(0.99)
Large-	-0.248	-0.866	0.732*	Value -	0.549**	0.677***	0.347
Small	(-0.72)	(-1.61)	(3.11)	Growth	(2.35)	(1.90)	(1.63)
Modern Sample (7/63-12/01)							
	N=440	N=217	N=223		N=440	N=217	N=223
Small	1.353*	2.235*	0.494	Growth	0.937*	1.591*	0.300
	(4.37)	(5.86)	(1.03)		(3.04)	(4.11)	(0.63)
2	1.323*	2.104*	0.562	2	1.152*	1.912*	0.413
	(4.78)	(5.98)	(1.34)		(4.50)	(5.83)	(1.07)
3	1.286*	2.023*	0.568	3	1.264*	2.022*	0.526
	(5.15)	(6.23)	(1.53)		(5.49)	(6.79)	(1.53)
4	1.238*	1.892*	0.601***	4	1.411*	2.133*	0.709**
	(5.25)	(6.09)	(1.72)		(6.44)	(7.34)	(2.21)
Large	1.056*	1.664*	0.464	Value	1.491*	2.261*	0.741**
	(5.31)	(6.25)	(1.60)		(6.19)	(7.16)	(2.08)
Large-	-0.297	-0.571**	-0.030	Value -	0.554*	0.670*	0.442
Small	(-1.30)	(-2.13)	(-0.08)	Growth	(3.06)	(2.85)	(1.61)
Full Sample (1/29-12/01)							
	N=843	N=464	N=379		N=843	N=464	N=379
Small	1.236*	2.050*	0.240	Growth	0.843*	1.360*	0.211
	(3.71)	(3.82)	(0.72)		(3.27)	(3.50)	(0.66)
2	1.207*	1.832*	0.441	2	1.019*	1.549*	0.371
	(4.55)	(4.40)	(1.51)		(4.28)	(4.16)	(1.39)
3	1.156*	1.703*	0.487***	3	1.145*	1.690*	0.478***
	(4.77)	(4.46)	(1.84)		(4.95)	(4.61)	(1.93)
4	1.089*	1.548*	0.527**	4	1.248*	1.822*	0.544**
	(4.74)	(4.29)	(2.08)		(5.06)	(4.57)	(2.23)
Large	0.963*	1.321*	0.524**	Value	1.395*	2.033*	0.614**
	(4.69)	(4.09)	(2.32)		(4.72)	(4.19)	(2.23)
Large-	-0.273	-0.728**	0.284	Value -	0.552*	0.674*	0.403
Small	(-1.34)	(-2.33)	(1.20)	Growth	(3.78)	(3.07)	(1.62)

The early sample has a total of 414 months; 11 months are excluded, yielding a sample of 403 months. I exclude months that mark the beginning of a new monetary policy. The modern sample (7/63-12/01) has 462 months, of which data for 22 months are excluded for the same reason

* Significant at 1 percent
** Significant at 5 percent
*** Significant at 10 percent

the full sample, respectively. The corresponding expansionary period annualized value premiums are 8.12 percent (= 0.677 percent × 12), 8.03 percent, and 8.09 percent in the three samples, respectively. The results are much less clear-cut during restrictive conditions. In the early sample, large stocks seem to have higher return than small stocks during restrictive conditions. This negative size premium indicates a flight-to-quality phenomenon during restrictive monetary policy in the early sample (maybe during the Great Depression and its aftermath). The be/me effect is also ambiguous in the early sample in restrictive policy months. In the modern sample (in restrictive monetary environments), average return also seems to increase with firm size (except for the largest size portfolio). The size effect (Large – Small) is economically and statistically insignificant. There is a mild (although statistically insignificant) be/me effect in average returns in the modern sample under restrictive conditions. The full sample results show no evidence of size or be/me effects in restrictive periods. Consistent with the results of Jensen, Mercer, and Johnson (1996), Thorbecke (1997), and Conover, Jensen, Johnson, and Mercer (2005), average returns are consistently higher during expansive policy months than during restrictive months. Most of the average returns are statistically insignificant during restrictive policy months.

The Two-Factor Model and Size and Value Premiums

I next examine the ability of the Campbell and Vuolteenaho (2004) two-factor model to explain size and value anomalies in returns in different monetary environments. As discussed earlier, Campbell and Vuolteenaho (2004) report that the size and be/me premiums are compensation for higher levels of cash-flow (and, in some cases, discount-rate) risks. They do not examine the performance of their model in different monetary environments, however. They also do not examine the residuals from their cross-sectional regressions for vestiges of size or be/me effects. The cross-sectional regression residuals can be interpreted as returns that are not explained by the model. Thus, while value and small stocks do have higher cash-flow (and in some cases discount-rate) betas, one cannot be certain that their model completely explains value and size anomalies in return.

I examine the residuals from Campbell and Vuolteenaho's (2004) cross-sectional regression (equation 1) in different monetary conditions. Equation (1) is estimated separately for all months and for the expansive and the restrictive policy months. Thus, the cross-sectional regression slopes (factor risk premiums) are allowed to vary between the monetary environments. The residuals [$\overline{R}_i$ - α - $\gamma_1(\beta_{i,CF})$ - $\gamma_2(\beta_{i,DR})$] in each sample can be interpreted as returns that are not explained by the two-factor model.[11] The results are presented in Table 6.

[11]Campbell and Vuolteenaho's model includes an intercept term (excess zero-beta rate) and the two risk factors. Thus, the part of a portfolio's excess returns that is explained by the model is the sum of the excess zero-beta rate and the components of return that are related to

Table 6—Cross-Sectional Regression Residuals of Size- and be/me-sorted Portfolios (percent per month) in Expansive and Restrictive Policy Months (1/1929-12/2001) (t-ratios in parentheses)

Size Sort	All Months	Expansive	Restrictive	BE/ME Sort	All Months	Expansive	Restrictive
Early Sample (1/29 – 6/63)							
Small	-0.071	0.108	-0.266	Growth	-0.213	-0.038	-0.345***
	(-.37)	(0.49)	(-1.75)		(-1.89)	(-0.45)	(-2.42)
2	0.073	0.182**	-0.061	2	-0.044	0.020	-0.086***
	(0.91)	(3.07)	(-0.41)		(-0.43)	(0.13)	(-2.30)
3	0.058	0.101	0.002	3	0.098***	0.117	0.022
	(1.25)	(1.31)	(0.03)		(2.53)	(1.23)	(0.21)
4	0.025	-0.007	0.012	4	0.091	0.129	-0.024
	(1.21)	(-0.11)	(0.13)		(1.64)	(0.88)	(-0.35)
Large	0.010	-0.076	0.121	Value	0.165	0.079	0.240*
	(0.12)	(-0.73)	(1.83)		(2.07)	(0.58)	(8.14)
Large-Small	0.081 (0.51)	-0.185 (-0.74)	0.388** (2.83)	Value - Growth	0.378*** (2.20)	0.117 (0.54)	0.585* (4.22)
Modern Sample (7/63-12/01)							
Small	0.153	0.236	0.108	Growth	0.028	-0.015	0.097
	(1.54)	(1.54)	(1.61)		(0.38)	(-0.16)	(1.40)
2	0.115**	0.135***	0.121**	2	-0.010	0.017	-0.019
	(2.98)	(2.77)	(3.26)		(-0.12)	(0.18)	(-0.25)
3	0.043	0.052**	0.070	3	0.035	0.077	-0.001
	(1.56)	(3.09)	(1.35)		(0.60)	(0.80)	(-0.04)
4	0.005	-0.048	0.080	4	0.107	0.130	0.113
	(0.08)	(-0.77)	(0.96)		(1.38)	(1.20)	(2.00)
Large	-0.062	-0.070	-0.072	Value	0.094	0.097	0.117
	(-1.21)	(-1.12)	(-1.62)		(1.51)	(1.07)	(1.85)
Large-Small	-0.215 (-1.44)	-0.306 (-1.42)	-0.180 (-1.71)	Value - Growth	0.066 (0.52)	0.112 (0.61)	0.020 (0.23)
Full Sample (1/29-12/01)							
Small	-0.009	0.098	-0.096	Growth	-0.107	-0.063	-0.093
	(-0.06)	(0.51)	(-0.81)		(-0.85)	(-0.59)	(-0.73)
2	0.089	0.161**	0.037	2	0.012	0.043	-0.003
	(1.97)	(3.63)	(0.65)		(0.26)	(0.47)	(-0.11)
3	0.058	0.091	0.045	3	0.068	0.106	0.008
	(2.11)	(1.48)	(1.86)		(1.31)	(1.14)	(0.28)
4	0.018	-0.011	0.048	4	0.073	0.113	0.024
	(0.57)	(-0.22)	(1.12)		(1.12)	(0.92)	(1.12)
Large	-0.052	-0.100	-0.014	Value	0.057	0.040	0.083
	(-1.62)	(-1.78)	(-0.58)		(1.19)	(0.38)	(1.99)
Large-Small	-0.043 (-0.24)	-0.198 (-0.86)	0.081 (0.58)	Value - Growth	0.164 (0.96)	0.103 (0.50)	0.175 (1.38)

The residuals are from cross-sectional regressions of size-, be/me- and risk-sorted portfolio returns on Campbell and Voulteenaho's (2004) cash-flow and discount-rate betas. Regression slopes are allowed to vary between monetary environments. The table reports average residuals and t-statistics for size- and be/me- sorted portfolios

* Significant at 1 percent
** Significant at 5 percent
*** Significant at 10 percent

the two risk factors. The difference between actual return and explained return is the residual unexplained return.

Table 6 shows that the residuals (unexplained returns) do not exhibit the strong and significant small-size and be/me effects that are observed in the raw returns (in Table 5) in expansive monetary environments. Most of the average unexplained returns (cross-sectional regression residuals) are small and statistically and economically insignificant.[12] Thus the two-factor model does a good job of explaining size and value anomalies in different monetary environments when risk prices are allowed to vary between monetary environments. Campbell and Vuolteenaho (2004) do not condition the risk premiums on Federal Reserve monetary policy. They do not examine the model's residuals either. I re-estimate equation (1) using their methodology. When the prices of risk are the same across the monetary regimes, the two-factor model fails to explain size and value premiums in expansive monetary policy environments. (Results are available upon request.) When monetary policy is not incorporated, the magnitude of the errors is economically and statistically significant.[13]

[12]Table 5 shows that the small-size and be/me effects are statistically and economically significant mainly during the expansive policy periods. The only exception is the significant negative size premium (higher return on large stocks than on small stocks) in the early sample during restrictive monetary policy months (0.732 percent per month). As explained earlier, this negative size premium indicates a flight-to-quality that occurred during restrictive monetary policy periods in the early sample (probably during the Great Depression and its aftermath). Campbell and Vuolteenaho's two-factor model does not fully explain this negative size premium during restrictive policy in the early sample. Also, a value premium seems to inexplicably appear in the residuals in Table 6 during restrictive policy months in the early sample, whereas there is no value premium in this sample in the raw returns in Table 5. However, the model does explain the size and be/me effects in expansive policy months.

[13]When monetary policy is accounted for, the average residual across the 10 portfolios (the 5 size-sorted and the 5 be/me-sorted portfolios in Table 6) in the early sample is 0.0615 percent per month in expansive policy environments - with only 1 of the 10 being significant at 5 percent (Table 6 - expansive policy months). When monetary policy is not controlled for (using CV's methodology), the average residual in the early sample in expansive policy periods is 0.3453 percent per month (4.14 percent per year) – with 8 of the 10 portfolio residuals significant at conventional levels. In the modern sample, the average residual from Table 6 (expansive policy months) is 0.0611 percent per month (with 1 of the 10 being significant at 5 percent, and a second one significant at 10 percent). Without accounting for monetary policy, the average residual is 0.8893 percent per month in expansive policy months (all 10 residuals are significant at 1 percent). The corresponding average monthly residuals for the full sample in expansive months are 0.0478 percent when monetary policy is taken into account (Table 6 – only one is significant at 5 percent), and 0.6068 percent per month (all significant at 1 percent or 5 percent) when the monetary environment is not accounted for. The ratio of the average residuals when monetary policy is ignored versus when it is taken into account varies from 5.61 in the early sample, to 14.55 in the modern sample, and 12.69 in the full sample. When monetary policy is not incorporated, the residual size and be/me effects are statistically significant in expansive policy months in all the samples, indicating the model's failure to explain value and size premiums during expansive monetary policy periods. Thus, it is important to condition the model on the monetary regime.

Robustness Checks

In this paper I use changes in Fed discount rates to identify changes in Fed monetary policy. There is no specific universally agreed-upon variable that best reflects the monetary policy stance. The difficulty in identifying a good policy indicator variable is that most variables that one may think of (for example, monetary aggregates such as M1 or M2, nonborrowed reserves, or short-term interest rates) can fluctuate for reasons other than changes in monetary policy. Friedman and Schwartz (1963) pioneered an entirely different narrative approach for classifying monetary policy. The narrative approach relies on Fed monetary policy directives and related official documents to classify stance of monetary policy. The narrative approach has been used by many authors since Friedman and Schwartz (1963) to study money neutrality (Poole, 1971; Uselton, 1974; Potts and Luckett, 1978; Romer and Romer, 1989; Brunner and Meltzer, 1989; Boschen and Mills, 1995; and Thorbecke, 1997). Following Thorbecke (1997), I use the Boschen and Mills narrative index (BMI) to check for robustness of the results that are reported in Tables 2 and 3.

Boschen and Mills (1995) examine Federal Open Market Committee (FOMC) monetary policy directives and associated policy discussions in Fed Annual Reports and classify monetary policy. The index is available from January 1953 to December 1991. They provide evidence that changes in monetary policy (as measured by their index) are associated with changes in monetary aggregates (M2, Fed monetary base, nonborrowed reserves) and short-term interest rates.

The results using the Boschen-Mills Index are very similar to the results that are reported in Tables 2 and 3 in this paper. I do not report these here (available upon request) because of the similarity in the results and the need for conciseness. Thus, the main results of the paper are robust whether monetary policy is classified using the Fed discount rate or using the Boschen-Mills (1995) narrative index.

I perform additional robustness checks using the federal funds rate. Bernanke and Blinder (1992) provide evidence that the federal funds rate indicates monetary policy actions because it is sensitive to shocks to the supply of bank reserves. Their empirical results demonstrate the dominance of the federal funds rate over monetary aggregates in terms of the ability to forecast numerous macroeconomic and financial variables. Bernanke and Blinder (1992) conclude that “movements in the (federal) funds rate are genuine policy changes, not simply endogenous responses of the federal funds market to changes in the economy.” The federal funds rate (or innovations in the funds rate) have been used to measure monetary policy by Bernanke and Gertler (1995), Patelis (1997), Thorbecke (1997), Park and Ratti (2000), Ewing (2001), Rigobon and Sack (2004), Crowder (2006), He (2006), and others. The federal funds rate is from the St. Louis Federal Reserve Bank’s website and is available from July 1954. The sample correlation (July 1954 to December 2001) between the discount rate and the federal funds rate is high at 0.96. Not surprisingly, the results using the two different interest rate variables are similar. The estimated risk premiums (especially for the modern sample; both interest rate series are available for the entire modern sample period) and regression adjusted R^2s are almost identical to those that are reported in Table 2.

Summary and Conclusions

Empirical research has uncovered anomalies in stock returns that the Sharpe-Lintner CAPM is not able to explain. Of these anomalies, the small-size effect and the book-to-market-equity effect have received the most attention in the finance literature. Average returns on small stocks and value stocks have been higher than the CAPM market beta can justify. Moreover, returns on high-beta stocks have not been found to be higher than low-beta stocks of similar size. The cumulative empirical evidence from this research casts doubts about the single-factor CAPM.

Campbell and Vuolteenaho (2004) split the CAPM market beta into two components: a cash-flow beta and a discount-rate beta. Cash-flow betas are priced much higher than discount-rate betas. Campbell and Vuolteenaho's (2004) two-factor inter-temporal CAPM successfully explains size and value anomalies that the single-factor Sharpe-Lintner CAPM fails to explain. Thus, the CAPM is resurrected (in a sense) as a two-factor model. The single-factor model's failure to explain anomalies is due to aggregation of the two betas into a single market beta.

In this paper, I examine the performance of the Campbell and Vuolteenaho (2004) two-factor model in different Federal Reserve monetary policy environments. There is extensive evidence in the literature that monetary policy shocks affect contemporaneous and expected stock returns. Several authors have reported that interest rate increases by the Fed lower contemporaneous and expected stock returns. Conversely, interest rate decreases by the Fed increase equity returns. Monetary policy, therefore, must have significant impact on equity risk premiums. Consistent with this view, I find that prices of cash-flow risk and discount-rate risk are significantly higher in expansive monetary environments (when the Fed is lowering interest rates) than in restrictive environments. I also use Campbell and Vuolteenaho's (2004) model to examine the transmission of the effects of monetary policy on stock returns via their impact on market-wide cash-flow and discount-rate factors. I find that the cash-flow factor is the dominant channel of transmission in the early sample. In the modern sample, both the cash-flow and the discount-rate factors jointly transmit policy effects to the stock market. The two-factor model is an asset pricing model and, as such, only permits examination of the transmission mechanism via market-wide factors. A more challenging and fruitful line of inquiry will be to estimate the impact of monetary policy on cash flows and discount rates at the individual firm level. That is left for future research.

Bernanke and Gertler (1989 and 1995) argue that rate hikes by the Fed worsen firms' balance sheets by increasing interest expenses and lowering revenues, net cash flows, and profits. Restrictive monetary policy also drains the banking system of loanable funds (and hence the supply of loans) and increases agency costs of lending. These developments affect bank-dependent small firms more than they affect large firms, as the latter may be better collateralized and may have access to commercial paper and other short-term credit. Consistent with this analysis, I find that small-size and value premiums are observed in average returns only in expansive environments (big firms tend to do as well or better than small firms in restrictive monetary policy periods). I examine cross-sectional regression residuals (unexplained returns) from the Campbell and Vuolteenaho two-beta model for vestiges of size or be/me effects. The residuals do not exhibit size or be/me effects (in the modern sample and the full sample) when the prices of risk are allowed to vary between monetary environments. Thus, the two-factor model is able to explain CAPM anomalies in different monetary environments.

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