STOCK RETURNS, INFLATION, AND THE FIRM SIZE EFFECT

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ABSTRACT

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This research examines an economic explanation for the previously found firm size effect in the traditional CAPM setting first documented for the 1970s by Reinganum (1981a, 1981b, and 1983). The size effect (small-capitalization stocks outperform large-capitalization stocks) is attributable to small firms' greater sensitivity to unexpected inflation, inflation beta, coupled with the high level of unexpected inflation in the 1970s. The observed insignificant size effect in the first half of the 1980s and the reversal of the size effect in the second half of the 1980s (Reinganum, 1992) may have been due to low unexpected inflation during this period as well as statistically insignificant differences in inflation betas between small and large firms.

One version of the inflation-extended market model and two versions of the inflation-adjusted CAPMs are used. The latter reduce significantly the excess returns derived compared to those obtained from the traditional CAPM, but the excess returns derived for large and small firms are still significantly different. These models only provide a partial explanation for the firm size effect.

The level of inflation risk (inflation beta) is closely related to several nominal contracting variables. Firm size is found to be a good proxy for these firm variables. A significant relationship is found between residual excess returns from the inflation-adjusted CAPMs and these nominal contracting variables. This indicates that firms with high debt levels tend to have larger excess returns during periods when inflation is greater than expected inflation.

To

My late parents

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I would like to thank the members of my dissertation committee for their critical insights and many helpful suggestions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter One

Introduction

INTRODUCTION

The primary motivation for this research is to determine if the firm size effect observed by Reinganum (1981a,1981b, and 1983) and Banz (1981) is due to the omitted risk of unexpected inflation in the single-period capital asset pricing model (CAPM). The higher excess returns of small firms compared to large firms observed in previous studies of firm size effect may be due to small firms bearing higher inflation risk, which is priced in the marketplace but not identified by the single-period CAPM.

Bernard (1986) and Pearce and Roley (1988) showed that firms sharing certain characteristics (for example, higher long-term debt ratios and higher market risk betas), have stock returns that tend to respond differently to unexpected inflation. Small firms tend to exhibit higher long-term debt ratios[1] (see Figure 1 and Table 5) and, as predicted by French, Ruback, and Schwert's (1983) nominal contracting hypothesis, should have more favorable stock returns during an inflation period than do larger firms, which have lower long-term debt ratios.

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[1] The long-term debt ratio is defined as the negative sum of long-term liabilities and preferred stocks, divided by market value of equity. The small firm portfolio contains the smallest 20 percent of the sample firms, while the large firm portfolio contains the largest 20 percent sample firms.

In addition, Chang and Pinegar (1987) found that firms with higher market risk betas[2] tended to have stock returns that were more sensitive to changes in expected inflation.[3] The present research shows that small firms have greater market risk betas than large firms (Figure 2 and Table 5), and therefore their stock returns are more sensitive to changes in expected inflation. The greater excess returns for small firms may be due to their superior performance (because of their favorable nominal contracting variables) during an inflation period, or the excess returns may represent greater compensation for omitted inflation risk in the traditional CAPM.

Furthermore, Keim (1983) showed that one-half of the size effect occurred, on average, in January for the NYSE and AMEX stocks during 1963 to 1979. The present research finds that, for the same period, the average January inflation rate was 0.31 percent, while the average for the other months was 0.44 percent. The average unexpected inflation rate for January was -0.12 percent during the period, compared to 0.22 percent

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[2] The market risk betas are defined as the co-movement between individual stock returns and the market rate of return. They are obtained by regressing monthly returns of individual stocks on monthly market returns. The coefficients are then averaged for the size-ranked portfolios.

[3] Chang and Pinegar (1987) derived the relationship between market risk and stock return responses to changes in expected inflation. This research extends their work, showing the relationship between market risk and stock return responses to unexpected inflation. The model will be derived in footnotes 14 and 15 of Chapter Two.

for the other months.[4] If Chang and Pinegar's (1987) arguments are correct, then small firms should have greater negative coefficients between the unexpected inflation and stock returns than do large firms. Since the unexpected inflation rates for January were on average negative, small firms should have higher stock returns than predicted by the CAPM during that month. This may explain why small firms have substantially higher excess returns in January than in other months. One objective of this research is to determine whether the abnormal returns for the small firms are related to inflation or unexpected inflation.

The tests conducted for this research contained in chapters Four, Five, and Six. Chapter Four conducts the firm size study using more recent data. The intent is to show how the firm size effect may be associated with the levels of inflation risk and firms' responses to it. The results indicate that the firm size effect found in the 1970s coincides with significantly more negative inflation betas (that is, greater inflation risk) for small firms than large firms. The size effect reverses in the second half of the 1980s, which coincides with a change from negative to positive

[4] The measurement of unexpected inflation follows Fama and Gibbons (1984) and is discussed in detail in Chapter Three. The t-statistic for the January inflation rate is -2.20, and the t-statistic for the January unexpected inflation rate is -1.89.

inflation betas for small firms (see Figure 7) and the low inflation rate of the second half of the 1980s.[5]

Chapter Five examines whether the inclusion of inflation factors in the CAPMs would reduce excess returns for portfolios and thus reduce the firm size effect. The testing process examines one inflation-extended market model and two versions of the inflation-adjusted CAPMs, taking into account both market and inflationary risk factors for security returns. If the excess returns of portfolios found in Chapter Four can be eliminated or reduced by using the inflation-adjusted CAPMs, then the previously identified firm size effect may be attributable to small firms' differential interaction with inflation-related economic factors. It is found that the excess returns measured from the traditional CAPM are significantly reduced by using the inflation-adjusted CAPMs. That is, the inflation risk premium taken into account by market participants is reduced by the inflation-adjusted CAPM. The size effect (difference in excess returns between small and large firm portfolios) still remains, however, and in a few cases becomes more significant.

The purpose of Chapter Six is to establish an economic explanation of the previously identified firm size effect.

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[5] The inflation betas are defined as individual stock returns' response to unexpected inflation. They are obtained by regressing individual stock returns on unexpected inflation for the period. The coefficients are then averaged according to the size-ranked portfolios.

Bernard (1986) and Pearce and Roley (1988) showed that firms' responses to unexpected inflation (inflation betas) were associated with certain firm characteristics (for example, long-term debt ratios, depreciation tax shields, and market risk). If small firms possess larger inflation betas (in negative terms) than large firms (as established in Chapter Five), then the previously identified firm size effect may be attributable to small firms' high sensitivity to inflation risk and their interactions with unexpected inflation. Chapter Six examines which firm characteristics may contribute to firms' level of inflation risk and whether firm size is a proxy for those characteristics.

The Chapter Six results show that inflation betas have a significant relationship with not only the firm's market value (that is, small firms have larger negative inflation betas than do large firms), but also to the firms' long- and short-term debt ratios and levels of market risk. This may indicate possible economic explanations that certain characteristics of small firms lead to the higher inflation risks priced but not identified by the traditional CAPM. Firm size is also found to be closely related to those characteristics. It is reasonable to believe that the high inflation risk for small firms may be due to the proxy relationship between firm size and these firm characteristics.

Finally, in Chapter Six the excess returns for portfolios measured from the inflation-adjusted CAPMs in Chapter Five are still significant in magnitude. A possible explanation may be due to the firm's performance during an inflationary period. These residual excess returns may be attributable to the firm's favorable or unfavorable nominal contracting positions during periods of inflation. Unexpected inflation may have unexpected economic effects on stock returns, reflected in the intercept terms of the asset pricing models, as well as in the inflation betas (the slope terms of the asset pricing models) proposed by Bernard (1986) and Pearce and Roley (1988).

Residual returns measured from the inflation-adjusted CAPMs (obtained from Chapter Five) are regressed on the firms' nominal contracting variables, and results show that the residual excess returns are significantly related to those variables. The coefficients of the regressed nominal contracting variables are significant and have correct signs as predicted by the nominal contracting hypothesis. That is, firms with favorable nominal contracting positions tend to have higher excess returns than do firms with unfavorable nominal contracting positions.

Chapter Two

Literature Review

LITERATURE REVIEW

A. REVIEW OF FIRM SIZE EFFECT STUDIES

It has been known for some time that small-capitalization stocks provide higher (CAPM) risk-adjusted returns than do large-capitalization stocks. Banz (1981) and Reinganum (1981a, 1981b, and 1983) found persistent higher excess returns for small than for large firms after adjusting for systematic (market) risk by the CAPM. This anomaly violates the joint hypotheses that (1) the single-period CAPM has descriptive validity and (2) security price behavior is consistent with market efficiency.

Banz (1981) examined the empirical relationship between stock returns and total market value of NYSE common stocks. Results showed that, over the period 1936-1975, common stock of small firms had, on average, higher (CAPM) risk-adjusted returns than the common stock of large firms. Banz used an arbitrage portfolio approach and found that the average excess returns from holding very small firm stocks long and very large firm stocks short is, on average, 1.52 percent per month, or 19.8 percent on an annualized basis. He also showed that this size effect is not linear with respect to market value; the main effect occurred for very small firms, while there was little difference in return for average and large size firms.

Reinganum (1981b) examined the firm size effect across a broader universe, including both NYSE and AMEX firms, and found superior (CAPM) risk-adjusted returns for small firms for the years 1963-1977. Reinganum collected aggregate stock market values and returns for firms represented both on the University of Chicago's CRSP tape and the COMPUSTAT Merged Industrial tape. He ranked all firms in the resulting sample on the basis of aggregate stock values and combined the ranked securities into ten equally weighted portfolios, all of which turned out to have betas close to one. If the single-period CAPM is correct, the rate of return for these portfolios should approximate the rate of return for the market as a whole.

Performance of the resulting portfolios was analyzed in two ways. First, average returns were computed in the year subsequent to the formation of the ten portfolios, which were ranked by size over the years 1962-1975, and it was then determined whether the size ranking correlated with stock returns. The portfolio containing the smallest firms realized an average rate of return of more than 20 percentage points per year higher than the portfolio containing the largest firms. Second, rates of return were averaged over the second year following the formation of each portfolio. The abnormal returns of the smallest firms persisted at about the same level as in the first test.

Both Reinganum studies (1981a, 1981b) used compounded daily returns of common stocks implicitly based upon a portfolio strategy that required daily rebalancing. The administrative and transaction costs of implementing such a strategy may have been so great as to make it uneconomical, however. In his 1983 article, Reinganum investigated whether the strategies that call for buying and holding securities for longer periods were capable of yielding results similar to those using the daily trading strategy. Results showed that the firm size effect was substantial even without daily rebalancing. The rate of return on a hypothetically managed portfolio of small capitalization companies was outstanding. For example, based on his strategy, one dollar invested in the smallest firms at the end of 1962 would have increased in value to more than $46 by the end of 1980. For the same period, the comparable figure for large firms was slightly more than $4, while for medium size firms it was approximately $13.

All previous research had shown that superior risk-adjusted returns for small firms persisted for at least two years. Given previous evidence of market efficiency, this persistence reduces the likelihood that these results are generated by a market inefficiency. Rather, the evidence seems to indicate that the equilibrium pricing model (CAPM) is misspecified.

Yet, the results from Brown, Kleidon, and Marsh (1983) and Reinganum (1992) rejected the stability of the size effect. Small firms have higher excess returns than large firms in some years, while the reverse is true in other years. Reinganum (1992) even showed that the variability in the size effect is not entirely random, exhibiting predictable reversal over five-year periods. That is, a five-year period in which large-capitalization stocks outperform small-capitalization stocks is typically followed by a five-year period in which the relative performance is reversed.[6]

If the size effect is not constant, some explanations for its existence can be ruled out, and others need modifying. Blume and Stambaugh (1983) found that studies using daily returns tended to overstate the small firms' returns because of the "bid-ask" spread. Roll (1981) proposed that since small stocks traded less frequently than large stocks, their

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[6] Two problems in Reinganum (1992) may result in some potential bias in his results. First, stock returns were not adjusted for risk by any asset pricing model. If small firms have higher betas than large firms, they will perform better than large firms in prosperous years and worse than large firms in recession years. The reversal of size effect may be due to business cycles in our economy.

Second, the number of reversals of the size effect in Reinganum (1992) may be overstated. The reversals in subsequent years may be due to the size effect in one specific year being carried over the next five-year holding horizon.

Nevertheless, the variability in the size effect is established by Reinganum (1992), as well as by Brown, Kleidon, and Marsh (1983). Results in Chapter Four also show the same variability in the size effect.

risk. The higher excess returns for small firms are the compensation for nontrading-induced underestimation of risk. These arguments can only explain why small firms outperform large firms, not why large firms outperform small firms, for example, over 1984-1989.

This research provides a possible explanation for the variability in the size effect. The firm size effect may be due to small firms' greater sensitivity to inflation risk, coupled with high inflation risk during the 1970s. The reversal of the firm size effect in the second half of the 1980s may be due to small firms' decreasing sensitivity to inflation risk, coupled with low inflation risk in the 1980s. This explanation is pursued in Chapter Four.

B. REVIEW OF STUDIES RELATING STOCK RETURNS AND INFLATION

Equities are financial claims against physical assets whose returns should remain unaffected by inflation. Therefore, equities traditionally have been regarded as an ideal hedge against inflation. But recent research has shown an inverse relationship between real (inflation-adjusted) stock returns and various expected and unexpected inflation measures (Fama 1981; Geske and Roll 1983; Kaul 1987). Researchers also have shown that this inverse relationship between stock returns and inflation is cross-sectionally different at the firm level (Bernard 1986; Pearce and Roley 1988). The magnitude of this inverse relationship depends on firms' nominal contracting positions[7] and other firm characteristics.[8]

Fama (1981) first proposed the "proxy hypothesis" to explain the inverse relationship between real stock returns and inflation rates. This inverse relationship results from

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[7] Nominal contracts are those set at a nominal amount of monetary value and not subject to changes in inflation. Since payments of the contracts only incorporate expected inflation, unexpected inflation will increase debtors' wealth, and vice versa. Examples of nominal contracts are short- and long-term debt contracts, labor contracts, and tax obligations. For further discussion, see French, Ruback, and Schwert (1983), Bernard (1986), and Pearce and Roley (1988).

[8] Bernard (1986) showed that some variables other than nominal contracting variables also were significantly associated with the inflation risk. Examples are levels of market risk and operating cash flows of firms.

the positive relationship between stock returns and real activity that comes out of the real sector of the economy, combined with the negative relationship between inflation and real activity that comes out of the monetary sector. It induces a spurious negative relationship between stock returns and inflation. That is, inflation is negatively related to real activity, while stock returns are positively related to real activity; therefore, inflation is negatively related to stock returns.

Fama showed, first, a negative relationship between inflation and real activity, which he interpreted in the context of money demand theory and the quantity theory of money. Second, he showed that real stock returns are positively related to measures of real activity, which are proxied by capital expenditures and average rates of return of capital. Finally, he related real common stock returns to real variables, to inflation measures, and to combinations of the two. Fama regressed the stock returns on both real activity variables and inflation variables, and he found that the real activity variables dominated in terms of the variability explained. Therefore, he concluded that the negative relationship between real stock returns and inflation was actually the proxy for the positive relationship between stock returns and real activity.

In monthly, quarterly, and annual data, growth rates of money and real activity variables eliminated the negative relationship between real stock returns and expected inflation rates. In the annual stock return regressions, unexpected inflation also lost its explanatory power when placed in competition with real activity variables. Fama's evidence implies that the inverse relationship between stock returns and inflation actually resulted from a proxy relationship between real activity and inflation. When real activity variables are put into the regression along with inflation variables, the explanatory power of the inflation variables vanishes.

In a similar study, Geske and Roll (1983) argued that stock returns are negatively related to contemporaneous changes in expected inflation[9] because the changes signal a chain of events that result in a higher rate of monetary expansion (inflation). A random negative real economic shock affects stock returns, which in turn signal higher unemployment and lower corporate earnings. This leads to lower personal and corporate tax revenues for government. Government expenditures do not change to accommodate the changes in revenues, so the Treasury's deficit increases. The Treasury responds by increasing borrowing from the public. The Federal Reserve System purchases some of the changes in Treasury debts and eventually pays for it by expanding the

[9] Geske and Roll (1983) also showed that the change in expected inflation is a function of unexpected inflation. Therefore, the relationship between stock returns and changes in expected inflation also can be applied to stock returns and unexpected inflation.

growth rate of the monetary base. Higher inflation is induced by the altered monetary base growth rate, and vice versa. Therefore, positive inflation is associated with negative economic shocks and, in turn, negative stock returns.

The empirical results after World War II support the links in the causative chain described above. Stock returns signal changes in nominal interest rates and changes in expected inflation.

Kaul (1987) hypothesized that the negative relationship between stock returns and inflation could be explained by a combination of money demand and countercyclical[10] money supply effects. More important, he argued that if money demand effects are coupled with monetary responses that are procyclical,[11] then the relationship between stock returns and inflation can be either insignificant or even positive.

Kaul extended previous research by including data from four industrialized countries (the United States, Canada, the

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[10] The countercyclical money supply function describes the negative relationship between real activity and the money supply. The federal government increases the money supply to reduce the deficit caused by low real activity in the economy, which will result in inflation and recession, as Geske and Roll (1983) proposed.

[11] Procyclical money supply responses cause a positive relation between real activity and money supply. The federal government increases the money supply when the economy is in prosperity, while it decreases the money supply while the economy is in recession. For example, between 1929 and 1933, gross national product (GNP) fell by nearly 30 percent and unemployment rose from 3 to 25 percent, while both the money supply and prices fell by about 25 percent. Furthermore, real GNP, the money supply, and prices tended to rise together after 1933.

United Kingdom, and Germany). The negative relationship between stock returns and inflation was consistent across all four countries during the postwar years. Kaul also extended the research period to the prewar 1930s, which had procyclical monetary policies. The relationship between inflation and stock returns during the 1930s was either positive or insignificant as well as statistically different from the negative postwar relationship.

Although there is some disagreement in explaining the reasons for the negative relationship between stock returns and inflation, Fama (1981), Geske and Roll (1983), and Kaul (1987) agree that these relationships result from real economic activities and their interactions with monetary growth rates (inflation rates). In later research, Bernard (1986) and Pearce and Roley (1988) found individual firms responded differently to this negative relationship due to their nominal contracting positions. Furthermore, Chang and Pinegar (1987) pointed out that firms with higher betas should respond more negatively to the relationship between stock returns and changes in expected inflation. Their results are consistent with Bernard's (1986) empirical evidence that firms with higher market risk betas respond more significantly to unexpected inflation.

Bernard (1986) attempted to identify and measure the sources of differential effects of unexpected inflation on stock returns. When stock returns were regressed on unexpected inflation, the results indicated that cross-sectionally different coefficients exist in individual stocks' responses to unexpected inflation. This implies that different firms have different levels of inflation risk.

Bernard attributed the differences of the coefficients (inflation betas) to magnitudes of firms' nominal contracting variables. He concluded that the differential association between stock returns and unexpected inflation is partially attributable to the revaluation of nominal monetary assets and liabilities recorded in corporate balance sheets, as well as a set of nominal contracts between corporations and government, consisting of historical cost-based tax shields.

Bernard also found that half the cross-sectional variance in stock returns associated with unexpected inflation could be explained by cross-sectional differences in systematic risks (market risk betas) of common stocks. This is not surprising if unexpected inflation, or the associated change in expected inflation, reflects change in expected aggregate real activity, and if market risk betas reflect the co-movement between individual stocks and aggregate real activity. Bernard also showed that real cash flows from operations were affected differently by unexpected inflation; consequently, these cash flows explain a portion of the cross-sectional variance in the negative relationship between stock returns and unexpected inflation.

The implication of Bernard's results is that market risk betas may not totally capture the effects of unexpected inflation on stock returns. Although market risk betas could explain half the variance of stock returns with respect to unexpected inflation, other factors could have a significant influence. For example, monetary assets and liabilities, depreciation tax shields, and real cash flows from operation also may explain part of the relationship between stock returns and unexpected inflation. Therefore, using the single-period CAPM to adjust only market risk for stock returns might not fully capture the effects of unexpected inflation on stock returns.

Pearce and Roley (1988) used a somewhat different approach to study the relationship between stock returns and unexpected inflation. Expected inflation survey data from Money Market Services, Inc., were used as a proxy for expected inflation. They gave a different specification (time-varying as well as fixed effects of firm characteristics) for the relationship between inflation betas and nominal contracting variables, in order to obtain more efficient estimates for coefficients, and they also used additional nominal contracting variables in the regression.

Prior to Pearce and Roley, research had used time-series estimation of historical inflation to approximate investors' inflation expectations. The time-series approach relies on the assumptions of the models and has limited ability to track actual inflation behavior. In contract, the survey data from Money Market Services, Inc., were taken two weeks before each month's CPI announcement. Pearce (1987) showed that the median value of these data generally indicated an unbiased forecast of the CPI announcements. The data also fully reflected past information on inflation and outperformed univariate forecasting models in tracking actual inflation behavior.[12]

Pearce and Roley regressed portfolio stock returns on market returns and combined the effects of unexpected inflation with various nominal contracting variables.[13] Results showed that the combined effects of unexpected inflation and nominal contracting positions explained a statistically significant portion of the variance in stock returns. These nominal contracting positions included the debt-equity ratio and FIFO inventory accounting. The results

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[12] The Money Market Service survey for expected inflation has been conducted since 1977. This survey is not adopted in this research because the period of study begins in 1960.

[13] Pearce and Roley's regression is expressed as:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \Gamma_i Inf^e_t + \tau_i Inf^u_t + v_t,$$

where τ_i is referred to as inflation beta and may be further expressed as the following regression:

$$\tau_i = \pi_0 + \pi_1 (X_{1it} - \beta_i X_{1t}^*) + \pi_2 (X_{2it} - X_{2t}^*) + \dots .$$

X_{jit} is the jth characteristic for the ith firm at time t, and X_{jt}^* is the average of the jth characteristic over the portfolio at time t.

also indicated that the systematic market risk beta did not capture all the stock returns' responses to unexpected inflation. Other nominal contracting factors, such as the debt-equity ratios and depreciation tax shields, appeared to be important in determining stock returns' responses to unexpected inflation.

Chang and Pinegar (1987) followed Geske and Roll's (1983) transmission mechanism, which linked real activities to inflation through changes in money supply in the following stages. They showed that the sensitivity of excess returns to changes in expected inflation will increase (in the negative direction) as the security risk (β_j) increases.[14] That is,

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[14] Chang and Pinegar (1987) summarized Geske and Roll (1983) in the following two equations:

$$E(M_t) = a + b\ (RS_t - E(RS_t)) + e_t; \tag{1}$$

$$\Delta E(i_t) = r\ (E(M_t) - E(i_{t-1})) + u_t, \tag{2}$$

where $E(M_t)$ is the expected growth rate in the money supply;
$RS_t - E(RS_t)$ is the excess stock return, a proxy for real activity;
$E(i_{t-1})$ is the market's expected inflation from t-1 to t; and
$\Delta E(i_t)$ is the change in expected inflation.

The signs of the coefficients are $b < 0$ and $r > 0$. Then they substituted the right-hand side of (1) into (2):

$$\Delta E(i_t) = ar + br\ (RS_t - E(RS_t)) - rE(i_{t-1}) + z_t, \tag{3}$$

They then expressed excess stock returns as follows (Jensen 1968):

$$RS_t - E(RS_t) = \beta_j * \pi_t + \epsilon_{j,t}. \tag{4}$$

The parameter π_t is the unobservable market factor, and β_j is an estimate of market risk. They next substituted (4) for firms with higher market risk betas, stock returns will respond to the changes in expected inflation more strongly.

Geske and Roll (1983) also showed that the change in expected inflation is a function of unexpected inflation.[15] Therefore, we can extend the relationship between market risk and changes in expected inflation to the relationship between market risk and unexpected inflation. The sensitivity of stock return responses to unexpected inflation (that is, inflation beta) will increase as the beta increases. These results agree with Bernard's (1986) findings that common stocks with higher market risk betas also have greater negative inflation betas. Small firms with higher market risk betas also possess higher inflation risk, which may be ignored

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into (1) and showed:

$$b=\mathrm{Cov}(\beta_j\pi_t,\ M_t)/\mathrm{Var}(\beta_j\pi_t),\ \text{or}\ b=(1/\beta_j)[\mathrm{Cov}(\pi_t,M_t)/\mathrm{Var}(\pi_t)].$$

Because β_j is positive and b is negative, b becomes less negative as β_j increases. Equation (3) can be reversed as:

$$[RS_t - E(RS_t)] = (1/br)\ [\Delta E(i_t) - ar + rE(i_{t-1})] + z_t. \quad (5)$$

The coefficient (1/br) of $\Delta E(i_t)$ becomes more negative as the security risk β_j increases.

[15] Geske and Roll (1983) showed:

$$E(i_{t+1}) = E(i_t) + k\ [\ i_t - E(i_t)\ ] + e_t; \quad (6)$$

$$\Delta E(i_t) = E(i_{t+1}) - E(i_t) = k\ [\ i_t - E(i_t)\ ] + e_t. \quad (7)$$

This indicates that the change in expected inflation ($\Delta E(i_t)$) is a function of the unexpected inflation (i_t - $E(i_t)$). Therefore, Equation (5) from footnote 14 could be written as a function of the unexpected inflation.

when the single-period CAPM is used to adjust only market risk for the security returns.

In summary, researchers generally agree that a negative relationship exists between stock returns and unexpected inflation. They also agree that individual firms respond differently to this negative relationship according to their nominal contracting positions and other firm characteristics. Furthermore, from the specifications of Bernard (1986) and Pearce and Roley (1988), it is shown that systematic market risk is not the only factor priced in their regressions. The combined effects of unexpected inflation and firm characteristics also explain a large portion of variance in stock returns.

The review in the next section will show that the existence of a negative correlation between unexpected inflation and stock returns may cause the traditional CAPM to understate the relevant risk (namely, inflation risk) of common stocks.[16]

Previous research on the firm size anomaly that used only the traditional CAPM to adjust market risk for stock returns also might have understated the relevant risk of securities. Small firms may have a tendency toward certain nominal

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[16] Chen and Boness (1975) stated that the CAPM overstates the firm's relevant risk if its return is positively correlated with inflation rates. The CAPM understates the firm's relevant risk if its return is negatively correlated with the inflation rate.

contracting positions that cause them to respond systematically in a stronger manner to unexpected inflation than do large firms. The firm size research using the traditional CAPM setting incorrectly adjusts the risk of the securities and may explain the excess returns found in the previous research.

The primary observation of this research is that small firms tend to have higher long-term debt ratios (Figure 1) and higher betas (Figure 2) than do large firms.[17] Coupled with the results found by Bernard (1986), Chang and Pinegar (1987), and Pearce and Roley (1988), this study suggests that small firms tend to have higher inflation betas (Figure 3) than do large firms.[18] Therefore, small firms' abnormal returns in the traditional CAPM may be the compensation for bearing higher inflation betas and/or may reflect the favorable nominal contracting positions during inflation years.

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[17] The long-term debt ratio is defined as the sum of the preferred stock and long-term debt, divided by the market value of the firm's common stock. The market risk beta is obtained by regressing stock returns on market returns. (See footnotes 1 and 2 and Chapter Three.) The detailed statistics of firm characteristics for the size-ranked portfolios can be observed in Table 5.

[18] The inflation betas are obtained by regressing individual stock returns on unexpected inflation and averaging by size-ranked portfolios. The process is described in footnote 5 and in chapters Three and Six. The inflation betas for different sizes of firms can be observed in Table 5.

C. REVIEW OF THE INFLATION-ADJUSTED CAPM

From the extended version of the market model proposed by Pearce and Roley (1988), it is seen that stock returns respond consistently and significantly to unexpected inflation. The interest of the present research is to determine whether the small firm anomaly is caused by monetary-related economic forces not accounted for in the traditional CAPM. An obvious approach is to use an asset pricing model that incorporates risk premiums for both market and inflationary risk for security returns. If the substantial excess returns found in small firm securities are actually caused by higher inflation risk borne by these firms, then the adoption of the inflation-adjusted CAPM should eliminate at least part of the excess returns measured by the traditional CAPM for portfolios.

Chen and Boness (1975) argued that traditional CAPMs were derived without an explicit consideration of uncertain inflation. Thus, they investigated how uncertain inflation might affect a firm's investment and financing decisions. They derived an equilibrium capital asset pricing model as follows:

$$E(R_j) = R_f + R^* \, b^*_j, \tag{8}$$

and $b^*_j = S \ Cov(R_j, R_m) - W \ Cov(R_j, R_a)$

where b^{*}_{j} = systematic risk; it includes variability risk (market risk) and inflation risk in this model;

R^{*} = the risk premium for systematic risk;

R_j = rate of return for the stock j;

R_a = the inflation rate;

W = the aggregate investable wealth; and

S = aggregate market value of all stocks.

The equilibrium expected nominal rate of stock return equals the risk-free rate plus a risk premium. The risk premium consists of two factors. The first factor, b^{*}_{j}, is referred to as "systematic risk," which is the relevant risk measure associated with stock j. The systematic risk of each stock contains two elements: (1) the covariance between the stock's returns and the returns of the market portfolio, $Cov(R_j, R_m)$, which is called "variability risk," and (2) the covariance between the stock's rate of returns and the rate of inflation, $Cov(R_j, R_a)$, which is called "inflation risk." The second factor in the risk premium R^{*} is referred to as "the market price of risk," the risk premium of the systematic risk.

Chen and Boness (1975) also showed that the systematic risk of the traditional CAPM [S $Cov(R_j, R_m)$], where S is aggregate market value of stock, becomes [S $Cov(R_j, R_m)$ - W $Cov(R_j, R_a)$], where W is aggregate investable wealth, in an inflation-adjusted CAPM. Therefore, the traditional CAPM overstates the firm's relevant risk if its return is positively correlated with the rate of inflation, and the model understates the firm's relevant risks if its return is negatively correlated with the inflation rate.

In this research it will be shown that the relationship between stock returns and inflation is usually negative.[19] Therefore, the traditional CAPM, according to Chen and Boness (1975), would understate the relevant risk (namely, the inflation risk) for stock returns. From Figure 6, we note that covariance between inflation and stock returns is more negative for the small firm portfolio than for the large firm portfolio. Therefore, the understatement of the inflation risk is more serious for the small firm portfolio under the traditional CAPM. Thus, in Chapter Five, the available inflation-adjusted CAPMs are adopted to evaluate fairly both market and inflationary risk for security returns and to reduce the mispricing that may result from using the traditional CAPM.

Burnie (1986) proposed another version of the inflation-adjusted CAPM by incorporating the effects of the Friedman hypothesis (1977) and the Fisher hypothesis (1930) into the CAPM setting to account for the presence of unexpected

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[19] The negative relationship between inflation rates and stock returns was documented by Fama (1981), Geske and Roll (1983), and Kaul (1987). This negative relationship also may be obtained by observing the negative covariance between inflation rates and stock returns shown in Figure 6.

inflation. Friedman hypothesizes that unanticipated changes in prices cause disruption in the economy by colliding with the "normal" price level and economic agents' expectations; that is, inflation affects real output in terms of the minimum level of economic activity and the variability of economic activity. Fisher hypothesizes that the expected real return plus the expected inflation rate equals the nominal rate of return. Burnie argued that when the nominal risk-free rate is variable, the return on the risky asset may lag the return on the risk-free asset, perhaps due to an inability to adjust quickly to inflation pressures. In an imperfect market, any particular firm may not be able to respond promptly to inflationary risk.

Based on Friedman's and Fisher's hypotheses, Burnie's (1986) inflation-adjusted CAPM can be expressed as follows:

$$E(R_j) = E(R_z) + b_1 \operatorname{Cov}(R_j,R_m) + b_2 \operatorname{Cov}(R_z,R_a) + b_3 \operatorname{Var}(R_z) + b_4 \operatorname{Cov}(R_j,R_a), \quad (9)$$

where R_z = rate of return of a zero-beta portfolio, which is the proxy of the base level of the economy;

$\operatorname{Var}(R_z)$ = the variability of the general economy;

R_a = rate of the inflation;

$b_2 \operatorname{Cov}(R_z,R_a) + b_3 \operatorname{Var}(R_z)$ = the general economic inflation effect; and

$b_4 \operatorname{Cov}(R_j,R_a)$ = the firm-specific inflation effect.

Burnie indicates that the direct influence of inflation on the economy is through the covariance terms $Cov(R_z,R_a)$ and $Cov(R_j,R_a)$. The indirect economic effect is the effect of inflation on $Var(R_z)$ through changes in the base level of economic activity.

Several problems with Burnie's (1986) inflation-adjusted CAPM prevent it from being adopted in this research as a model that adjusts market and inflation risks for security returns. First, Burnie imposed Fisher's hypothesis into his model, but previous research showed there is poor or negative evidence to support Fisher's hypothesis empirically. Burnie had imposed the relation $R_j = r_j + R_a$ (where R_j is the nominal rate of return, r_j is the real rate of interest, and R_a is the inflation rate), then the $Cov(R_j,R_a)$ would always be positive, provided the real return is stable (an increase in inflation results in an increase in the nominal rate). But $Cov(R_j,R_a)$ (Figure 6) is not always positive.

Second, since the explanatory variables of $Cov(R_z,R_a)$ and $Var(R_z)$ are common for each security, it is impossible to invert the data matrices during the regression process. The cross-sectional difference of the firm effect from unanticipated inflation in Burnie's model $Cov(R_j,R_a)$ would be captured efficiently by Chen and Boness' $Cov(R_j,R_a)$.

Finally, Burnie's model was intended to test the validity of joining the Friedman and Fisher hypotheses. The purpose of this research is to incorporate inflation effects into the reduce or eliminate the firm size effect. Therefore, the Chen and Boness (1975) model will be sufficient for this purpose. That model is compatible with the inflation-extended market model adopted in Chapter Four, which includes unexpected inflation as an additional explanatory variable, and will provide consistency in different stages of testing.

The inflation-adjusted CAPMs have not been used in any previous studies of the firm size effects. The relationship between traditional CAPM-adjusted excess returns for small firms and their higher inflation risk is first identified in Chapter Four. There, the inflation-adjusted CAPMs are then adopted to adjust both market and inflation risk for security returns and to examine whether the inflation-adjusted CAPMs are able to reduce the excess returns for asset pricing and further eliminate the firm size effect found in the traditional CAPM research.

Chapter Three

The Data

THE DATA

A. SAMPLE SELECTION

Firms in the sample are chosen based on the data available on computerized databases. The same sample is used to conduct the research on both the asset pricing theory (chapters Four and Five) and the nominal contracting hypothesis (Chapter Six). Firms must be listed on either the New York or American Stock Exchanges and must have continuous monthly stock returns data during the estimation and evaluation periods on the CRSP Monthly Return Tape. Financial information required for this research must be available on the COMPUSTAT Annual Data File Tape.

These data requirements limit the sample size. The sample is small due to long estimation period for the asset pricing study and the additional data considerations for conducting the nominal contracting study. Therefore, a survivorship bias is inevitable, but no serious violation for the research results is expected. The data requirements for inclusion in the sample for the asset pricing study (that is, a long estimation period) causes no systematic bias for the nominal contracting study. The final number of sample firms for this research, 239 firms, is between the sample used by Bernard (136 firms) and Pearce and Roley (248 firms).

Similarly, meeting the data requirements for the nominal contracting study sample does not systematically bias the asset pricing study results. All sample firms have the financial data required for this research on the COMPUSTAT tape. The sample is adequate for conducting both studies. For example, the median market value of equity for the firms in the smallest firm portfolio (portfolio one of five portfolios) is about the same size as portfolio three or four (of ten portfolios) for Reinganum's (1992) study. The size of equity for the large firm portfolio (portfolio five of five portfolios) corresponds to portfolio ten in Reinganum's study (1992, p.57). Therefore, there is sufficient distinction between sizes of small and large firm portfolios in this research. (This issue is further discussed in Section F of this chapter and Appendix B to this chapter).

Although there is no obvious tendency for this small sample size to violate results for the firm size effect study, a small portfolio may not be sufficient to achieve diversification and reduce instability of the asset pricing relationship.

B. DATA REQUIREMENTS FOR THE CRSP TAPE

Every stock in the sample has to have 360 continuous monthly returns on the CRSP Monthly Return Tape: 132 monthly returns for the estimation period, and 228 monthly returns for the research period. The long estimation period is necessary to achieve the purposes of this research. For example, for the inflation-adjusted CAPMs in Chapter Five, an estimation period of (1) six years (72 monthly returns) is needed for estimating $Cov(R_i, R_m)$ and $Cov(R_i, R_a)$ before an estimation period of (2) five years (60 monthly returns) is used for estimating the coefficients (for example, $a_{1,i}$ and $b_{1,i}$ in Equation 15) in the asset pricing models.

The sample selection process for the CRSP tape is as follows: (1) There are 366 firms registered to have 360 monthly returns between 1960 and 1989 on the CRSP Monthly Return Tape. (2) The possible universe of firms with data on both the CRSP Monthly Return Tape and the COMPUSTAT Annual Data File Tape is 1,483 firms. (3) There are 325 firms that satisfying both requirements 1 and 2. (4) There are 24 out of 325 firms that have missing monthly return data during 1960 through 1989. This leaves 301 firms with 360 continuous monthly returns on the CRSP Monthly Return Tape and financial data on the COMPUSTAT Annual Data File Tape. These 301 firms still

tape

still have to meet the data requirements for the COMPUSTAT tape described in the next section.

C. DATA REQUIREMENTS FOR THE COMPUSTAT TAPE

From the 301 firms satisfying the data requirements noted in the last section, potentially 5,719 observations are available for the research period 1971 to 1989 (that is, 19 potential observations for each firm), before the screening criteria are applied. These criteria are explained below.

Nine variables from the COMPUSTAT Annual Data File Tape are used to calculate the firm characteristics for the nominal contracting study in Chapter Six. Definitions of variables retrieved from the COMPUSTAT tape and the calculation formulas for firm characteristics are given in an appendix A to this chapter.

The firm characteristics included are consistent with those found in previous studies to be relevant in determining the levels of inflation risk. These characteristics include short- and long-term monetary positions, depreciation tax shields, and equity market values. The definitions and calculation formulas are the same as used in previous research (French, Ruback, and Schwert 1983; Bernard 1986; Pearce and Roley 1988).

Short-term monetary position (SMR) is defined as the sum of cash and accounts receivable, minus current liabilities, divided by the market value of common stock in order to get a similar scale among different firm sizes. Long-term monetary position (LMR) is defined as the negative sum of long-term debt and preferred stock, divided by the market value of common stock. The depreciation tax shield (DTS) is defined as plant, equipment, and property minus two times deferred tax (presuming a 50 percent marginal tax rate), divided by the market value of common stock. The market value of the firm's common stock is obtained by multiplying the number of common stock shares outstanding by the common stock closing price at the year end, and it is used as the proxy for firm size.[20]

The screening process is as follows. (1) The aforementioned firm characteristics are calculated from the variables retrieved from the COMPUSTAT tape for each of the 301 firms, resulting in a potential observation sample of 5,719. (2) The first screen eliminates firms with a long-term monetary position less than -1. Since the definition of long-term monetary position is the negative sum of long-term liabilities and preferred stock, divided by the market value of equity, these firms with a LMR less than -1 are either financial companies, or are regarded as firms with high bankruptcy risk. Since the objective of Chapter Six is to

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[20] The reasons for using this proxy for firm size are twofold. First, since most of the previous firm size studies used this variable as a proxy for the firm size, Using it here makes the results of this research comparable to other research. Second, Brown, Kleidon, and Marsh (1983) showed a high degree of stability in market value of rankings. They also showed a strong correlation between market value of equity and alternative size measures. Therefore, the results derived from this research are not likely to be sensitive to the particular size variable used.

measure the relationship between inflation risk and firm characteristics, a financially risky firm may confound inflation risk with bankruptcy risk. A total of 1,897 observations are eliminated under this screen, leaving 3,822 observations. (3) The second screen eliminates firms with an SMR less than -1. These firms have an extremely high current debt position and are financially distressed. The logic is the same as in (2). After elimination, 3,785 observations remain. (4) The third screen eliminates firms with a DTS greater than 1. These firms have a higher depreciation tax shield than the market value of equity and possibly a very depressed stock price because of other confounding factors. Another 835 observations are eliminated, resulting in a final sample of 239 firms and 2,950 observations over a 19-year period. The sample size ranges from 101 firms in 1974 to 185 firms in 1989.

D. INFLATION MEASURES

The inflation measures used are actual, expected, and unexpected inflation. Actual inflation is collected from monthly CPI data. Expected inflation is derived in the same way as in Fama and Gibbons's (1984) naive interest rate model, which uses the difference in the monthly Treasury-bill returns and expected real risk-free rate as the expected inflation. The expected real risk-free rate is proxied by the previous 12-month average of inflation-adjusted Treasury-bill rates of return. The derived expected real risk-free rates then are substracted from monthly Treasury-bill returns to obtain the expected inflation rates.[21] The unexpected inflation rate is defined as the actual inflation rate (CPI) minus the derived expected inflation rate from the naive interest rate model.

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[21]. Fama and Gibbons (1984) showed that a naive interest rate model which estimated the expected real risk-free rate as a simple average of the twelve most recent realized real risk-free rates mimicked the estimates of a more sophisticated model (the interest rate model), in which the expected real risk-free rate follows a random walk. They showed that both interest rate models provide slightly better monthly forecasts and substantially better eight- and fourteen-month inflation forecasts of inflation than does a univariate time-series model. The interest models also showed little bias and tracked ex-post eight- and fourteen-month inflation rates better than the Livingston survey. The reasons for adopting the naive interest rate model in this research are its simplicity and its accuracy in tracking actual inflation behavior.

E. THE ESTIMATION OF MARKET RISK BETAS AND INFLATION BETAS

The estimates of the market risk betas for individual securities and portfolios each month (or year) are obtained from regressing the previous 132 monthly returns on concurrent market returns.[22] For example, the beta estimate for 1971 is obtained by regressing monthly returns from 1960 to 1970 on the (value-weighted) market returns covering the same period. Both monthly returns for the firms and the market are retrieved from the CRSP tape.

The estimation processes for inflation betas are different for the individual securities and portfolios due to different research purposes.

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[22] The process of estimating market risk betas does not adjust for the bias that may be caused by nonsynchronous trading for the following reasons. First, the sample firms employed in this research do not include over-the-counter stocks. Second, this research estimates the market risk betas by using monthly returns, the potential nonsynchronous bias would be much higher for daily returns. Third, the market risk beta estimation in chapters Four and Five is conducted at the portfolio level. The nonsynchronous trading adjustment usually applies at the individual security level.

Although the market risk beta estimation in Chapter Six is conducted at the security level, the potential nonsynchronous trading bias may favor the null hypothesis. The test conducted in Chapter Six is to examine the relationship between inflation betas and market risk betas. The potential underestimation of market risk beta for small firms caused by nonsynchronous trading would bias the result toward the null hypothesis. Since this research already finds a significant relation between inflation betas and market risk betas, an adjustment for non-synchronous trading can only enhance the results.

Inflation betas for the portfolios (τ_i in Equation 12) are derived in chapters Four and Five. Chapter Four examines the additional explanatory power of including of unexpected inflation in the asset pricing models. Also examined are the cross-sectionally different response coefficients for stock returns on unexpected inflation between small and large firm portfolios. Inflation betas for portfolios are obtained by regressing the previous 132 months of portfolio returns on both market returns and unexpected inflation. The coefficient of unexpected inflation is referred to as inflation beta.

In Chapter Five, the same regressions (Equation 12) are conducted for the purpose of measuring excess returns for portfolios and the size effects for portfolios. The estimation of market risk beta and inflation beta for the inflation-extended market model is required for measuring excess returns. The portfolio approach is adopted to reduce possible measurement errors that might damage the research results of the valuation process.

In Chapter Six, the relationship between firms' inflation risk (inflation betas) and their nominal contracting variables is observed. The relationship is examined at the individual firm level, so the portfolio approach stated above would not be suitable. When individual stock returns are regressed on both market returns and unexpected inflation, insignificant coefficients on unexpected inflation are found. Therefore, inflation risk is measured by regressing individual stock returns only on unexpected inflation per Bernard (1986). Since both estimates measure the inflation risk, they are considered interchangeable inflation betas even though they are obtained differently.

F. PORTFOLIO FORMATION

A portfolio approach is used to conduct the asset pricing study in chapters Four and Five. Five portfolios ranked by the total market value of outstanding common stocks are formed. Portfolio one contains firms with the smallest market value in the sample, while portfolio five includes those with the largest. Each portfolio has roughly the same number of firms, and the portfolios are regrouped every year based on updated market values of the firms.

The same sample of firms is used for both the asset pricing study and the nominal contracting study. The size of portfolios (ranging from 20 to 37 firms each year) tends to be much smaller than in other research, which had portfolio size usually in the hundreds. The following comparison between this sample and Reinganum's (1992) sample (see Appendix B to chapter Three) shows that the potential bias of this small sample is minimum.

Although the market values for the small and large firm portfolios in this research are significantly larger than those in Reinganum's work, a significant distinction exists among different sizes of portfolios in this research (see Table 5). No serious bias is expected for two reasons.

First, Reinganum (1992) divided all NYSE firms into ten equal portfolios ranked by the market value of firms, with each portfolio containing approximately 200 firms. Here, the five portfolios include from 20 to 37 firms each year. The median market value for the small firm portfolio is about the same as portfolios 3 and 4 in Reinganum. The large firm portfolio for this research is totally included in the portfolio 10 for Reinganum. Therefore, there is a sufficient gap between the small and large firm portfolios to permit research regarding different firm sizes. No serious bias that could be found in this portfolio formation process.

Second, the median market value of small firm portfolios in this research does not exceed $300 million. Although this value is larger than in previous research, Reinganum (1992, p.56) indicated that many institutional investors may consider a small stock to be in the range of $500 million to $1 billion. Therefore, the definition of small firm portfolio in this research is not misleading.

APPENDIX A

Following is a list of variables retrieved from the COMPUSTAT tape. The data items, identities, and explanations are provided directly from the ANNUAL DATA FILE of COMPUSTAT II. Also shown are the definitions of the firm characteristics.

1. Cash and Short-term Investment (Data Item # 1)

This item represents cash and all securities readily transferable to cash as listed in the current asset section.

2. Receivable - Total (Data Item # 2)

This item represents claims against others (after applicable reserves) collectible in cash, generally within one year of the balance sheet date.

3. Current Liabilities - Total (Data Item # 5)

This item represents liabilities due within one year, including the current portion of long-term debt. This item is the sum of:

Accounts Payable

Current Liabilities - Other

Debt in Current Liabilities

Income Tax Payable

4. Property, Plant, and Equipment - Total(Net) (Data Item # 8)

This item represents the cost, less accumulated depreciation, of tangible fixed property used in the production of revenue. The first year of data availability is 1969.

5. Long Term Debt - Total (Data Item # 9)

This item represents debt obligations due more than one year from the company's balance sheet date.

6. Price (of Common Stock) - Close (Data Item # 24)

This item represents the absolute close transaction during the year for companies on national stock exchanges. Prices are adjusted for all stock splits and stock dividends that occurred in the calendar year.

7. Common Shares Outstanding (Data Item # 25)

This item represents the net number of all common shares outstanding at year-end for the annual file, excluding treasury shares and scrip.

8. Deferred Taxes (Data Item # 74)

This item represents the accumulated tax deferrals due to timing differences between the reporting of revenues and expenses for financial statement and tax forms.

9. Preferred Stock - Carrying Value (Data Item # 130)

This item represents the par or stated value of preferred stock. If the stock has neither par nor stated value, it is represented at the cash value of the consideration received for such stock.

The definitions of the firm characteristics used in this research are similar to those in French, Ruback, and Schwert (1983), Bernard (1986) and Pearce and Roley (1988).

Market Value = 6 * 7

Short-Term Monetary Position (SMR) = [(1+2) - 3] / (6*7)

Long-Term Monetary Position (LMR) = -(5+9) / (6*7)

Depreciation Tax Shield (DTS) = (4 - two * 8) / (6*7)

APPENDIX B

Below is a comparison between size statistics of this research and Table 1 of Reinganum (1992, p.57).

Reinganum ranked all NYSE stocks into ten portfolios with an equal number of securities. Therefore, the maximum value of portfolio 1 in Reinganum is equivalent to the median value of portfolio 1 in this research. Similarly, the maximum value of portfolio 9 in Reinganum is equivalent to the median value of portfolio 5 in this research.

($ millions)

	MAX PORT.1 REINGANUM	MED PORT.1 CHEN	MAX PORT.9 REINGANUM	MED PORT.5 CHEN
1971	24.86	94.11	847.17	4618.81
1973	28.39	69.85	1014.25	5967.10
1975	8.73	81.38	598.60	5232.36
1977	18.89	114.32	997.11	5418.17
1979	24.54	186.30	973.78	5868.58
1981	31.92	197.75	1645.73	6273.11
1983	43.46	221.15	1803.21	7514.97
1985	45.88	260.69	2299.54	9550.43
1987	53.18	297.00	3577.39	12741.15
1989	48.23	252.00	4123.83	18286.32

Chapter Four

The Size Effect Revisited

THE SIZE EFFECT REVISITED

A. INTRODUCTION

The objectives of this chapter are to revisit the issue of firm size effect by using more recent data and to examine the relationship between firm size effect and characteristics related to inflation.

In the studies covering the late 1970s or early 1980s, the firm size effect (small-capitalization stocks outperform large-capitalization stocks) was significant and observable. By using more recent data (up to 1989), this research finds that the firm size effect becomes variable and even reverses (large-capitalization stocks outperform small-capitalization stocks) in the second half of the 1980s. This agrees with what was found by Brown, Kleidon, and Marsh (1983) and Reinganum (1992).

Previous explanations of the firm size effect have focused on why small firms perform better than large firms. If firm size is actually a consistent economic factor, the returns of small firms should be consistently higher than the returns of large firms. The variability in the size effect gives us an opportunity to examine whether firm size is a proxy for economic factors other than those proposed by previous researchers.

Two factors appear to influence the firm size effect. The first is the magnitude of actual inflation (a proxy for inflation variability per Friedman [1976]). The second is the firm's sensitivity to unexpected inflation, as measured by inflation betas. This chapter documents the changing behavior of the firm size effect and shows the relationship between that effect and these two factors.

B. THE TESTING PROCESS

The studies conducted in the early 1980s (such as Banz 1981; Keim 1983; Reinganum 1981a, 1981b, and 1983) covered up to the late 1970s or early 1980s. The present replicates these studies and extends them through the late 1980s. Replication assures that the reverse size effect found in the late 1980s is not due to the sample selection process.

Five portfolios ranked by the total market value of outstanding common stock are formed. Portfolio 1 contains firms with the smallest market value in the sample, while portfolio 5 includes those with the largest. Each sample has roughly the same number of firms, and the portfolios are regrouped every year based on the updated market value of the firms. The rates of return of the portfolios each month are calculated by equally weighing the return of each security in the portfolio.

The CAPM relates the risk premium of security returns to the market risk betas:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i \ (R_{m,t} - R_{f,t}) + e_{i,t} , \qquad (10)$$

where $R_{i,t}$ = weighted average monthly returns of portfolio i, at period t;

$R_{m,t}$ = monthly returns for market portfolio;

$R_{f,t}$ = monthly risk-free rate (monthly Treasury-bill returns);

$e_{i,t}$ = error terms, and

α_i and β_i are regression coefficients.

Based on the CAPM, the market risk premium $(R_{m,t} - R_{f,t})$ is the compensation for market risk, β_i. The intercept α_i should be zero if prices of the securities are in equilibrium. If the firm size effect exists, the <u>observed</u> intercept terms (excess return) α_is should be inversely related to firm size. The excess returns (observed α_i) for each portfolio are calculated as follows:

$$\alpha_i = (R_{i,t} - R_{f,t}) - \beta_i \ (R_{m,t} - R_{f,t}). \tag{11}$$

Market risk β_i is estimated by using the market model. The estimated β_is are obtained by regressing the previous 132 months of portfolio returns on monthly market returns. In order to get the most precise results, β_is are estimated every month.

To test the joint hypotheses of market efficiency and correct specification of the CAPM, the excess returns for each portfolio are hypothesized to be zero:

H1a: $\alpha_i = 0$, $i=1, 2, 3, 4$, and 5.

Testing for the existence of the firm size effect could be described as testing the equivalence of the intercept terms between portfolio 1 and portfolio 5. That is, to test the hypothesis:

H1b: $\alpha_1 = \alpha_5$, (or $\alpha_1 - \alpha_5 = 0$).

Results of this research are shown in Table 1 and confirm previous research findings. Brown, Kleidon, and Marsh (1983) found that large firms performed better than small firms during 1969-1973 and that small firms performed better than large firms during 1974-1979. This research also finds that large firms performed better during 1971-1973, and that small firms performed better during the years 1974-1979 (in Figure 4, the size effect is defined as $\alpha_1 - \alpha_5$). The magnitudes of the excess returns and the size effect during different sub-periods are also displayed in Table 1.

The excess returns picture for small and large firms displays a different pattern after 1979. From Figure 4, the excess returns pattern during 1980-1983 shows no consistent trend as to which portfolio was performing better. The excess returns during 1984-1989 show that large firms performed better than small firms, which agrees with Reinganum (1992). The detailed data even show that firms of medium size outperformed both small and large firms during certain periods in the late 1980s.

The reversal of the size effect during the 1980s suggests that the size of the firm is not a consistent economic factor, as some researchers have claimed. If it were consistent, small firms should consistently perform better than large firms. This reversal of the size effect suggests that firm size may be a proxy for other economic factors or firm characteristics. When the economic environment changes, the proxy relationship between the size and those economic factors or firm characteristics may also change.

This research relates the size effect and reverse size effect to (1) inflation risk levels of the economy and (2) firms' differential responses to inflation risk. A possible explanation of the size effect found in the 1970s is that small firms respond more strongly to inflation risk than do large firms, an effect reinforced by the high inflation level during the 1970s.

Friedman (1976) stated that inflation variability (inflation risk) is positively related to the levels of inflation rates. Therefore, the higher inflation rate in the 1970s may have led to higher inflation risk in the same period. From Figures 4 and 5, we can observe that occurrences and magnitudes of the firm size effect (Figure 4) roughly match with inflation rates in the same period (Figure 5). If Friedman's argument is correct, then we could conclude that a positive size effect coincides with the time that inflation risk level is high.

Another way to measure the level of inflation risk is to measure inflation variability directly. When this research measures the covariance between portfolio returns and inflation rates, which can be defined as inflation variability (inflation risk), it is found that during 1974-1981 the covariance between portfolio returns and inflation rate was more negative than in the remainder of the research period (Figure 6). Also from Figure 6, we can see that the level of the inflation risk for small firms was more negative than for large firms.

A second element proposed by this research for explaining the size effect found in the 1970s is the firm's sensitivity to inflation risk. A coincidence in the size effect and small firms' high sensitivity to inflation risk is found in the 1970s; and the disappearance of the size effect coincides with small firms' decreasing sensitivity to the inflation risk in the second half of the 1980s.

This research adopts the notions from Bernard (1986) and Pearce and Roley (1988) that small firms (possessing high debt ratios and high market risk betas) may have higher sensitivity to inflation risk. Therefore, a regression is conducted, referred to as the inflation-extended market model, to observe whether different sizes of firms respond differently to inflation risk. An unexpected inflation variable is added to the original market model:

$$E(R_{i,t}) = \alpha_i + \beta_i R_{m,t} + \tau_i UI_t, \qquad (12)$$

where $R_{i,t}$ and $R_{m,t}$ are defined as above; UI_t is defined as unexpected inflation for the period t; and α_i, β_i, and τ_i are regression coefficients.

The regression serves two purposes. First, this equation can examine whether the additional variable of unexpected inflation increases the explanatory power of the valuation model, that is, whether unexpected inflation is a nontrivial factor for the valuation process. Second, we can examine whether τ_is for small and large firms are equal. The magnitudes of the τ_is can be regarded as the sensitivity of the firm's stock returns to unexpected inflation (inflation betas).

This research regresses 132 monthly portfolio returns prior to the month on the corresponding market rate of returns to estimate β_is and τ_is for that month for each size of portfolio. The τ_i for the small firm portfolio was significantly negative, while τ_i for the large firm portfolio was insignificantly positive during 1974-1981, the time when the firm size effect was found (Figure 7). The τ_is for the small and large firm portfolios showed no systematic and effect was reversed (excess returns for the large firm portfolio outperformed excess returns for the small firm portfolio) (see Figure 4).

The findings shown in Figure 7 imply an interesting economic effect. The regression results for the inflation-extended market model (Equation 12) show that the inclusion of unexpected inflation increases explanatory power of the market model at the portfolio level for the small firm portfolio but not medium and large portfolios. That is, unexpected inflation was a nontrivial factor in the asset pricing process for the small firm portfolio during the 1970s. The CAPM only relates stock returns to the market risk and so would have underestimated the effects of inflation risk on the small firm portfolio during that period.

Furthermore, as Chang and Pinegar (1987) predicted, the small firm portfolio not only has a higher level of market risk but also higher sensitivity to unexpected inflation (in negative terms). If we only use the CAPM to adjust the risk for securities, we indiscriminately ignore the inflation risk for all portfolios. For firms with higher market risk, such as small firms, the inflation risk is underestimated more seriously than for firms with lower market risk, like large firms. That is, the CAPM would misprice securities with higher market risk ßs more seriously than it would misprice securities with lower market risk ßs during an inflation period.

The combined findings shown in Figures 4, 5, 6, and 7 offer a possible explanation of the previously found firm size effect. The excess returns for small firms during the 1970s and early 1980s may have resulted from the interaction of two factors: (1) small firms' greater sensitivity to inflation risks and (2) the high levels of inflation risk (represented by the levels of inflation rates) of the 1970s and early 1980s. The reversal of the firm size effect during the second half of the 1980s may have resulted from the low inflation risk level in the economy and the trivial magnitude of inflation betas for both small and large firms.

Finally, this research tries to relate the excess returns measured from the CAPM to the inflation risk (inflation betas) measured from Equation 12 to see whether the excess returns measured from the CAPM (from Equation 11) are associated with levels of inflation risk. The annual excess returns of portfolios are regressed on inflation betas for portfolios (τ_is obtained from Equation 12), and a significant relationship is revealed between excess returns and the levels of inflation risk.[23] That is, the higher the inflation risk

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[23] The regression is conducted by regressing excess returns measured from the traditional CAPM on the inflation betas obtained from Equation 12. The observed t-statistic for the coefficient is -2.67, probability of t-statistic less than observed t-statistic is 0.008, and the R^2 is 0.01.

for the portfolio, the higher is the excess return. These results indicate the excess returns from the CAPM may be related to inflation risk factor in portfolio return which is not identified by the traditional CAPM.

These possible explanations lead to the research interests of Chapter Five: Does inclusion of the inflation risk factors in the CAPM (1) help the pricing of securities and (2) eliminate or reduce the magnitudes of size effect found? One inflation-extended market model and two inflation-adjusted CAPMs are adopted in Chapter Five to examine whether the inclusion of inflation risk in the asset pricing models reduces the excess returns for portfolios and further reduce the firm size effect.

Chapter Five

The Inflation-Adjusted CAPM and the Firm Size Effect

THE INFLATION-ADJUSTED CAPM AND THE FIRM SIZE EFFECT

A. INTRODUCTION

The objective of this chapter is to examine whether the size effect found in Chapter Four is due to the possible underestimation of inflation risk by the traditional CAPM. This research adopts an inflation-extended market model and two inflation-adjusted CAPMs that take both market risk and inflationary risk into account in the asset pricing process. That is, the risk premiums of security returns should compensate both market and inflation risks, not just market risk, as in the CAPM. These inflation-adjusted models are used to adjust market and inflation risk for portfolio returns to determine whether the excess returns for the portfolios and the size effect can be reduced from what they were in the traditional CAPM.

B. INFLATION-EXTENDED MARKET MODEL

The first inflation-adjusted model adopted in this research extends the market model to include unexpected inflation as an explanatory variable. This inflation-extended market model was shown earlier as Equation 12.

$$E(R_{i,t}) = \alpha_{1,i} + \beta_{1,i} R_{m,t} + \tau_i UI_t \tag{12}$$

The definitions of the equation elements and the estimation process of the β_i and τ_i for each portfolio each month are the same as described in Chapter Four.

The research process begins by measuring the excess returns for each portfolio each month by using the original market model, which takes into account only market risk for security returns.[24] Then, excess returns for each portfolio are measured each month by using the inflation-extended market model. If excess returns from the original market model are reduced by using the inflation-extended market model, we may attribute part of the excess returns from the original market model as the compensation for inflation risk.

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[24] The reason for using the market model instead of the CAPM is to compare the excess returns using the market model with those from the inflation-extended market model. This approach can ensure that the reduction of the excess returns is from the inclusion of unexpected inflation, not from the usage of a different model.

The market model can be expressed as follows:

$$E(R_{i,t}) = \alpha_{0,i} + \beta_{0,i} R_{m,t}. \tag{13}$$

The excess returns for each portfolio can be measured by the following calculation:

$$ER_{0,i,t} = R_{i,t} - a_{0,i} - b_{0,i} R_{m,t}. \tag{14}$$

The coefficients $a_{0,i}$ and $b_{0,i}$ are estimates for the $\alpha_{0,i}$ and $\beta_{0,i}$ of Equation 13 by regressing 132 monthly portfolio returns on corresponding market returns. The estimation of the $a_{0,i}$ and $b_{0,i}$ is conducted for every month in order to assure precision.

The excess returns of the portfolios using the inflation-extended market model can be shown as follows:

$$ER_{1,i,t} = R_{i,t} - a_{1,i} - b_{1,i} R_{m,t} - h_i UI_t. \tag{15}$$

The coefficients $a_{1,i}$, $b_{1,i}$, and h_i are estimates for the $\alpha_{1,i}$, $\beta_{1,i}$, and τ_i of Equation 12. The estimation also regresses the prior 132 monthly portfolio returns on the market returns and unexpected inflation rates, a process repeats for every month. The measurement of the unexpected inflation rates is described in Chapter Three.

If the inflation-extended market model can better describe the security returns than the original market model, the magnitudes of the $ER_{1,i,t}$ will be lower than the magnitudes of the $ER_{0,i,t}$. The size effect ($ER_{1,1,t}$ - $ER_{1,5,t}$) derived from the inflation-adjusted market model also will be lower than the size effect ($ER_{0,1,t}$ - $ER_{0,5,t}$) derived from the original market model. That is, the effectiveness of the inflation-adjusted market model can be conducted using a t-test for the following null hypotheses:

H2a: $ER_{0,i,t} = ER_{1,i,t}$, i= 1, 2, 3, 4, and 5.

H2b: $ER_{0,1,t} - ER_{0,5,t} = ER_{1,1,t} - ER_{1,5,t}$.

Results for the entire research period show that the inflation-extended market model reduces (in absolute value) monthly excess returns for the small firm portfolio from -0.090 percent to -0.087 percent; the reduction (in absolute value) for the large firm portfolio is from -0.031 percent per month to -0.028 percent (the top panel of Table 2). The size effects (defined as excess return for portfolio 1 minus excess return for portfolio 5, that is, α_1-α_5) are almost the same by using the market and inflation-extended market models. The magnitudes and patterns of excess returns for small and large firm portfolios and the size effect of each subperiod using the market model and the inflation-extended market model also can be observed in Figure 8 and Table 2.

Results show that the inflation-extended market model more consistently reduces excess returns for the small firm portfolio than for the large firm portfolio (this is observed from excess returns for small and large firm portfolios within various subperiods in Table 2), but only at a marginal magnitude. This agrees with the finding in Chapter Four that only the small firm portfolio has a significant inflation beta, while inflation betas for medium and large size portfolios are insignificant.

There are three possible explanations for the inability of the inflation-extended market model to reduce a large quantity of the previously identified firm size effect. First, the inflation-extended market model adopted here is more of an information (signalling) equation, which is better used in observing changes in the dependent variable caused by changes in the independent variables, than a valuation model. The valuation models depend heavily on a stable relationship between rates of returns and risk premiums. The coefficients of the unexpected inflation τ_i are significant for the small firm portfolio but not for the large firm portfolio. Therefore, there is little improvement using this inflation-adjusted market model to reduce a large quantity of excess returns and the size effect.

Another explanation is that the asset pricing effectiveness of the inflation-extended market model is subject to the accurate measurement of unexpected inflation. An improved measure of unexpected inflation may help reduce the magnitudes of the size effect found.

A third possible explanation is that small firms were actually performing better than large firms during the inflation period of the 1970s. According to the literature on the nominal contracting hypothesis, certain firm characteristics may help small firms perform better than large firms during an inflation period. For example, small firms had substantially higher long-term debt ratios than large firms throughout the research period, and the nominal contracting hypothesis would predict that small firms should have superior performance compared to large firms. This explanation will be further discussed in Chapter Six.

C. THE CHEN AND BONESS INFLATION-ADJUSTED CAPM

The second inflation-adjusted asset pricing model adopted by this research is the inflation-adjusted CAPM of Chen and Boness. Its rationale is described in the literature review. To test this model, a research process similar to that described in the last section is used. First, the traditional CAPM is used to adjust only market risk for the portfolio returns and measure the excess returns for each portfolio. Then the Chen and Boness inflation-adjusted CAPM is used to adjust both market and inflation risks for portfolio returns and measure the excess returns for the portfolios.

If the excess returns measured from the traditional CAPM can be reduced by using the inflation-adjusted CAPM, we may conclude that part of the excess return from the traditional CAPM is the compensation of inflation risk.

The traditional CAPM can be rewritten as:

$$E(R_{i,t}) - R_{f,t} = c_{1,i} \operatorname{Cov}(R_i, R_m). \tag{16}$$

The excess returns of each portfolio are calculated as follows:

$$ER_{2,i,t} = R_{i,t} - R_{f,t} - d_{1,i} \operatorname{Cov}(R_i, R_m). \tag{17}$$

The definitions and explanations for elements of the pricing model are described in the literature review. The coefficient $d_{1,i}$ is the estimate of the parameter $c_{1,i}$, obtained by regressing the prior 60 months of market risk premium ($R_{i,t} - R_{f,t}$) on the corresponding covariance terms. The covariance $Cov(R_i, R_m)$ is estimated from the prior 72 monthly portfolio returns and market returns. The estimation process of $d_{1,i}$ and $Cov(R_i,R_m)$ is repeated every month to assure precision.

Similarly, the Chen and Boness inflation-adjusted CAPM can be expressed as follows:

$$E(R_{i,t}) - R_{f,t} = f_{1,i}\ Cov(R_i,\ R_m) + f_{2,i}\ Cov(R_i,\ R_a). \quad (18)$$

The excess returns for the portfolios are derived as follows:

$$ER_{3,i,t} = R_{i,t} - R_{f,t} - g_{1,i}Cov(R_i,R_m) - g_{2,i}Cov(R_i,R_a). \quad (19)$$

The coefficients $g_{1,i}$ and $g_{2,i}$ are the estimates for the parameters $f_{1,i}$ and $f_{2,i}$. The estimation processes for the estimates and the covariance are the same as noted above. The tests are conducted to see whether the excess returns measured from the traditional CAPM can be reduced by using the inflation-adjusted CAPM. The effectiveness of the Chen and Boness inflation-adjusted CAPM can be determined by testing the following null hypotheses:

H3a: $ER_{2,i,t} = ER_{3,i,t}$, where i=1, 2, 3, 4, and 5.

H3b: $ER_{2,1,t} - ER_{2,5,t} = ER_{3,1,t} - ER_{3,5,t}$.

Results for the entire research period (Table 3) show that the excess return for the small firm portfolio from the traditional CAPM, -0.387 percent per month, is reduced (in absolute value) to -0.300 percent by using the inflation-adjusted CAPM. The excess return for the large firm portfolio is reduced (in absolute value) from -0.304 percent per month from the traditional CAPM, to +0.089 percent per month by using the inflation-adjusted CAPM (the top panel of Table 3). But the firm size effect increases (in absolute value) from -0.083 percent in the traditional CAPM, to -0.389 percent per month in the inflation-adjusted CAPM. That increase is due to the larger decrease of excess returns for the large firm portfolio than for the small firm portfolio. The magnitudes and patterns of excess returns and the size effects for the traditional and inflation-adjusted CAPMs for each subperiod can be observed in Figure 9 and Table 3. Although the inflation-adjusted CAPM reduces a larger quantity of excess returns for both small firm and large firm portfolios, a significant size effect still remains.

Several research problems are found during the testing of this model. First, the magnitudes of $Cov(R_i, R_a)$ are much smaller than those of $Cov(R_i, R_m)$. Therefore, the coefficients of Cov(R_i, R_s) are large and unstable from period to period. Second, this research finds significantly negative intercept terms for Equations 16 and 18 when conducting the estimation process. The intercept terms are taken into account when excess returns are calculated, but they should be zero based on Chen and Boness (1975).

D. THE EXTENSION OF THE CHEN AND BONESS MODEL

In the previous section, it is noted that the intercept terms for the traditional and inflation-adjusted CAPMs are significantly negative. In this section, the assumption that the intercept term is zero is relaxed, the Chen and Boness (1975) model is modified to an inflation-adjusted CAPM with an intercept. This new model is referred to as the Chen and Boness extension model. The traditional CAPM can be expressed as follows:

$$E(R_i) = l_{0,i} + l_{1,i} \, Cov(R_i, R_m). \tag{20}$$

The Chen and Boness extension model can be expressed as follows:

$$E(R_i) = m_{0,i} + m_{1,i} \, Cov(R_i, R_m) + m_{2,i} \, Cov(R_i, R_a). \tag{21}$$

The excess returns for each portfolio using the traditional CAPM are calculated as follows:

$$ER_{4,i,t} = R_{i,t} - p_{0,i} - p_{1,i} \, Cov(R_i, R_m). \tag{22}$$

The excess returns for each portfolio using the Chen and Boness extension model can be expressed as follows:

$$ER_{5,i,t} = R_{i,t} - q_{0,i} - q_{1,i}\ \mathrm{Cov}(R_i,\ R_m) - q_{2,i}\ \mathrm{Cov}(R_i,\ R_a). \quad (23)$$

The coefficients p_i and q_i are estimates for the parameters l_i and m_i of the traditional CAPM and the Chen and Boness extension model. The following null hypotheses are tested to see whether the Chen and Boness extension model can reduce the excess returns measured from the traditional CAPM:

H4a: $ER_{4,i,t} = ER_{5,i,t}$, where i=1, 2, 3, 4, and 5.

H4b: $ER_{4,1,t} - ER_{4,5,t} = ER_{5,1,t} - ER_{5,5,t}$.

Results shown in Table 4 reveal that for the entire research period the average monthly excess return for the small firm portfolio is -0.374 percent per month using the traditional CAPM, compared to -0.304 percent using the Chen and Boness extension model. The average monthly excess returns for the large firm portfolio are -0.295 percent and -0.058 percent, respectively. The size effect increases (in absolute sense) from -0.079 percent per month in the CAPM to -0.362% in the Chen and Boness extension model (the top panel of Table 4). The excess returns are reduced greatly by incorporating inflation risk factors into the CAPM, but the size effect becomes more significant. That increase is due to the larger decrease in excess returns for the larger firm portfolio than for the small firm portfolio. The patterns and magnitudes of excess returns and the size effect can be observed in Figure 10 and Table 4.

E. SUMMARY

The inflation-adjusted pricing models used to adjust the security returns yield mixed results. The inflation-extended market model only reduces a trivial amount of excess returns for the small firm and large firm portfolios. The size effect of the inflation-extended market model, however, remains at the same level as that of the market model.

The Chen and Boness inflation-adjusted CAPM and extension model show greater effectiveness in reducing excess returns for small and large firm portfolios. The size effect is increases, however, using the inflation-adjusted CAPMs. The reduction in excess returns shows that the inflation-adjusted CAPMs can better describe the relationship between systematic risk and common stock returns. Inflation risk may be an important factor for the asset pricing model for common stocks. A summary of the pricing models adopted in this research, their excess returns, and the size effect profiles can be observed in Table 11.

There are two possible explanations for the remaining size effect. First, a better model or better research methodology is needed to evaluate the security returns and reduce the size effect.[25] Second, the remaining excess

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[25] Due to the design of this research, securities in the portfolios range from 20 to 37, which are far fewer than in other asset pricing research. This may lead to instability in

returns may be attributable to the performance of different sizes of firms during periods with various inflation levels.

According to the nominal contracting hypothesis, wealth redistribution from creditors to debtors occurs in a period of unexpected inflation. Different sizes of firms have different nominal contracting variables and should have different performance during an inflationary period. Chapter Six examines whether the remaining excess returns are due to differences in the nominal contracting variables that lead to different performance by different sizes of firms.

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the asset pricing relationship. Increasing the scale of research and enlarging the number of securities in a portfolio might improve the results.

Chapter Six

Inflation Risk, Firm Characteristics, and Firm Size

INFLATION RISK, FIRM CHARACTERISTICS, AND FIRM SIZE

A. INTRODUCTION

Both Bernard (1986) and Pearce and Roley (1988) showed that individual firms respond differently to the inverse relationship between unexpected inflation and stock returns (referred to as inflation betas). They further documented that firms' differential inflation betas result from different positions in certain firm characteristics (nominal contracting variables). The firm characteristics relevant to inflation risk (inflation beta) documented in previous research are short-term monetary positions (SMR), long-term monetary positions (LMR), depreciation tax shields (DTS), and market risk (beta).

This research seeks to determine whether small firms, due to certain firm characteristics, have higher inflation risk than large firms. If so, which firm characteristics contribute to this higher inflation risk? Is the size of the firm a proxy for the firm characteristics contributing to higher inflation betas?

Finally, results presented in Chapter Five show that excess returns are decreased by the inflation-adjusted CAPMs but not totally eliminated. One explanation is that the remaining excess returns may be due to performance resulting from portfolios' nominal contracting positions. This research relates the excess returns of portfolios measured by two inflation-adjusted CAPMs to corresponding nominal contracting positions.[26] If the relationship is significant, then the remaining excess returns may be attributable to the effects of unexpected inflation on portfolio returns, which is shown in the intercept term of the asset pricing model as well as in the systematic risk (inflation betas).

[26] The inflation-extended market model is not included in this analysis because it is not a pricing model. Its intercept term is not truly an excess return.

B. INFLATION BETAS AND FIRM CHARACTERISTICS

The objective of this section is to observe the relationship between the level of a firm's inflation risk and its firm characteristics.[27] The measurement of inflation betas needs to be conducted at the individual security level rather than the portfolio level. Unfortunately, Equation 12, which includes both market risk betas and unexpected inflation as explanatory variables, does not describe inflation risk behavior at the security level as well as it does at the portfolio level. The coefficient of the unexpected inflation in Equation 12 is insignificant at the individual security level. Therefore, following Bernard (1986), this research uses the following regression to measure the inflation risk for individual securities:

$$RR_{j,t} = k_{0,j} + k_{1,j}\, UI_t + v_{j,t}, \qquad (24)$$

where $RR_{j,t}$ = real stock returns for individual security j at time t, $k_{0,j}$ and $k_{1,j}$ are regression coefficients, and $k_{1,j}$ is referred to as the inflation beta of the security.

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[27] Previous research examined the relationship between inflation risk and nominal contracting variables. The present research includes not only those variables, but also other firm characteristics, such as firm size and the market risk beta. Therefore, the term <u>firm characteristics</u> refers to the variables examined in this chapter.

The regressions are conducted by regressing the prior 132 monthly real (inflation-adjusted) security returns on the corresponding unexpected inflation. The coefficient $k_{1,j}$ shows stock return sensitivity to unexpected inflation. Inflation beta $k_{1,j}$ is the proxy for inflation risk for individual securities.

This research also calculates several firm characteristics considered by Bernard and Pearce and Roley as relevant in determining the level of inflation betas. These are SMR, LMR, DTS, and market risk betas. The calculation formulas for and definitions of these firm characteristics are described in Chapter Three.

The first test determines whether the inflation betas (in negative terms) of firms are negatively related to firm size. The regression of the inflation betas of securities on the logarithm of firms' market value finds a significantly positive coefficient (Test 1 in Table 7). The inflation betas are primarily negative, and the positive coefficient indicates that the larger the size of the firm, the less negative is the inflation beta. Also, an analysis of variance (ANOVA) is conducted to see whether the inflation betas are related to firms sizes.[28] Results (see Test 5 in Table 6) show that

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[28] The regression analysis is used to discover the linear relationship between dependent and independent variables. Analysis of variance can discover the nonlinear relationship between dependent and independent variables.

inflation betas are significantly related to the firm size variable represented by the portfolio identity.

These results confirm the prediction in Chapter Four: Small firms have consistently higher inflation risk than large firms. This higher level of inflation risk may have caused the overstatement for small firms' stock returns in the CAPM-based research, thus producing the firm size effect.

The second test examines whether the inflation betas of the individual securities are positively related to their market risk betas. This is to confirm what Chang and Pinegar (1987) and this research predict: Firms with higher market risk also have higher inflation risk.[29] Firms' inflation betas are regressed on firms' market risk betas, and a significant negative coefficient is found on the market risk betas (Test 2 in Table 7). This finding agrees with Bernard's (1986) evidence and Chang and Pinegar's (1987) prediction. That is, firms with higher market risk betas have more negative inflation betas. An ANOVA is also conducted and finds similar results (Test 4 in Table 6).

These results confirm the prediction in Chapter Four: The traditional CAPM may be inadequate in describing the risk-return relationship for firms with high market risk. Since

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[29] Chang and Pinegar showed the relationship between market risk and security response to changes in expected inflation. This research further extends the statement to relate the market risk to security response to unexpected inflation (inflation beta).

small firms generally have a higher level of market risk, a portion of systematic risk (namely, inflation risk) may be consistently underestimated.

The third test examines whether the inflation risk is closely associated with the firm characteristics proposed. This test is simply a replication of Bernard (1986) and Pearce and Roley (1988). Since it is possible for the proposed firm characteristics to have multicollinearity, the inflation betas are regressed on SMR, LMR, DTS, and beta separately, and then inflation beta is regressed on all independent variables aggregately.

When inflation betas are regressed separately on individual firm characteristics, a significant relationship is found between inflation betas and both SMR (Test 3 in Table 7) and beta (as described in the last test, Test 2 in Table 7). A moderately significant relationship is found between inflation beta and LMR (Test 4 in Table 7).[30] The positive coefficient is due to negative signs for both inflation beta and LMR; therefore, higher debt ratios (in absolute terms) are associated with higher inflation risk. The regression of

[30] The sign of coefficient should be negative according to the nominal contracting hypothesis, that is, the higher the debt ratio, the better is the stock return, given an unexpected inflation. The positive coefficient found in this research agrees with French, Ruback, and Schwert (1983). This may be due to a signalling effect. Firms with high debt ratios, may see unexpected inflation as a bad signal due to the increase in bankruptcy risk. Therefore, stock returns may drop due to the signalling effect. The improper sign may also be caused by the underspecification of the model.

inflation betas on DTS shows no significant relationship (Test 5 in Table 7).

When regressing inflation betas on the SMR, LMR, DTS, and beta aggregately, significant coefficients are found for SMR and beta (test 1 in Table 8). When betas are excluded from the regression, the inflation betas have a significant relationship with SMR and LMR, but not with DTS (Test 2 in Table 8). These results imply that some collinearity exists between market risk beta and long-term monetary position.

In summary, this test confirms Bernard (1986). The market risk beta can explain the majority of the variability in the inflation betas, while other firm characteristics (such as SMR and LMR) also contribute some explanatory power. The depreciation tax shields show no significance in the general regression, perhaps because they may vary significantly from year to year, while inflation betas tend to be more stable.

C. FIRM CHARACTERISTICS AND FIRM SIZE

As indicated in the last section, this research finds that small firms have a higher level of inflation risk. The tests reported in this section examine whether firm size is a proxy for the characteristics that contribute to the level of inflation risk.

First, an ANOVA is conducted on firm characteristics and size variables (represented by portfolio identity 1, 2, 3, 4, and 5). Significant relationships (levels of significance at 0.0001) are found between the size variable and SMR, LMR, DTS, and Beta (Tests 1, 2, 3, and 4 in Table 6).

Second, the logarithm of the market value is regressed on the firm characteristics (SMR, LMR, DTS, and betas) aggregately. A significant relationship (level of significance at 0.0001) between inflation betas and firm characteristics. The coefficients of SMR, LMR, DTS, and beta are all significant (see Table 9). These results show an extremely strong relationship between firm size and the firm characteristics associated with inflation risk. Therefore, it appears that the size of the firm may be a proxy for the characteristics that contribute to the level of inflation risk and further influence the level of excess returns.

Detailed statistical data on firm characteristics (Table 5) for different size firms also show that small firms consistently have a significantly higher level of long-term monetary position, market risk beta, and depreciation tax shield and a slightly higher short-term monetary position (for the significance levels for differences among portfolios, refer to ANOVA in Table 6). These firm characteristics may lead to a higher inflation risk for small firm securities and cause excess returns for them during a period of high inflation, such as the 1970s.

D. RESIDUAL EXCESS RETURNS AND NOMINAL CONTRACTING VARIABLES

Results reported in Chapter Five show that excess returns of portfolios are reduced significantly by the Chen and Boness inflation-adjusted CAPM and the Chen and Boness extension model. Yet, the remaining excess returns of portfolios are still significant. One possible explanation is the nominal contracting hypothesis. Bernard (1986) and Pearce and Roley (1988) only related nominal contracting factors to inflation betas that indicated systematic inflation risk levels. The nominal contracting hypothesis states that there is a wealth redistribution effect from fixed monetary contracts during unexpected inflation. The effect of unexpected inflation on stock returns may go beyond the inflation risk notions proposed by Bernard (1986) and Pearce and Roley (1988) and have an unexpected real cash flow effect on the firm's stock returns. This effect may be shown as intercept terms of the asset pricing models (excess returns, ER in Chapter Five) and can be treated as the performance measure of stock returns.

This section examines whether the residual excess returns (the excess returns measured from the Chen and Boness inflation-adjusted CAPM and extension model) could be explained by the nominal contracting variables of firms that lead to differential performances for portfolios.

The annual residual excess returns from the Chen and Boness inflation-adjusted CAPM (obtained from Section C in Chapter Five) are regressed on the average nominal contracting variables (SMR, LMR, and DTS) of the portfolio for the year. The results show a significant relationship with two out of three nominal contracting variables examined (LMR and DTS), and the signs are as predicted by the nominal contracting hypothesis (Test 1 in Table 10).

Similarly, the annual excess returns from the Chen and Boness extension model (obtained from Section D in Chapter Five) are regressed on the average nominal contracting variables of the portfolios for the year. Results are similar to those reported (Test 2 in Table 10).

These results possibly explain why the inflation-adjusted CAPMs may be adequate for adjusting risk for security returns. The remaining excess returns, although significant, may be attributable to firms' performance during an inflationary period. These performance measures (excess returns) may have resulted from the firm's position on the nominal contracting variables, which interact with unexpected inflation. These results agree with the prediction of the nominal contracting hypothesis proposed by French, Ruback, and Schwert (1983). That is, firms with favorable nominal contracting positions tend to have higher excess returns than do those firms with unfavorable nominal contracting positions.

The nominal contracting variables used in this research are preliminary and not exclusive. More nominal contracting variables can be introduced in order to achieve stronger results.

Chapter Seven

Conclusions

CONCLUSIONS

This research seeks to establish an economic explanation for the firm size effect found in the traditional CAPM setting. The conjecture here is that excess CAPM-adjusted returns of small firms may be due to their higher inflation risk, which is priced in the market but not identified in the traditional CAPM.

In this research the size effect is explained by the excess returns for small firms attributable to their greater sensitivity to inflation risks and the high inflation risk of the 1970s, when the firm size effect was found. The reversal of the size effect documented here in the second half of the 1980s may be attributed to low inflation risk in the economy and an insignificant level of inflation betas for both small and large firms.

This research examines an inflation-extended market model and two versions of inflation-adjusted asset pricing models to improve the pricing of the security returns and further reduce the excess returns found in previous research. The excess returns are reduced in all three models. The inflation-adjusted CAPMs reduce a great portion of excess returns derived from the traditional CAPM, but the size effect and reverse size effect remain significant.

This research also finds that inflation betas are negatively related to firm sizes, and small firms have higher inflation risk. It is also found that the high level of inflation risk for small firms is significantly related to the firm characteristics of monetary positions and market risk. Furthermore, firm size is likely to be a proxy for the firm characteristics that contribute to the level of inflation risk.

Finally, this research examines the relationship between the residual excess returns from the inflation-adjusted CAPMs and nominal contracting variables. The significant relationship found indicates that the remaining excess returns may be treated as a performance measure attributable to nominal contracting positions. The effects of unexpected inflation may not be totally captured by systematic inflation risk measures and may have a cash flow effect on stock returns, reflected in the excess returns of the asset pricing models.

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TABLE 1: THE EXCESS RETURNS FOR SMALL AND LARGE FIRMS, AND THE SIZE EFFECT, USING THE TRADITIONAL CAPM:

	EXCESS RETURNS SMALL FIRMS	EXCESS RETURNS LARGE FIRMS	THE SIZE EFFECT
	-0.0039	0.0092	-0.0131
1971-73	-0.9265	4.1654	-2.2642
	0.3605	0.0002	0.0299
	0.0110	0.0006	0.0104
1974-81	3.4841	0.2904	2.2336
	0.0007	0.7721	0.0279
	0.0009	0.0043	-0.0034
1982-86	0.2590	2.5386	-0.8162
	0.7966	0.0138	0.4177
	-0.0036	0.0073	-0.0109
1987-89	-0.6419	3.7003	-1.6858
	0.5251	0.0007	0.1007

The excess return is defined as: $ER_{i,t}=(R_{i,t}-R_{f,t})-(R_{m,t}-R_{f,t})\ \beta_i$,

where $R_{i,t}$ is monthly portfolio returns, $R_{f,t}$ is monthly risk-free rate (proxied by monthly T-bill return), $R_{m,t}$ is value-weighted market rate of return, and β_i is market risk beta.

The size effect is defined as excess return for small firm portfolio minus excess return for large firm portfolio (that is $ER_{1,t}$ - $ER_{5,t}$).

The statistics shown in the table are average monthly excess returns for the portfolios or size effect, t-statistics for zero excess returns or size effect, and the probabilities that t-statistics are greater or less than observed t-statistics.

TABLE 2: THE EXCESS RETURNS FOR SMALL AND LARGE FIRMS, AND THE SIZE EFFECT: MARKET MODEL vs INFLATION-EXTENDED MARKET MODEL:

EXCESS RET SMALL(MKT)	EXCESS RET SMALL(EXT)	EXCESS RET LARGE(MKT)	EXCESS RET LARGE(EXT)	SIZE EFF (MKT MDL)	SIZE EFF (EXT MDL)
		1971-89			
-0.0009	-0.0009	-0.0003	-0.0003	-0.0006	-0.0006
-0.4510	-0.4336	-0.2854	-0.2608	-0.2186	-0.2160
0.6524	0.6650	0.7756	0.7944	0.8272	0.8292
		1971-73			
-0.0076	-0.0073	0.0035	0.0031	-0.0112	-0.0104
-1.8279	-1.7771	1.6130	1.3731	-1.9439	-1.8280
0.0761	0.0842	0.1157	0.1785	0.0600	0.0770
		1974-81			
0.0055	0.0051	-0.0049	-0.0048	0.0104	0.0099
1.7454	1.5821	-2.4913	-2.4177	2.2153	2.0698
0.0842	0.1169	0.0145	0.0175	0.0291	0.0412
		1982-86			
-0.0045	-0.0040	0.0019	0.0020	-0.0063	-0.0060
-1.2448	-1.1202	1.0829	1.1465	-1.4917	-1.4147
0.2181	0.2672	0.2832	0.2562	0.1411	0.1624
		1987-89			
-0.0054	-0.0052	0.0045	0.0045	-0.0099	-0.0097
-0.9564	-0.9136	2.2540	2.2192	-1.5279	-1.4918
0.3454	0.3672	0.0306	0.0331	0.1335	0.1447

Excess return (MKT) = $R_{i,t} - \alpha_i - \beta_i R_{m,t}$. (14)
Excess return (EXT) = $R_{i,t} - \alpha_i - \beta_i R_{m,t} - \tau_i UI_t$. (15)
Size effect (MKT) = ER (MKT) for small firms minus ER (MKT) for large firms.
Size effect (EXT) = ER (EXT) for small firms minus ER (EXT) for large firms.

$R_{i,t}$ is monthly portfolio return, $R_{m,t}$ is value-weighted monthly market return, and UI_t is expected inflation for month t. α_i, β_i, and τ_i are regression coefficients from Equations 12 and 13.

The statistics shown are average monthly excess returns and size effect, t-statistics for zero excess returns or size effect, and the probabilities that t are greater or less than observed t-statistics.

TABLE 3: THE EXCESS RETURNS FOR SMALL AND LARGE FIRMS, AND THE SIZE EFFECT, CHEN AND BONESS'S CAPM vs INFLATION-ADJUSTED CAPM:

EXCESS RET SMALL(CAPM)	EXCESS RET SMALL(INF)	EXCESS RET LARGE(INF)	EXCESS RET LARGE(INF)	SIZE EFF (CAPM)	SIZE EFF (INF)
		1971-89			
-0.0039	-0.0030	-0.0030	0.0009	-0.0008	-0.0039
-0.9759	-0.7237	-0.8784	0.2405	-0.3027	-1.3227
0.3302	0.4700	0.3807	0.8102	0.7624	0.1873
		1971-73			
-0.0231	-0.0302	-0.0112	-0.0002	-0.0119	-0.0300
-2.5129	-3.3007	-1.9133	-0.0307	-1.8904	-4.3841
0.0167	0.0022	0.0639	0.9757	0.0670	0.0001
		1974-81			
-0.0040	-0.0030	-0.0108	-0.0048	0.0068	0.0019
-0.6204	-0.4434	-1.8305	-0.7728	1.3886	0.3576
0.5365	0.6585	0.0703	0.4416	0.1682	0.7215
		1982-86			
0.0102	0.0091	0.0081	0.0054	0.0021	0.0037
1.7644	1.5333	1.4238	0.9350	0.5078	0.9124
0.0828	0.1305	0.1598	0.3536	0.6135	0.3653
		1987-89			
-0.0077	0.0039	0.0073	0.0097	-0.0150	-0.0058
-0.6491	0.2954	0.7424	0.8462	-2.4304	-0.9400
0.5205	0.7695	0.4628	0.4032	0.0203	0.3537

$ER_{i,t}$ (CAPM) = $(R_{i,t} - R_{f,t}) - d_{1,i}\, Cov(R_i, R_m)$. (17)

$ER_{i,t}$(INF) = $(R_{i,t} - R_{f,t}) - g_{1,i}\, Cov(R_i, R_m) - g_{2,i}\, Cov(R_i, R_a)$. (19)

Size effect (CAPM) = $ER_{1,t}$ (CAPM) - $ER_{5,t}$ (CAPM).

Size effect (INF) = $ER_{1,t}$ (INF) - $ER_{5,t}$ (INF).

$R_{i,t}$ is monthly portfolio return, $R_{f,t}$ is monthly risk-free rate, $Cov(R_i,R_m)$ is covariance between portfolio returns and market returns, and $Cov(R_i,R_a)$ is covariance between portfolio returns and inflation rates. Both covariance terms are estimated from 72 prior monthly observations.

The statistics shown above are: average monthly excess returns for portfolios or monthly size effect, t-statistics for excess returns or size effect equal to zero, and the probabilities that t-statistics are greater or less than observed t statistics.

TABLE 4: THE EXCESS RETURNS FOR SMALL AND LARGE FIRMS, AND THE SIZE EFFECT, CHEN AND BONESS EXTENSION MODEL:

EXCESS RET SMALL(CAPM)	EXCESS RET SMALL(INF)	EXCESS RET LARGE(CAPM)	EXCESS RET LARGE(INF)	SIZE EFF (CAPM)	SIZE EFF (INF)
		1971-89			
-0.0037	-0.0030	-0.0030	-0.0006	-0.0008	-0.0036
-0.9483	-0.7356	-0.8584	-0.1594	-0.2864	-1.2337
0.3440	0.4627	0.3916	0.8735	0.7748	0.2186
		1971-73			
-0.0228	-0.0297	-0.0109	-0.0000	-0.0119	-0.0297
-2.4857	-3.2388	-1.8591	-0.0000	-1.9075	-4.3625
0.0179	0.0026	0.0714	1.0000	0.0647	0.0001
		1974-81			
-0.0026	-0.0027	-0.0093	-0.0049	0.0067	0.0023
-0.3973	-0.4002	-1.5758	-0.7937	1.3758	0.4359
0.6920	0.6899	0.1184	0.4294	0.1721	0.6639
		1982-86			
0.0086	0.0082	0.0059	0.0044	0.0027	0.0038
1.4986	1.3985	1.0294	0.7661	0.6723	0.9426
0.1393	0.1672	0.3075	0.4467	0.5040	0.3497
		1987-89			
-0.0083	0.0038	0.0072	0.0095	-0.0155	-0.0057
-0.7044	0.2956	0.7398	0.8373	-2.5372	-0.9223
0.4859	0.7693	0.4643	0.4081	0.0158	0.3627

$ER_{i,t}$ (CAPM) $= R_{i,t} - a_{0,i} - a_{1,i}\,Cov(R_i, R_m)$. (22)
$ER_{i,t}$ (INF) $= R_{i,t} - b_{0,i} - b_{1,i}\,Cov(R_i, R_m) - b_{2,i}\,Cov(R_i, R_a)$. (23)
Size effect (CAPM) $= ER_{1,t}$ (CAPM) $- ER_{5,t}$ (CAPM).
Size effect (INF) $= ER_{1,t}$ (INF) $- ER_{5,t}$ (INF).

$Cov(R_i, R_m)$ is covariance between portfolio returns and market returns, $Cov(R_i, R_a)$ is covariance between portfolio returns and inflation rates. Both covariance terms are estimated from 72 prior monthly observations.

The statistics shown above are average monthly excess returns or size effect, t-statistics for excess returns or size effect equal zero, and the probabilities that t-statistics are greater or less than the observed t-statistics.

TABLE 5: THE FIRM CHARACTERISTICS OF PORTFOLIOS RANKED BY SIZE:

PORTF.	SMR.	LMR.	DTS.	MKT VALUE	BETA	INF. BETA
			1971-73			
1	0.041	-0.290	0.500	82.79	1.086	-4.871
2	0.028	-0.325	0.461	356.52	1.074	-4.286
3	0.003	-0.295	0.447	717.60	1.075	-3.547
4	0.012	-0.209	0.337	1560.48	1.096	-3.679
5	0.000	-0.104	0.291	8238.20	0.974	-2.239
			1974-1981			
1	0.085	-0.362	0.528	139.78	1.137	-6.634
2	0.023	-0.311	0.530	454.63	1.098	-6.153
3	-0.010	-0.302	0.473	921.24	1.138	-5.666
4	-0.018	-0.250	0.435	1836.95	1.089	-4.880
5	-0.006	-0.164	0.403	8423.65	0.969	-3.563
			1982-86			
1	0.050	-0.350	0.476	222.63	1.148	-3.257
2	0.004	-0.276	0.446	774.05	1.059	-3.329
3	-0.058	-0.251	0.415	1572.98	1.069	-3.213
4	-0.036	-0.230	0.400	2858.60	1.063	-3.076
5	-0.056	-0.174	0.400	12450.81	0.961	-2.692
			1987-89			
1	-0.024	-0.399	0.501	279.46	1.081	-0.133
2	-0.040	-0.351	0.472	1009.21	1.049	-0.517
3	-0.075	-0.326	0.463	2211.48	1.054	-0.040
4	-0.096	-0.254	0.396	4316.05	1.036	-0.208
5	-0.034	-0.188	0.291	18444.02	0.943	-0.700

SMR (short-term monetary position) = [Cash + Acct. Rec. - Cur. Liab.] / Size;
LMR (long-term monetary position) = [-(PF Stocks + LT Liab.)] / Size;
DTS (depreciation tax shield) = (Plant and Equip. - 2 Deferred Taxes) / Size;
MARKET VALUE (Size) = Stock Price * Shares Outstanding (millions of dollars);
BETA = Market Risk Beta, obtained by regressing previous 132 months' individual stock returns on market returns;
INF BETA = Inflation Beta; obtained by regressing previous real stock returns on unexpected inflation; as defined in Equation 24.

The variables used in this table are the averages of characteristics of individual firms in the portfolios. SMR, LMR, DTS, and MARKET VALUE are averages of annual numbers, while BETA and INF BETA are averages of monthly numbers.

TABLE 6: ANALYSIS OF VARIANCE (ANOVA) FOR FIRM CHARACTERISTICS AND SIZE RANKED PORTFOLIOS:

SOURCE	DF	SUM SQ	MEAN SQ	F	PR > F	R^2
		1. LMR vs SIZES				
MODEL	4	12.843	3.211	72.35	0.0001	0.090
ERROR	2945	130.703	0.004			
TOTAL	2949	143.546				
		2. SMR vs SIZES				
MODEL	4	2.902	0.726	20.98	0.0001	0.028
ERROR	2945	101.832	0.035			
TOTAL	2949	104.734				
		3. DTS vs SIZES				
MODEL	4	7.947	1.987	31.13	0.0001	0.041
ERROR	2945	187.969	0.064			
TOTAL	2949	195.916				
		4. BETA vs SIZES				
MODEL	4	8.544	2.316	31.68	0.0001	0.041
ERROR	2945	198.589	0.067			
TOTAL	2949	207.133				
		5. INFLATION BETA vs SIZES				
MODEL	4	1004.921	251.230	17.72	0.0001	0.024
ERROR	2945	41750.816	14.177			
TOTAL	2949	42755.737				

SMR (short-term monetary position) = [Cash + Acct. Rec. - Cur. Liab.] / Size;
LMR (long-term monetary position) = [-(PF Stocks + LT Liab.)] / Size;
DTS (depreciation tax shield) = (Plant and Equip. - 2 Deferred Taxes) / Size;
BETA = Market Risk Beta, obtained by regressing previous 132 months' individual stock returns on market returns;
INF BETA = Inflation Beta; obtained by regressing previous real stock returns on unexpected inflation, as defined in Equation 24.

The variables used in this table are the averages of characteristics of individual firms in the portfolios. SMR, LMR, and DTS are averages of annual numbers, while BETA and INF BETA are averages of monthly numbers.

The independent variable size is represented by the portfolio identity 1, 2, 3, 4, and 5. Portfolio 1 contains firms with the smallest size, while portfolio 5 contains firms with the largest size.

TABLE 7: RELATIONSHIP BETWEEN INFLATION BETAS AND FIRM CHARACTERISTICS

ESTIMATES	OBSERVED t	PROB. > OBS. t	ADJ. R^2	SAMPLE #
1. INF BETA = α LOG (MARKET VALUE)				
0.564	12.87	0.0001	0.05	2950
2. INF BETA = α BETA				
-4.196	-16.58	0.0001	0.09	2950
3. INF BETA = α SMR				
-1.781	-4.81	0.0001	0.01	2950
4. INF BETA = α LMR				
0.518	1.63	0.10	0.001	2950
5. INF BETA = α DTS				
0.151	0.56	0.58	0.00	2950

SMR (short-term monetary position) = [Cash + Acct. Rec. - Cur. Liab.] / Size;
LMR (long-term monetary position) =[-(PF Stocks + LT Liab.)] / Size;
DTS (depreciation tax shield) = (Plant and Equip. - 2 Deferred Taxes) / Size;
MARKET VALUE (Size) = Stock Price * Shares Outstanding (millions of dollars);
BETA = Market Risk Beta, obtained by regressing previous 132 months' individual stock returns on market returns;
INF BETA = Inflation Beta; obtained by regressing previous real stock returns on unexpected inflation; as defined in Equation 24.

The variables used in this table are the averages of characteristics of individual firms in the portfolios. SMR, LMR, DTS, and MARKET VALUE are averages of annual numbers, while BETA and INF BETA are averages of monthly numbers.

TABLE 8: RELATIONSHIP BETWEEN INFLATION BETAS AND FIRM CHARACTERISTICS (MULTIPLE REGRESSION):

1. INF BETA = Const. + α SMR + β LMR + Γ DTS + τ BETA

VAR	ESTIMATE	OBSERVED t	PROB. > OBS. t
Const.	0.959	3.096	0.002
SMR	-1.186	-3.258	0.001
LMR	0.388	0.986	0.32
DTS	-0.138	-0.404	0.68
BETA	-4.012	-16.035	0.0001

F = 72.065
PROB. > F = 0.0001
ADJ. R_2 = 0.09
SAMPLE NO. = 2950

2. INF BETA = Const. + α SMR + β LMR + Γ DTS

VAR	ESTIMATE	OBSERVED t	PROB. > OBS. t
Const.	-3.511	-24.984	0.0001
SMR	-1.762	-4.665	0.0001
LMR	0.951	2.328	0.02
DTS	0.423	1.190	0.23

F = 9.554
PROB. > F = 0.0001
ADJ. R^2 = 0.01
SAMPLE NO. = 2950

SMR (short-term monetary position) = [Cash + Acct. Rec. - Cur. Liab.] / Size;
LMR (long-term monetary position) = [-(PF Stocks + LT Liab.)] / Size;
DTS (depreciation tax shield) = (Plant and Equip. - 2 Deferred Taxes) / Size;
MARKET VALUE (Size) = Stock Price * Shares Outstanding (millions of dollars);
BETA = Market Risk Beta, obtained by regressing previous 132 months' individual stock returns on market returns;
INF BETA = Inflation Beta; obtained by regressing previous real stock returns on unexpected inflation; as defined in Equation 24.

The variables used in this table are the averages of characteristics of individual firms in the portfolios. SMR, LMR, DTS, and MARKET VALUE are averages of annual numbers, while BETA and INF BETA are averages of monthly numbers.

TABLE 9: RELATIONSHIP BETWEEN SIZES OF FIRMS AND FIRM CHARACTERISTICS

$$\text{LOG (MKT VAL)} = \text{Const.} + \alpha\ \text{SMR} + \beta\ \text{LMR} + \Gamma\ \text{DTS} + \tau\ \text{BETA}$$

VAR	ESTIMATE	OBSERVED t	PROB. > OBS. t
Const.	8.772	71.116	0.0001
SMR	-1.623	-11.263	0.0001
LMR	1.552	9.962	0.0001
DTS	-0.616	-4.544	0.0001
BETA	-1.000	-9.874	0.0001

F = 126.56

PROB. > F = 0.0001

ADJ. R^2 = 0.15

SAMPLE NO. = 2950

SMR (short-term monetary position) = [Cash + Acct. Rec. - Cur. Liab.] / Size;
LMR (long-term monetary position) = [-(PF Stocks + LT Liab.)] / Size;
DTS (depreciation tax shield) = (Plant and Equip. - 2 Deferred Taxes) / Size;
MARKET VALUE (Size) = Stock Price * Shares Outstanding (millions of dollars);
BETA = Market Risk Beta, obtained by regressing previous 132 months' individual stock returns on market returns.

The variables used in this table are the averages of characteristics of individual firms in the portfolios. SMR, LMR, DTS, and MARKET VALUE are averages of annual numbers, while BETA is the average of monthly numbers.

TABLE 10: RELATIONSHIP BETWEEN RESIDUAL EXCESS RETURNS AND NOMINAL CONTRACTING VARIABLES

1. CHEN AND BONESS' INFLATION-ADJUSTED CAPM

$ER1 = Const. + \alpha\ SMR + \beta\ LMR + \Gamma\ DTS$

VAR	ESTIMATE	OBSERVED t	PROB. > OBS. t
Const.	0.214	1.68	0.10
SMR	-0.318	-0.83	0.41
LMR	-0.741	-1.78	0.08
DTS	-0.993	-2.29	0.02

F = 2.154
PROB. > F = 0.10
ADJ. R^2 = 0.04
SAMPLE NO. = 95

2. CHEN AND BONESS EXTENSION MODEL

$ER2 = Const. + \alpha\ SMR + \beta\ LMR + \Gamma\ DTS$

VAR	ESTIMATE	OBSERVED t	PROB. > OBS. t
Const.	0.196	1.58	0.12
SMR	-0.336	-0.90	0.37
LMR	-0.724	-1.78	0.08
DTS	-0.948	-2.24	0.03

F = 2.118
PROB. > F = 0.10
ADJ. R^2 = 0.034
SAMPLE NO. = 95

Const. = Constant term for the regression;
ER1 = excess returns from Chen and Boness inflation-adjusted CAPM, in annual terms;
ER2 = excess returns from Chen and Boness extension model, in annual terms;
SMR (short-term monetary position) = [Cash + Acct. Rec. - Cur. Liab.] / Size;
LMR (long-term monetary position) = [-(PF Stocks + LT Liab.)] / Size;
DTS (depreciation tax shield) = (Plant and Equip. - 2 Deferred Taxes) / Size.

SMR, LMR, and DTS in this table are the annual averages of individual firm characteristics in the portfolios. ER1 and ER2 are annual excess returns from the inflation-adjusted CAPMs ($ER_{3,i,t}$ in Equation 19, and $ER_{5,i,t}$ in Equation 23).

TABLE 11: COMPARISON OF EXCESS RETURNS AND THE SIZE EFFECT BY USING DIFFERENT CAPMs AND INFLATION-ADJUSTED CAPMs

MODELS	AVG. MONTHLY EXCESS RETURNS SMALL	LARGE	THE SIZE EFF.
1. MARKET MODEL			
$R_{i,t} = \alpha_i + \beta_i R_{m,t} + e_{i,t}$	-0.090%	-0.031%	-0.059%
2. INFLATION-ADJUSTED MARKET MODEL			
$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \tau_i UI_t + e_{i,t}$	-0.087%	-0.028%	-0.059%
3. THE TRADITIONAL CAPM (NO INTERCEPT)			
$R_{i,t} = R_{f,t} + c_{1,i} Cov(R_i, R_m) + e_{i,t}$	-0.387%	-0.304	-0.083%
4. THE INFLATION-ADJUSTED CAPM (NO INTERCEPT)			
$R_{i,t} = R_{f,t} + f_{1,i} Cov(R_i, R_m) + f_{2,i} Cov(R_i, R_a) + e_{i,t}$	-0.300%	+0.089%	-0.389%
5. THE TRADITIONAL CAPM (WITH INTERCEPT)			
$R_{i,t} = l_{0,i} + l_{1,i} Cov(R_i, R_m) + e_{i,t}$	-0.374%	-0.295%	-0.079%
6. THE CHEN AND BONESS EXTENSION MODEL (WITH INTERCEPT)			
$R_{i,t} = m_{0,i} + m_{1,i} Cov(R_i, R_m) + m_{2,i} Cov(R_i, R_m) + e_{i,t}$	-0.304%	-0.058%	-0.362%

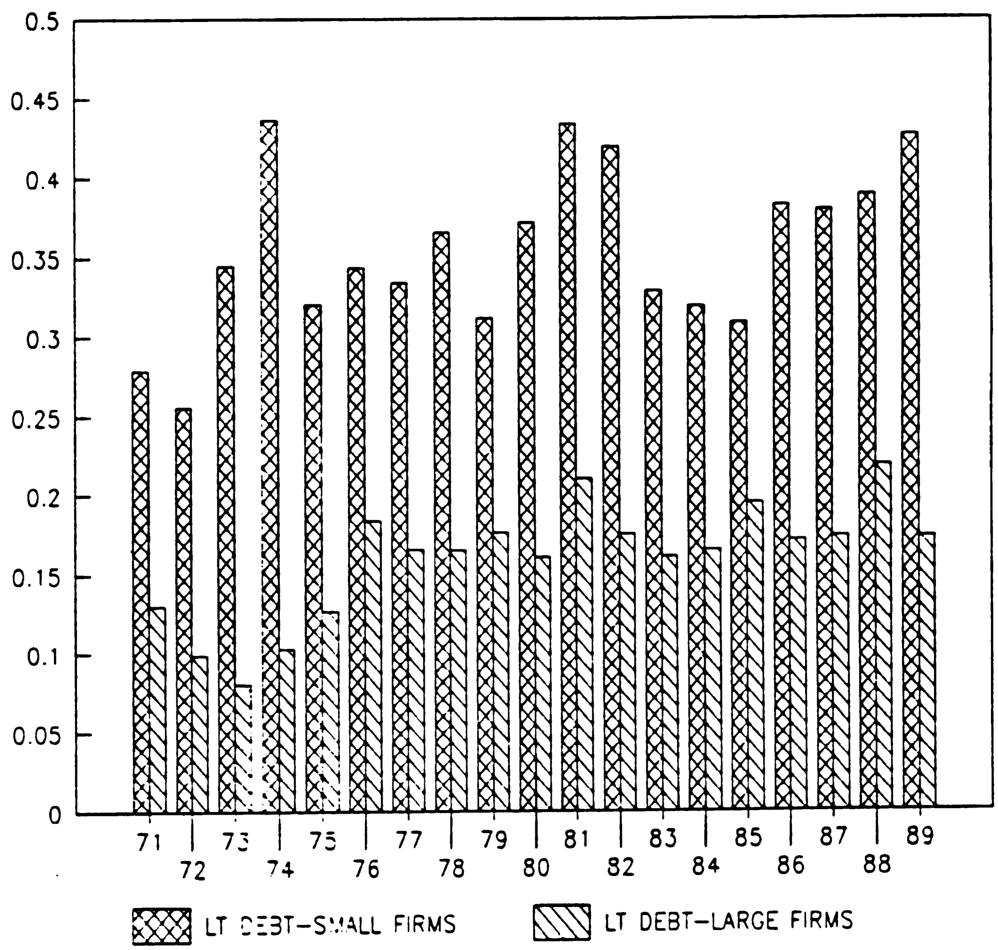
Where $R_{i,t}$ is monthly portfolio returns, $R_{f,t}$ is monthly risk-free rate (proxied by monthly T-bill return), $R_{m,t}$ is value-weighted market rate of return, and β_i is market risk beta. R_a is monthly inflation rate, proxied by monthly CPI.

$Cov(R_i,R_m)$ is covariance between portfolio returns and market returns, and $Cov(R_i,R_a)$ is covariance between portfolio returns and inflation rates. Both covariance terms are estimated from 72 prior monthly observations.

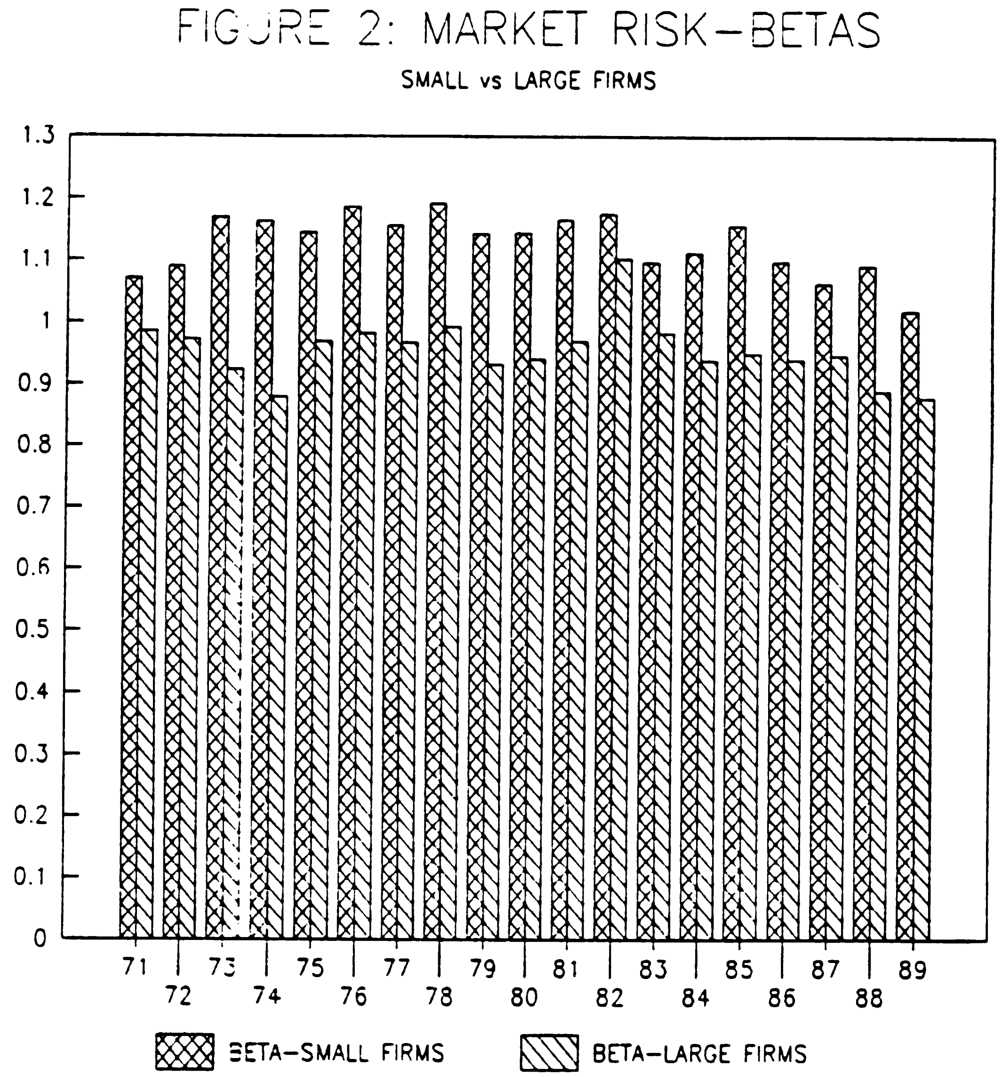
The excess returns and the size effect for each model are described in Tables 2, 3, and 4. The t-statistics and significance levels are also in the aforementioned tables.

FIGURE 1: LONG-TERM DEBT RATIOS

SMALL VS LARGE FIRMS



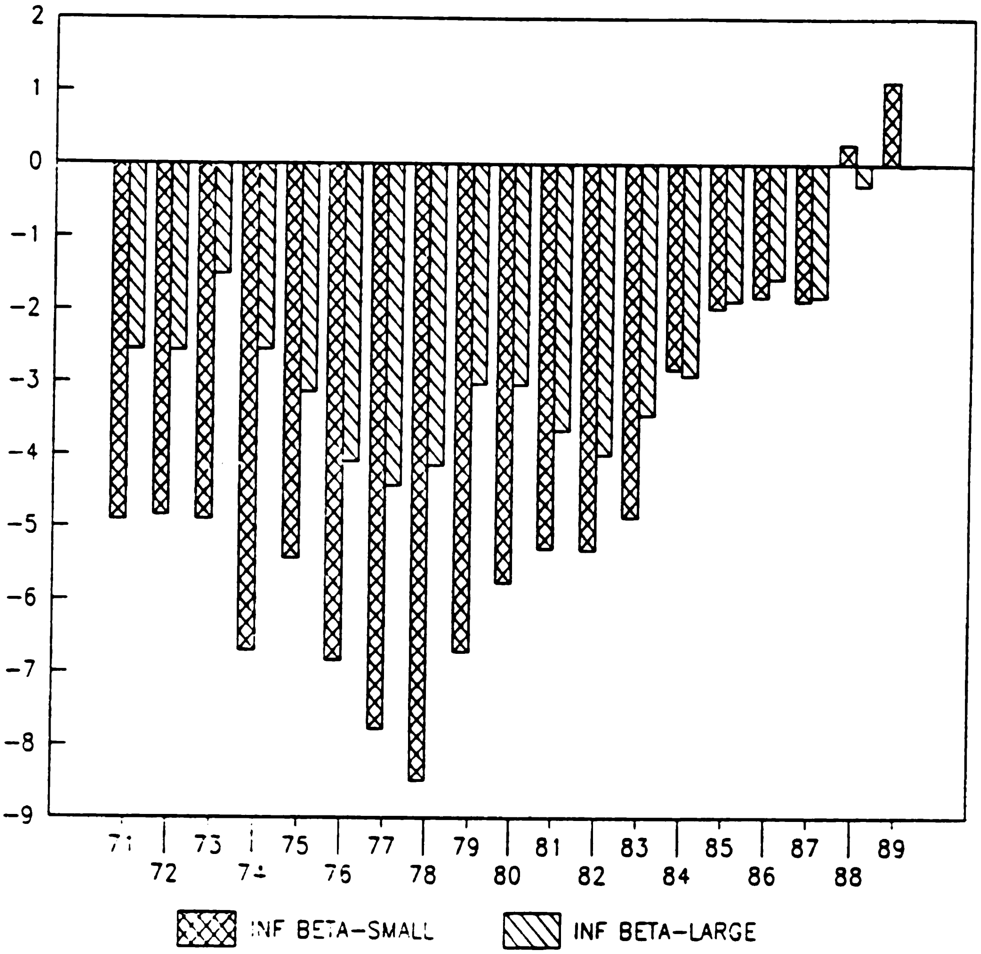
Note: Long-term debt ratio is defined as the sum of preferred stock and long-term liabilities, divided by the market value of common stocks. The measurements shown in this figure are obtained by averaging individual long-term debt ratio in the size-ranked portfolios. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.



Note: Market risk betas are obtained by regressing monthly returns of individual stocks on the value-weighted market returns. The estimation period is 132 months prior to the year. The market risk betas for securities are then averaged in each portfolio to obtain average market risk for the size-ranked portfolio, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.

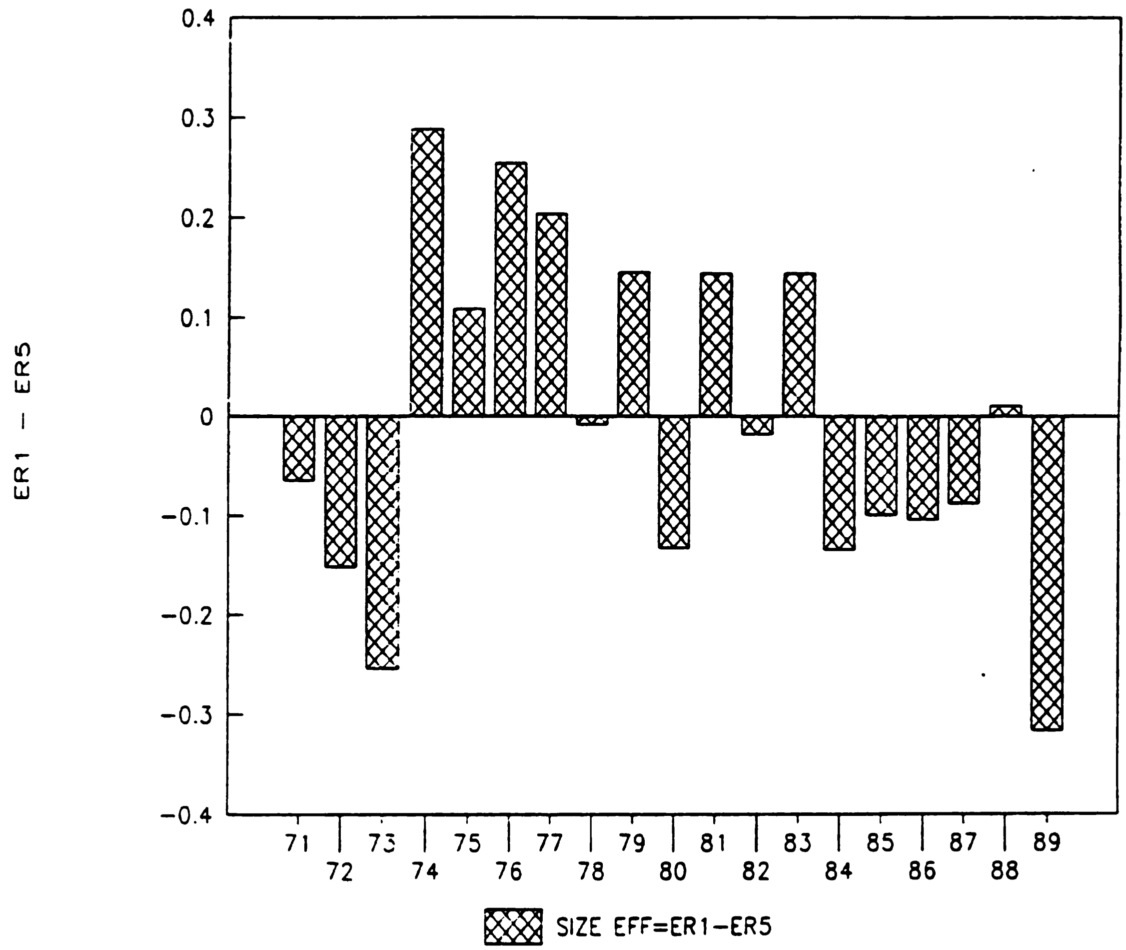
FIGURE 3: INFLATION BETAS

SMALL vs LARGE FIRMS



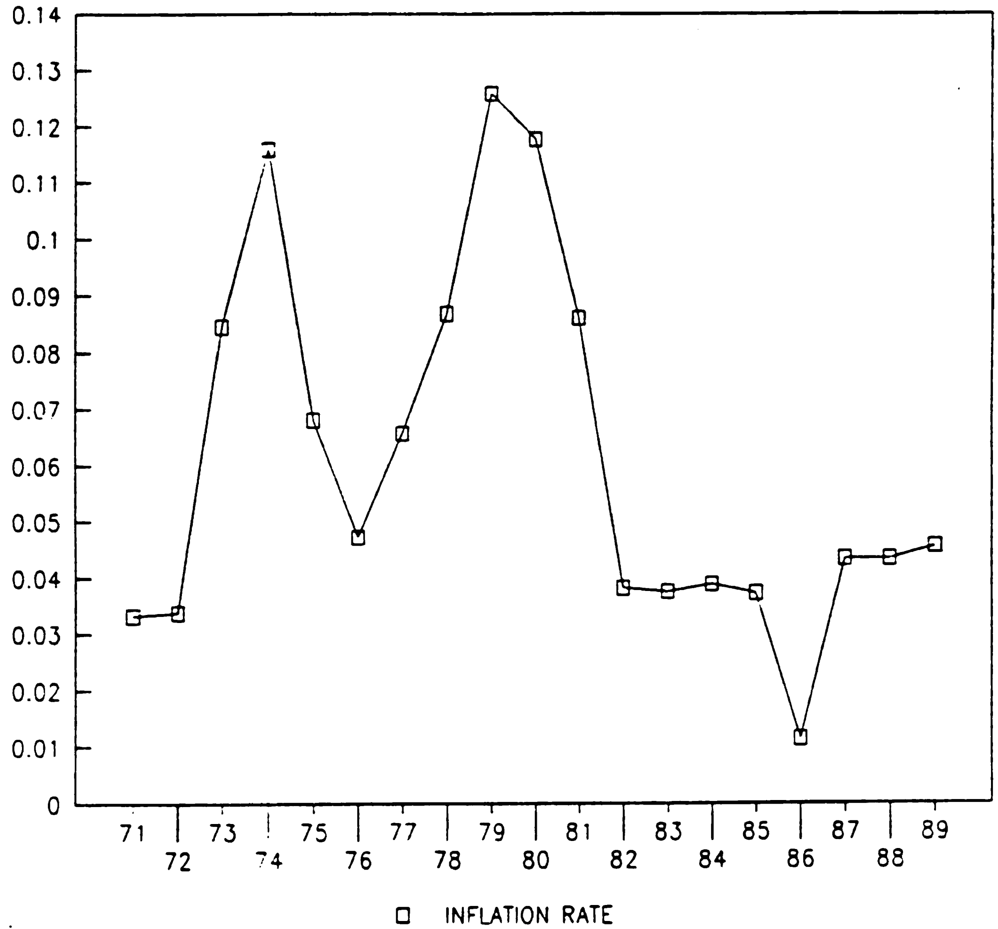
Note: Inflation beta (τ_i) is obtained by regressing real stock returns on unexpected inflation (Bernard 1986). It is also shown as Equation 24 ($R_{i,t} = \alpha_i + \tau_i UI_t + e_{i,t}$) in Chapter Six. The estimation period is 132 months prior to the year. The inflation betas for securities are then averaged in each portfolio to obtain average inflation betas for the size-ranked portfolio, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.

FIGURE 4: SIZE EFFECT - CAPM



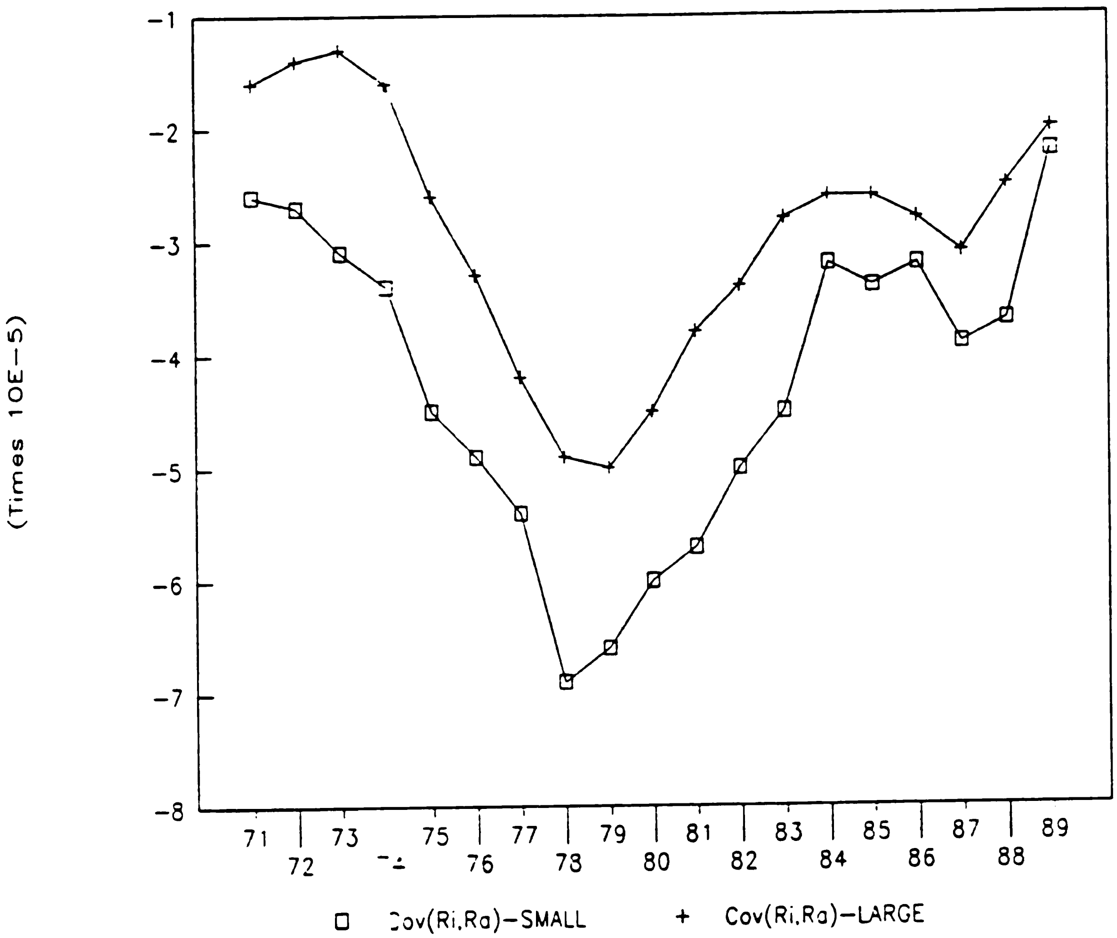
Note: The size effect is defined as the monthly excess return for the small firm portfolio (ER1, or α_1) minus the monthly excess return for the large firm portfolio (ER5 or α_5). The monthly excess returns are obtained by Equation 11 [$\alpha_i = (R_{i,t} - R_{f,t}) - \beta_i\ (R_{m,t} - R_{f,t})$] of Chapter Four. The monthly size effects (ER1-ER5, or $\alpha_1 - \alpha_5$) are aggregated to be annual size effect, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.

FIGURE 5: INFLATION RATE, 1971-89



Note: The annual inflation rate is obtained from the annual Consumer Price Index (CPI).

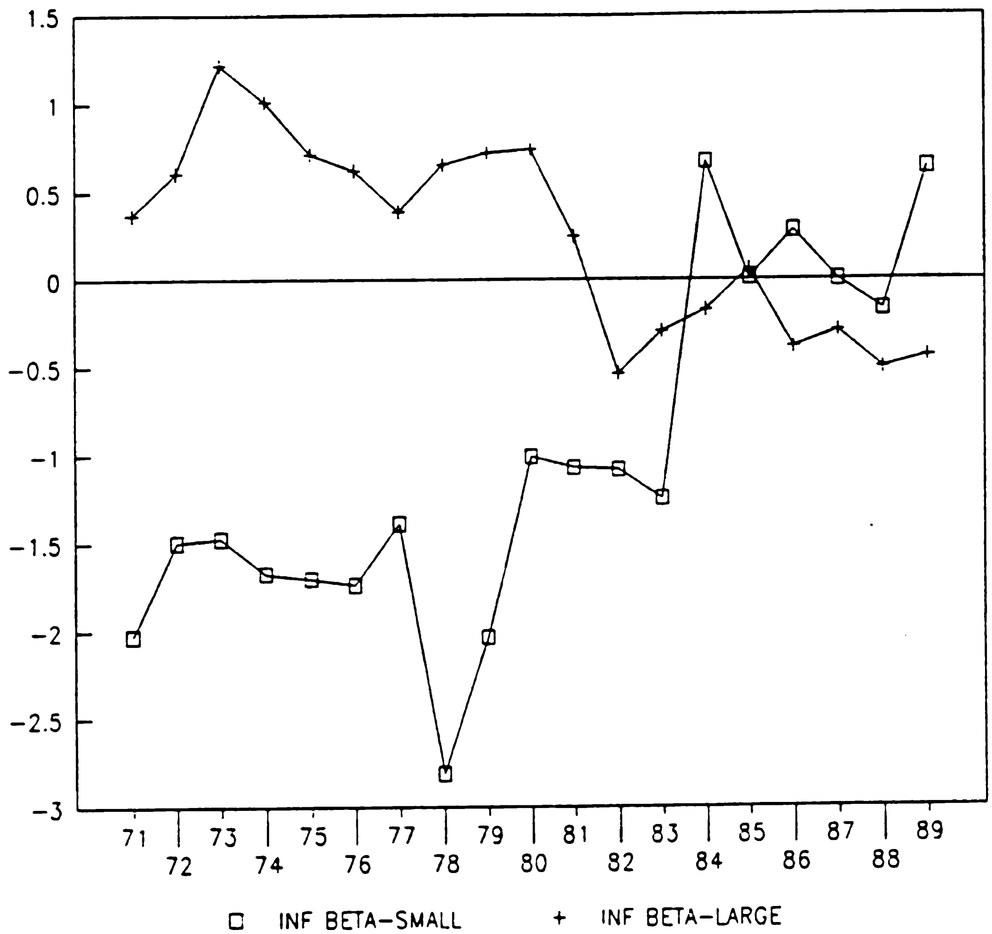
FIGURE 6: INFLATION VARIABILITY, 1971-89



Note: The inflation variability [Cov(R_i,R_a)] is defined as the covariance between stock returns and inflation rates (CPI). The covariance terms are estimated from 72 prior monthly observations of portfolio returns and inflation rates. The monthly covariance terms are then averaged for each size-ranked portfolio each year, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.

FIGURE 7: INFLATION BETAS, 1971–89

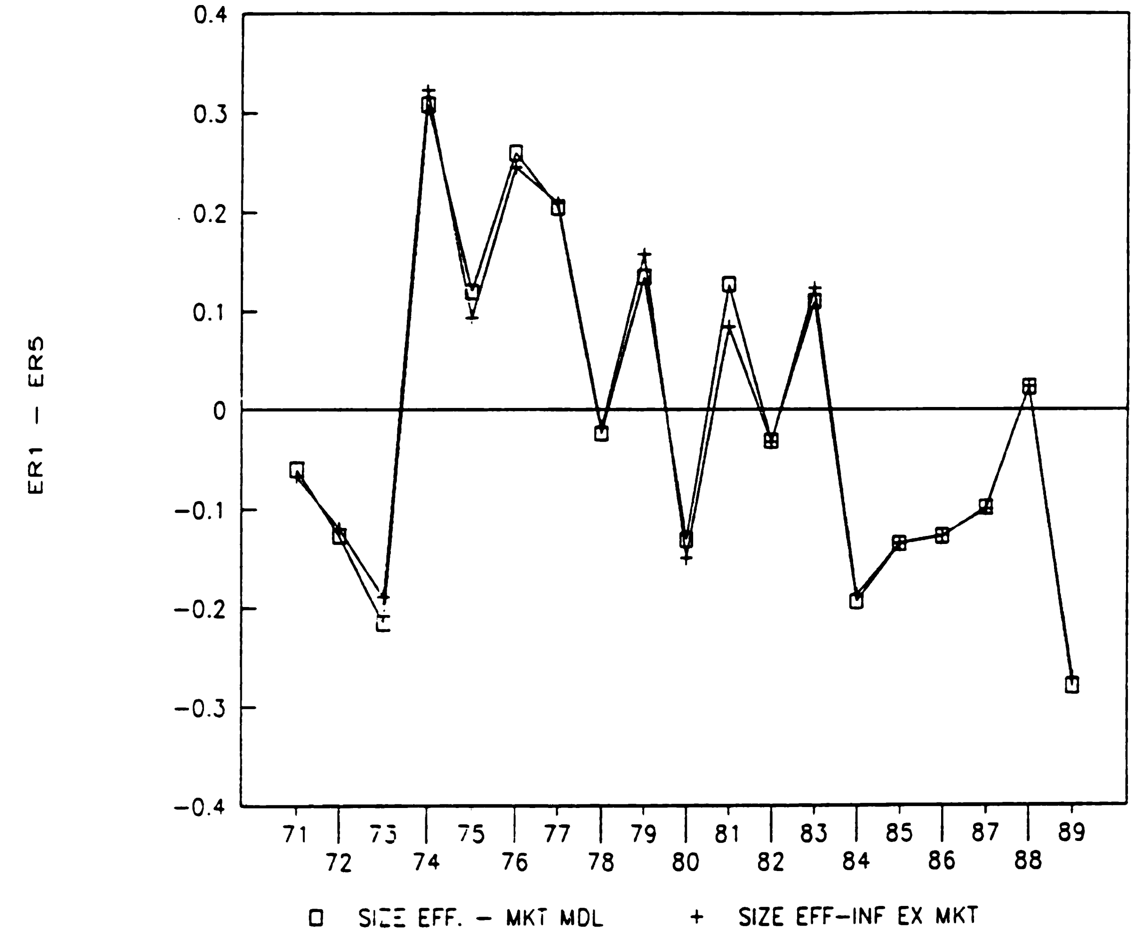
PORTFOLIO APPROACH, EQUATION 12



Note: The monthly inflation betas (τ_is) for portfolios are obtained by Equation 12 ($R_{i,t} = \alpha_i + \beta_i R_{m,t} + \tau_i UI_t + e_{i,t}$) in Chapter Four. The monthly inflation betas are then averaged to obtain annual inflation betas for each size-ranked portfolio, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.

FIGURE 8: SIZE EFFECT

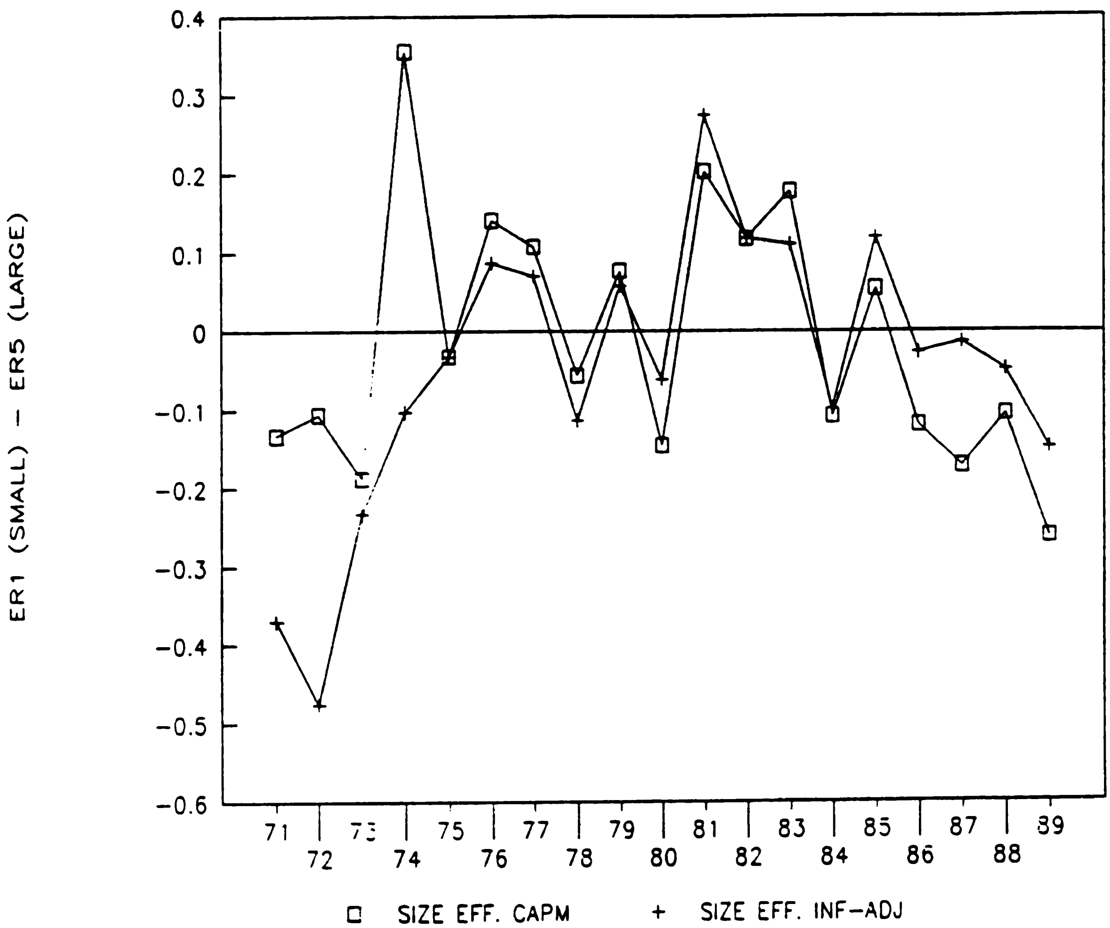
MARKET MDL vs INF EXT MARKET MDL



Note: The size effect is defined as the monthly excess return for the small firm portfolio (ER1, or α_1) minus the monthly excess return for the large firm portfolio (ER5 or α_5). The monthly excess returns for the market model are obtained by Equation 14 (ER or $\alpha_i = R_{i,t} - a_{0,i} - b_{0,i} R_{m,t}$) of Chapter Five. The monthly excess returns for the inflation-extended market model are obtained by Equation 15 (ER or $\alpha_i = R_{i,t} - a_{1,i} - b_{1,i}*R_{m,t} - h_i UI_t$) of Chapter Five. The monthly size effects (ER1-ER5, or $\alpha_1 - \alpha_5$) are aggregated to be annual size effect, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.

FIGURE 9: THE SIZE EFFECT

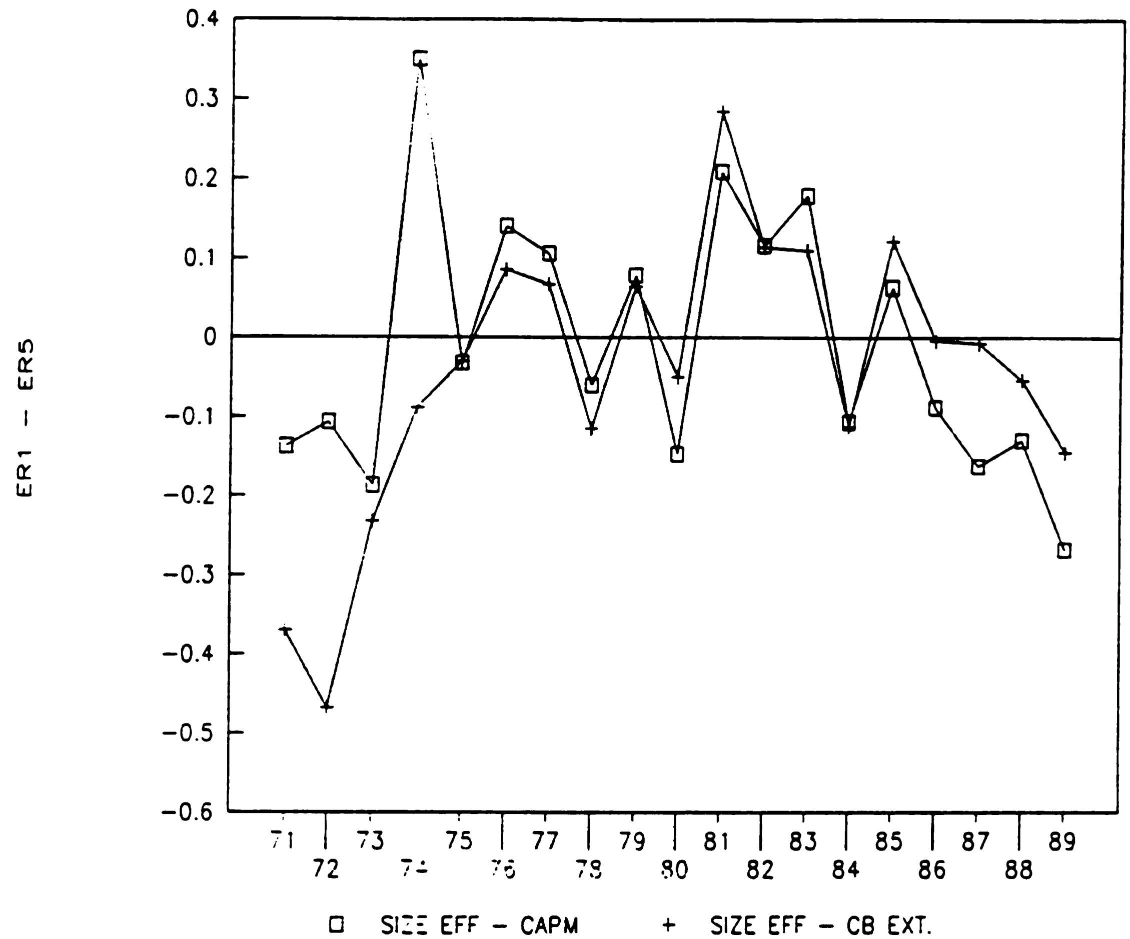
THE CAPM vs INF. ADJ. CAPM



Note: The size effect is defined as the monthly excess return for the small firm portfolio (ER1, or α_1) minus the monthly excess return for the large firm portfolio (ER5 or α_5). The monthly excess returns for the traditional CAPM are obtained by Equation 17 [ER or $\alpha_i = R_{i,t} - R_{f,t} - d_{1,i}\ Cov(R_i,R_m)$] of Chapter Five. The monthly excess returns for the inflation-adjusted CAPM are obtained by Equation 19 [ER or $\alpha_i = R_{i,t} - R_{f,t} - g_{1,i}\ Cov(R_i,R_m) - g_{2,i}\ Cov(R_i,R_a)$] of Chapter Five. The monthly size effects (ER1-ER5, or $\alpha_1 - \alpha_5$) are aggregated to be annual size effect, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.

FIGURE 10: SIZE EFFECT

CAPM vs CHEN AND BONESS EXTENSION



Note: The size effect is defined as the monthly excess return for the small firm portfolio (ER1, or α_1) minus the monthly excess return for the large firm portfolio (ER5 or α_5). The monthly excess returns for the traditional CAPM are obtained by Equation 22 [ER or $\alpha_i = R_{i,t} - p_{0,i} - p_{1,i}\, Cov(R_i,R_m)$] of Chapter Five. The monthly excess returns for the Chen and Boness extension model are obtained by Equation 19 [ER or $\alpha_i = R_{i,t} - q_{0,i} - q_{1,i}\, Cov(R_i,R_m) - q_{2,i}\, Cov(R_i,R_s)$] of Chapter Five. The monthly size effects (ER1-ER5, or $\alpha_1 - \alpha_5$) are aggregated to be annual size effect, shown in this figure. The small firm portfolio contains the smallest 20 percent of sample firms in this research, while the large firm portfolio contains the largest 20 percent of sample firms in this research.