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Monetary Policy and the Stock Market: Theory and Empirical Evidence

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1. Introduction

This paper surveys the literature on the interaction between real stock returns, inflation, and money growth, with a special emphasis on how monetary policy affects stock prices. This is an area that has interested monetary and financial economists for a long time. Strangely enough this paper seems to present the first comprehensive review of the literature to date. While a broad literature survey was intended some bounds had to be set. Hence, this survey does not deal with the literature on asset prices as leading indicators of economic activity, nor with the optimal response of monetary policy to unexpected changes in asset prices.[1] The focus is on the role of monetary policy rather than on the issue of market efficiency, which would have been an alternative way of looking at the literature.

The gathering of material for this survey on monetary policy and the stock market was made somewhat difficult because of the lack of relevant references encountered in the literature. To some extent this could perhaps be explained by the fact that this area lies between the fields of monetary economics and financial economics. The researchers in one of these fields are not always aware of papers being written in the other field (or even articles published in the other fields' journals). While this is perhaps less true today than a decade or more ago there still seems to be a need for a comprehensive survey paper that bridges the gap in this area.

A division has been made into empirical and theoretical studies. This is of course not a water-tight division. Some of the 'theoretical studies' test some implications of the derived models, while there is some theoretical reasoning in the 'empirical papers'. Nevertheless, the analyses of the 'empirical papers' have in most cases been conducted in a more ad hoc framework without considering an explicit model of the underlying economy.

The plan of the paper is the following. In the next section we review the empirical evidence of the relation between money and stock returns. The section is divided into subsections dealing with the potential role of money in predicting stock returns (Section 2.1), the question of whether or not stocks are a good hedge against inflation (Section 2.2), the impact of monetary policy announcements on stock returns (Section 2.3), and a summary (Section 2.4). The theoretical models are treated in section 3, with subsections on the different approaches represented by money-in-the-utility-function models (Section 3.1), cash-in-advance models (Section 3.2), transactions-cost models (Section 3.3), and structural macroeco-

[1] See Smets (1997) for a recent discussion of these issues.

nomic models (Section 3.4). A summary is given in Section 3.5, while Section 4 concludes.

2. Empirical Studies of Money, Inflation, and Stock Returns

Macroeconomists have tended to focus on the question whether money (or monetary policy) has any effect on real stock prices. Financial economists, on the other hand, have have been more interested in the question of whether equity is a good hedge against inflation. This division has been maintained in this section. The studies in Subsection 2.1 deal with money and stock returns while those in Subsection 2.2 analyze the relationship between inflation and stock returns. The impact on stock prices from monetary policy announcements is discussed in Subsection 2.3. A summary of the empirical findings is given in Subsection 2.4.

2.1. Money and the Predictability of Stock Returns

In the early 1970's a number of papers were published that purported to show that past money supply data could be used to predict future stock returns (Sprinkel (1964), Homa and Jaffee (1971), Hamburger and Kochin (1972)). This finding seemed to contradict the recently developed theory of efficient markets (surveyed in Fama (1970)), which states that all available information should be reflected in current stock prices. However, these findings were disputed by subsequent research, which showed that there is no predictive content in past changes in money but that there could be a reverse causality (in the Granger sense) from stock returns to changes in money (Cooper (1974), Pesando (1974), Rozeff (1974), Rogalski and Vinso (1977)).

Rozeff (1974) tested the efficient markets hypothesis against what he termed the "predictive monetary portfolio model". The monetary portfolio model, developed by Brunner (1961), Friedman (1961), and Friedman and Schwartz (1963) among others, views money as an asset among other assets in investors' portfolios. Monetary supply shocks will then lead investors to substitute between money and other assets in an attempt to reestablish their desired money holdings. Investors will typically respond with a lag, which would imply that money could help predict stock returns. Rozeff (1974) showed that lagged money supply data in fact do *not* predict future stock returns. He also gave a detailed review of the earlier studies and showed why their conclusions are dubious. Rozeff stressed the importance of allowing for a publication lag and ascertain precisely at what point in time the information is available. On the other hand, he found that returns are related to contemporaneous and future changes in the money supply. He pointed out, however, that these findings do not contradict the efficient markets hypothesis. Rogalski and Vinso (1977) further improved Rozeff's (1974) analysis by synchronizing the data so that the money supply data were generated at intervals that were the same as those for the stock return data and also by taking proper account of the autocorrelation in the time series. Rozeff's results proved to be robust to these technical improvements. Rogalski and Vinso concluded that "causality does not appear to go from money supply to stock prices but rather from stock prices to money supply" (p. 1029).

In the literature cited above, even though the term money supply is used, it is not clear that the money stocks used could not equally well reflect money demand. If velocity varies over time, and is related to variation in stock prices, the results in these empirical studies could be difficult to interpret. Friedman (1988) found that the real quantity of money demanded relative to income is positively related to the real (and nominal) price of equity three quarters earlier, but that the contemporaneous correlation is negative. He offers three explanations of an inverse relationship between equity prices and velocity: a wealth effect, a risk spreading effect, and a transactions effect. A rise in equity prices results in increased nominal wealth, which in turn leads to a higher wealth to income ratio. This should be reflected in a higher money to income ratio. The second explanation starts by noting that higher equity prices and higher expected excess returns on equity could reflect higher risk. This would induce investors to eschew equity in favor of lower risk assets, money among them. The third rationale given is that higher equity prices would imply a higher dollar volume of transactions, which would require increased money balances. Offsetting the three effects mentioned is a substitution effect. As the real price of equities rises these will be more attractive in a portfolio and should be substituted for money. The substitution effect is contemporaneous, since it merely involves a rebalancing of investors' portfolios, and thus explains the negative contemporaneous correlation between money and equity prices.

In the 1990's a couple of studies were done on international data. Darrat (1990) considered the effects of monetary and fiscal policy on the returns on the Toronto Stock Stock Exchange 300 Index. Monetary policy is measured by the percentage change in the monetary base while fiscal policy is measured by structural budget deficits. Other (nonpolicy) variables were also included in the analysis. He learned that monetary policy does not Granger cause stock returns. On the other hand, he found that budget deficits exert a significant negative impact on stock returns with a lag of 2-3 months. Lastrape (1996) estimated the short-run responses of interest rates and equity prices to money supply shocks in the G-7 countries and Holland. He used a vector autoregression (VAR) with output, a real equity price index, an interest rate, a measure of the price level, and a nominal stock of money. Money supply shocks were identified by imposing long-run monetary neutrality. Hence, in contrast to the earlier studies by Rozeff (1974) and Rogalski and Vinso (1977) that investigated the effect of money on equity prices, Lastrape (1996) tried to distinguish between demand and supply shocks. He found that money supply shocks have a positive and significant effect on real equity prices for all countries except France and the U.K. For the latter two countries the estimated effect was also positive but quite weak.

Some articles published in the late 1980's showed that stock returns could be predicted to a surprisingly high degree using proxies for the business cycle. For example, Fama and French (1989) regressed stock returns at increasing time horizons on the dividend yield, the default spread, and the term spread. The predictability was found to increase with the time horizon.[2] It could of course be the case that the predictive power of the interest rate spreads reflects their ability to proxy for the stance of monetary policy. As suggested by Bernanke (1990), a more restrictive monetary policy forces companies to substitute commercial paper for bank loans. This causes an increase in the default spread, which is one of the variables that has been shown to help predict stock returns. Jensen, Mercer, and Johnson (1996) set out to reexamine the findings of Fama and French (1989) in a setting that explicitly considers the potential influence of monetary policy. More specifically they were interested in thee issues. First, does the monetary sector capture rational variation in expected stock returns? Second, do the structural relations between the three business-conditions proxies and stock returns differ across monetary regimes? Third, do the structural relations among the three proxies change with monetary regime? They found that the predictable variation in stock returns depends on monetary as well as business conditions. After including a measure of monetary policy (a dummy variable for discount rate changes) an asymmetry became apparent: business conditions could predict future stock returns only in periods of monetary expansion.

Chan, Foresi, and Lang (1996) developed and tested a Money-based Capital Asset Pricing Model (M-CAPM). Inside money was used as a proxy for consumption. This was justified on the grounds that inside money (as opposed to outside

[2]Results showing increased predictability at longer horizons have recently been questioned on econometric grounds. See for example Kirby (1997).

money) can be viewed as endogenous and varies with the transactions requirements in the economy. The use of money as a proxy for consumption results in a stochastic discount factor which captures the risk associated with monetary factors in addition to those associated with real factors. The use of a broad monetary aggregate instead of consumtion data should result in a more volatile discount factor and a lower estimated coefficient of relative risk aversion compared to consumption based models. This is exactly the result Chan, Foresi, and Lang (1996) got when testing the model on U.S. monthly data for the period 1959-1988. Also, the pricing errors of the M-CAPM were found to be smaller than those of the consumption based CAPM. Hence, broad monetary aggregates seem to have an important role to play in the pricing of equity.

Thorbecke (1997) used a number of different approaches to examine the relationship between monetary policy and equity prices. The first approach uses a VAR as did Lastrape (1996). But in addition to using a stock market index, Thorbecke (1997) used ten size-ranked portfolios. He learned that monetary tightening has the strongest (negative) effect on the equity prices of small firms. This evidence is consistent with the hypothesis that an important channel of monetary policy is that it affects small firms' ability to borrow (Gertler and Gilchrist (1993)). Another approach employed by Thorbecke (1997) was to use Boschen and Mills' (1995) index of monetary policy to identify monetary shocks. This index classifies the monetary policy stance into five categories from stongly anti-inflationary to stongly pro-growth and is based on Federal Open Market Committee records and other relevant documents. Thorbecke concluded that "expansionary monetary policy, whether measured by innovations in the federal funds rate and nonborrowed reserves or by narrative indicators, exerts a large and statistically significant positive effect on monthly stock returns". The third approach is an event study, the discussion of which we postpone to section 2.3 below. The fourth approach is different from the previous three in that it considers ex ante returns rather than ex post returns. Thorbecke estimated a multifactor model as in Chen, Roll, and Ross (1986) but added a monetary policy variable to their set of macroeconomic factors. As measures of monetary policy he used the innovations in the fed funds rate (from the VAR model of the first approach mentioned above) and the Boschen and Mills' index. The results indicated that monetary policy is a common factor and that stocks must pay large positive premiums to compensate for their exposure to it (similar results were reported in an earlier paper by Thorbecke and Alami (1992)).

Patelis (1997) examined the part of stock return predictability which can be attributed to monetary policy. He employed the long-horizon regression methodology of Fama and French (1989) using two sets of explanatory variables: monetary policy indicators and 'financial variables'. The monetary variables are the federal funds rate, the spread between the federal funds rate and the ten-year Treasury bond, the (default) spread between the yield on six-month commercial paper and six-month Treasury bills, the quantity of nonborrowed reserves, and the portion of nonborrowed reserve growth orthogonal to total reserve growth. The financial variables are the dividend yield, the (term) spread between the ten-year Treasury bond and the one-month Treasury bill, and the one-month real interest rate. The variance of excess stock returns explained goes from 10% for the monthly horizon to 45% for the biannual horizon. These findings of higher predictability at longer horizons are in line with those of Fama and French (1989). Patelis finds that "There is predictive power in the financial variables that is independent of the predictive power of the monetary variables, and vice versa." (p. 11). In the second part of the paper Patelis (1997) employs the methodology, due to Campbell and Shiller (1988a, 1988b) and Campbell (1991), to decompose stock returns into innovations in dividend growth expectations, real interest rate expectations, and excess return expectations. He finds that monetary policy influences expected excess returns and expected dividend growth but has little to do with the expected real interest rate. The monetary policy variables are found to account for only 3 percent of the total unexpected stock return variance. Most of the unexpected return variance is explained by the dividend yield.

To summarize, while the earlier literature is ambiguous as to the effect of monetary policy on real stock returns, more recent studies have mostly found strong evidence of such an effect. The problem with the earlier literature is that no distinction is made between shocks to the supply and demand for money. This makes the results of those studies difficult to interpret.

2.2. Stock Returns and Inflation

The focus of the papers in this section is on the Fisher relation and on whether or not stocks are a good hedge against inflation. Fisher (1930) proposed that the expected nominal return on an asset should equal the expected real return plus expected inflation. Intuitively, stocks, representing claims to real output, should be a good hedge against inflation whether expected or unexpected. This reflects the "classical view" according to which the economy can be dichotomized into a mutually independent real and nominal part. These issues may not seem to be of direct relevance for monetary policy. However, when the literature turns to explanations of the empirical findings concerning these relationships monetary policy is brought into the picture.

In the inflationary environment of the 1970's financial economists became interested in the question of whether or not equity is a good hedge against inflation. Some surprising results were reported regarding the relationship between stock returns and inflation. Lintner (1975), Bodie (1976), Jaffe and Mandelker (1976), Nelson (1976), Fama and Schwert (1977), Schwert (1981) all found evidence that nominal stock returns and inflation were *negatively* correlated in post-war U.S. data. Cohn and Lessard (1981), Solnik (1983), and Gultekin (1983) reported the same empirical relationship for international data.[3] This is contrary to the classical view according to which nominal stock returns should be positively related to both expected and unexpected inflation. Fama and Schwert (1977), and many after them, regressed nominal stock returns on expected and unexpected inflation (rather than on actual inflation as in the earlier studies). We can write their regression equation as

$$R_t = c + a\pi_t^e + b\left(\pi_t - \pi_t^e\right) + \varepsilon_t, \tag{2.1}$$

where R_t is the nominal return on a well-diversified stock portfolio and π_t^e is the expected and π_t the actual inflation rate in period t. Fama and Schwert (1977), and most of the subsequent studies, use the Treasury bill rate at the beginning of the period as a measure of expected inflation. This is justified by observing that the variability in the real rate was very small for the period studied, and thus almost all of the variability in the Treasury bill rate is due to revisions of inflation expectations.[4] Testing whether $a = 1$ represents a test of the Fisher relationship, which says that expected nominal asset prices and expected inflation should move one-to-one. Another test is whether stocks represent a good hedge against unexpected inflation, $b = 1$. Both the coefficients on expected and unexpected inflation were found to be negative. As mentioned above, this is not what we would expect in a perfect market. It is no wonder then that the first explanations were in terms of market imperfections.

[3] Not all of the countries in Gultekin's study showed a negative stock returns-inflation relation. Also, Firth's (1979) study of the British stock market is an exception to the rule.

[4] This approach is extensively justified in Fama (1975).

2.2.1. Market Imperfections

As reported above, the dismal performance of the stock market in the high inflation decade of the 1970's was the focus of a number of articles published in the late 1970's and early 1980's, which found a negative relationship between stock returns and expected as well as unexpected inflation. These findings stimulated a number of researchers to attempt to explain what was regarded as an anomaly. According to Modigliani and Cohn (1979) an explanation of the negative stock returns-inflation relation could be that investors suffer from money illusion. If investors erroneously use the inflated nominal interest rate to discount future dividends they will underestimate the value of equity with a resulting fall in prices. Malkiel (1979) instead suggested that the depressed stock prices during the 1970's resulted from a higher risk premium.[5]

Feldstein and Summers (1979) proposed that the tax laws in the U.S. could explain the negative relation between inflation and real stock returns. Sales revenues increase faster than the cost of goods sold when the inflation rate increases, because of inventories valued at historical cost. Thus, with higher inflation there is a tendency for firms' taxable incomes to be overstated. The value of the depreciation tax shield declines with the rate of inflation since it is fixed in nominal terms. Taxes are levied on nominal capital gains and dividends. Thus, the real after tax return will be lower the higher is the unexpected rate of inflation. The tax hypothesis received some support in the studies by Feldstein (1980a), VanderHoff and VanderHoff (1986), and Bernard (1986).[6]

Feldstein (1980b) included noncorporate real assets in the Feldstein (1980a) framework. The interaction between alternative assets was also analyzed in Hendershott (1981) and Summers (1981). According to Hendershott low returns in the stock market could in part be caused by a sharp decline in the real user cost of owner-occupied housing between 1964 and 1978. The high returns in the housing market should have forced up the required rate of return on equity, leading to lower stock prices. Summers (1981) found support for the 'alternative assets hypothesis'. He noted that while the tax treatment of housing was inflation neutral inflation had increased the effective tax rate on corporate capital between 1965 and 1980. Hence, higher inflation resulted in higher house prices and this led to lower prices on alternative assets like equity.

[5] We will consider the possibility of an inflation risk premium in Section 2.2.7. below.

[6] Dermine (1985) considers the effect on the value of bank stocks of taxes in an inflationary environment. Perry (1992) also focus exclusively on bank shares.

In an influential study, French, Ruback, and Schwert (1983) tested the 'nominal contracs hypothesis' as an explanation for the negative relation between stock returns and unexpected inflation. According to this hypothesis, suggested by Kessel (1956), companies that have a positive net level of nominal contracts should be hurt by unexpected inflation, while firms that have a negative net level of nominal contracts should gain. The greater the net exposure of a company the larger the effect should be. However, using cross-sectional accounting data French, Ruback, and Schwert (1983) could not find support for the hypothesis. Bernard (1986), on the other hand, found that the revaluation of monetary claims explained a significant portion of the differential relations between unexpected inflation and equity returns across firms. However, the stock's systematic risk[7] was found to be more important for the relationship than firm characteristics. Pearce and Roley (1988) reexamined the nominal contracts hypothesis using a larger set of nominal contracts and using unexpected announced changes in the CPI as a measure of unanticipated inflation. Contrary to Bernard (1986) they found firm characteristics (especially the debt-equity ratio and inventory level) to be more important than the firm's systematic risk in determining the effect of unanticipated inflation on real stock returns.[8]

Amihud (1996) investigates if there is a negative stock returns-unexpected inflation relation in Israel. He points out that Israeli data for the time-period he considers are particularly interesting because they rule out some explanations of the relation given in studies using U.S. data. For the period studied contracts were not stipulated in nominal terms but usually in real terms. Thus, the nominal contracts hypothesis of French, Ruback, and Schwert (1983) could not explain a negative relation in Israel. The Israeli tax system was designed to neutralize inflation effects, which Feldstein and Summers (1979) put forth as an explanation. Almost all of the public debt was denominated in real terms. Hence, there could be no unexpected decline in real wealth becuse of unexpected inflation, causing investors to rebalance their portfolios and reducing the real value of their stock investments as suggested by Stulz (1986). The money illusion hypothesis of Modigliani and Cohn (1979) is not very likely to hold in an environment where investors have become accustomed to thinking in terms of real and nominal changes through a long history of high inflation. Still, Amihud (1996) finds that unexpected inflation has a negative and significant effect on real equity prices.

[7] The sensitivity of an individual stock's returns to the returns of the aggregate stock market.

[8] Other studies related to the nominal contracs hypothesis include Bradford (1974), Hong (1977), Feldstein, Green, and Sheshinski (1978), and Flannery and James (1984).

2.2.2. The 'Proxy Hypothesis'

Fama (1981) suggested that the negative correlation that several researchers had reported was in fact a spurious relation. There is no causal relationship between inflation and stock returns. It is rather the case that both are determined by real activity. Higher expected future output lead to higher current stock prices and also to an increased demand for money. For a given growth rate of the supply of money, an increase in expected future output must lead to lower inflation for the quantity theory equation to clear. If real activity is left out of the regression relating stock returns to inflation we will have inflation proxying for real activity. This has become known as the "proxy hypothesis". Leaving out real variables, as in equation (2.1) above, means that the estimates of the coefficients a and b will be downward biased. However, when Fama introduce measures of real activity into an equation relating real stock returns to anticipated and unanticipated inflation they did not entirely eliminate the negative relation between inflation and stock returns. So this explanation seemed to be only a partial explanation of the negative correlation between stock returns and inflation and led to continued efforts to find an explanation.

The "proxy hypothesis" has received some support in the literature, for example in the studies by VanderHoff and VanderHoff (1986) and Chang and Pinegar (1987). The relationship between inflation and the returns on stocks in seven branches of industry were investigated by VanderHoff and VanderHoff (1986). They found that when expected real income was added as an explanatory variable the negative relationship between inflation and returns was mitigated and became insignificant in all but two industry branches. They interpreted their results as giving strong support to the proxy hypothesis of Fama (1981). Chang and Pinegar (1987) found that Fama's use of a value-weighted stock index may have suppressed the effects of adding a measure of real activity to the regression. They showed that if an equally-weighted index is used instead the coefficient on the real activity variable becomes more positive and the coefficient on expected inflation becomes insignificant. However, their most interesting finding was that the severity of the left-out variable bias in Fama's inflation regression is a function of the security's risk. Portfolios with high betas were shown to seem to be more sensitive to expected inflation than portfolios with low betas. The explanation given for this was that the riskier a security is the more sensitive it will be to a real shock and the greater will be the bias in a regression leaving out real activity.

We turn next to two articles that provided some fundamental criticisms of Fama's analysis. Ram and Spencer (1983) did not accept Fama's finding of a negative relation between inflation and real activity, since it is contrary to the Phillips curve analysis which suggests a *positive* relationship between inflation and real activity. Ram and Spencer tried four different measures of real activity and found that the only coefficients for any of these measures that were significantly different from zero were in fact positive. The only measure that systematically gave a negative coefficient was growth of real GNP, which was used by Fama. In another set of regressions of real stock returns on real economic activity they found a significant *negative* relationship for all real activity measures except for growth of real GNP. Thus, they suggest that the negative relation between stock returns and inflation can be explained by a positive relation between inflation and real activity combined with a negative relation between stock returns and real activity. They point out that these results are consistent with Mundell's (1963) model in which an increase in inflation will lead investors to substitute financial assets (such as stocks) for money. This will result in lower asset prices as well as a lower real interest rate, which in turn will stimulate real activity.

In a little noticed article, Benderly and Zwick (1985) criticized Fama's somewhat unorthodox money demand theory, which is central to his proxy hypothesis. Fama assumed that money demand is a function of (expected) future rather than current output. This results in the demand for both stocks and money to increase with higher expected output. Benderly and Zwick (1985) noted that if the demand for both assets increases then the demand for some third asset like bonds must decrease. This is of course possible but it seems at odds with the response implied by most portfolio models, which would place bonds intermediate between money and equity. Benderly and Zwick reinterpreted the estimates from Fama's inflation equation,

$$\pi_t = \beta_0 + \beta_1 b_t + \beta_2 y_{t+1} + \beta_3 y_t + \beta_4 y_{t-1} + \varepsilon_t, \tag{2.2}$$

where b_t is the growth rate of money and the y's proxy for the expected future growth rate of output and we expect that $\beta_1 > 0, \beta_2, \beta_3, \beta_4 < 0$, as estimates of the real balance output equation,

$$y_t = \alpha_0 + \alpha_1 b_{t-1} + \alpha_2 \pi_{t-1} + \alpha_3 u_{t-1} + \eta_t \tag{2.3}$$

where u_t is unemployment relative to its natural rate. Output is a function of the growth rate of lagged real balances, approximated by $b_{t-1} - \pi_{t-1}$. Output is also positively related to the lagged unemployment variable, reflecting the tendency of the economy to revert to a natural level of unemployment. This equation was shown to be better specified than the inflation equation estimated by Fama (1981). In the real balance model we can derive the following stock return equation,

$$R_t = \gamma_0 + \gamma_1 b_t + \gamma_2 \pi_t + \gamma_3 u_t + \varsigma_t \tag{2.4}$$

The estimated coefficients are found to be significant and to have the expected signs. They interpret the negative relation between stock returns and inflation as working through the real balance effect described above. Note also the finding of a positive effect of monetary growth on stock returns, which is also interpreted as going through the real balance effect on output. This contrasts with Fama's finding of a negative relation.

2.2.3. The Role of Monetary Policy

In an influential article Geske and Roll (1983) augment Fama's (1981) money demand explanation by a money supply explanation. In Fama's analysis the monetary authority does not respond to real output shocks. Geske and Roll consider a central bank that conducts a counter-cyclical monetary policy. Stock prices fall in response to an expected decline in real economic activity. When the government's income declines, due to the lower level of economic activity, it will tend to run a deficit. To the extent that this deficit is monetized by the central bank it will raise inflation expectations. Thus, stock returns will be negatively related to expected inflation. Note that a reverse causality results from this sequence of events: stock returns Granger-cause inflation.[9]

It was pointed out by Kaul (1987) that if the monetary authority instead follows a pro-cyclical monetary policy we could observe a positive relation between inflation and stock returns. A counter-cyclical monetary policy will accentuate the negative relationship while a pro-cyclical policy will weaken or even reverse the relationship. Kaul used data from the postwar period (counter-cyclical policy) and the 1930's (pro-cyclical policy) for the U.S., Canada, the U.K., and Germany. He found that the negative relations between inflation and real activity along with counter-cyclical monetary policy is able to explain the negative relation between real stock returns and expected, unexpected, and changes in expected inflation. However, for the pro-cyclical monetary policy period of the 1930's he finds either

[9] Geske and Roll (1983) also showed that if stock returns are inversely related to changes in the real interest rate then stock returns can be negatively related to the proxy of expected inflation (the Treasury bill rate) even if it is not negatively related to inflation. However, they did not think that this was a problem for the period studied by Fama (1981).

positive or insignificant relations. Thus, the type of policy pursued by the monetary authority plays an important role for the relationship between stock returns and inflation.

Kaul (1990) analyzed the relationship between stock returns and unexpected inflation/changes in expected inflation under alternative monetary policy regimes. If the monetary authority pursues a target for the growth rate of money the relation between money supply and economic activity is likely to be weak. In these circumstances monetary policy is unlikely to accentuate the negative stock return-inflation relations predicted by Fama's "proxy hypothesis". On the other hand, if the monetary authority is pursuing an activist interest rate policy this could accentuate or reverse the negative relation between stock returns and inflation depending on whether the policy pursued is counter- or pro-cyclical. Kaul used post-war data for the U.S., Canada, the U.K., and Germany. He found that the negative relation between stock returns and changes in expected inflation was significantly stronger during interest rate regimes than under money-supply regimes. It appears that central banks in an interest rate regime pursued strong counter-cyclical policies. Kaul also found that there was no change in the relation between stock returns and inflation in countries that only experienced one type of policy regime during the period studied.

Graham (1996) was critical of Kaul's (1990) division of post-war monetary policy into interest-rate-targeting and monetary-aggregate-targeting regimes: "even if the Fed does shift between monetary aggregate and interest rate targets, there is no reason to suppose that one or the other is likely to be more or less counter-cyclical" (p. 30). Instead he reverses the procedure used by Kaul. He regresses the real stock return on the inflation rate and conducts a series of searches for break points, using the F-statistic as his criterion. Based on this procedure he divides his sample 1953:Q1-1990:Q4 into three subperiods according to wich the stock return-inflation relation was positive for the middle period, 1976:Q1-1982:Q1, and negative for the first and last subperiods. This division is quite different from the one employed by Kaul (1990). Graham (1996) regresses the growth rate of the monetary base on the rate of unempoyment and the real federal deficit as a percentage of trend real GNP to determine whether monetary policy is pro- or counter-cyclical and to determine to what extent the deficit is monetized by the Fed. The breakpoints found for the returns-inflation tradeoff are found to be significant in this equation also. He finds that monetary policy is neutral in the subperiods with a negative returns-inflation relation and counter-cyclical in the middle period when the relation is positive. These results are consistent with those of Kaul (1990). On the other hand, there is no evidence of the Geske and Roll (1983) debt monetization mechanism, which should have manifested itself in a positive coefficient on the deficit variable in the middle period and a non-positive coefficient in the periods with a negative returns-inflation relation.

2.2.4. The Role of Monetary Policy: Systems Approaches

In the seminal articles by Fama (1981) and Geske and Roll (1983) each link in the causal chains were examined and estimated separately. Since the error terms in the equations are likely to be correlated it would be more efficient to estimate the models as a system. James, Koreisha, and Partch (1985) were the first to use this approach to analyze the realationship between real stock returns and inflation. They estimated a vector autoregressive moving average model with stock returns, real activity, money supply, and inflation. The causal links between these variables were examined. They found that stock returns signal changes in real activity as well as changes in the monetary base. This is consistent with the debt-monetization hypothesis of Geske and Roll (1983).

Ely and Robinson (1992) used a model which allowed them to test the relation between stock returns and unexpected inflation while controlling for real output effects and money. In addition to unexpected inflation as an explanatory variable, stock returns were regressed on expected and unexpected growth in GNP as well as expected and unexpected growth in the monetary base. This equation was estimated simultaneously with the forecasting equations for inflation, GNP growth, and money base growth. Ely and Robinson (1992) reject the debt-monetization hypothesis of Geske and Roll (1983). Stock returns are not found to be useful in forecasting the growth rate of the monetary base or inflation, which it should have been if the debt-monetization hypothesis were true. While a counter-cyclical monetary policy was found to prevail for the whole sample as well as for all three subperiods, a negative relation between real stock returns and unexpected inflation was found for the whole sample period but for only one of the subperiods. Hence, a counter-cyclical monetary policy does not provide a consistent explanation for the negative relation between stock returns and unexpected inflation.

Lee (1992) followed the approach of James, Koreisha, and Partch (1985) in using a VAR analysis, since the bivariate causal tests in other studies may not be robust in a larger system of variables. However, he pointed out two weaknesses in the study by James, Koreisha, and Partch. First, by using the change in nominal interest rates as a proxy for the change in expected inflation there is no independent role for real interest rates in their model (since real interest rates are implicitly assumed to be constant). Second, Lee thought it would be more interesting to investigate the extent to which a variable helps explain other variables and how a variable responds to shocks in other variables in the system, rather than merely conducting simple tests of causal relations. Lee estimated a four-variable VAR system with real stock returns, real interest rates, growth in industrial production, and the rate of inflation for the period January 1947 to December 1987 (U.S. data). He finds that the response of industrial production to shocks in real stock returns is strongly positive up to 12 months after the shock. He does not find a consistent negative response of inflation to shocks in stock returns, or vice versa. On the other hand, real interest rates are found to explain a substantial fraction of the forecast error variance in inflation. Finally, inflation explains little of the variation in real activity. Hence, with real interest rates and a measure of real activity in the system the relation between stock returns and inflation breaks down. This is consistent with Fama's "proxy hypothesis".

Canova and Nicoló (1997) conducted a study that is similar to Lee's for the U.S., the U.K., Germany, and Japan for the more recent period 1973-93. They estimated a VAR with nominal stock returns, the slope of the term structure, industrial production, and inflation. They discovered a significant negative relation between real stock returns and inflation in all four countries. On the other hand, the negative correlation between nominal stock returns and inflation is significant only in the U.S. Canova and Nicoló allow for international interactions by estimating bilateral VAR's with the U.S. as one country and the U.K., Germany, or Japan as the other country. When international influences are allowed for in this manner, the negative link between output growth and inflation, which is central to the 'proxy hypothesis', disappears.

Balduzzi (1995) considered a VAR with the rate of inflation, real returns on the value-weighted NYSE portfolio, growth in industrial production, and monetary base growth. He used vector moving averages to study the correlation between two series. He found a negative contemporaneous correlation between inflation and stock returns, irrespective of the origin of the innovation but with inflation shocks resulting in the strongest correlations. When the system was augmented to include the three-month Treasury bill rate, interest rate innovations were found to play a significant role although inflation innovations still mattered the most.

2.2.5. Long-Horizon Relations Between Inflation and Stock returns

Boudoukh and Richardson (1993) and Frennberg and Hansson (1993) considered longer-horizon returns (up to five years), regressing stock returns on expected and unexpected inflation as in (2.1). They found that at longer horizons stocks are good hedges against both expected and unexpected inflation. For the Swedish data set used by Frennberg and Hansson the Fisher relation holds even at short horizons (as short as one month). Boudoukh, Richardson, and Whitelaw (1994) show that it is possible to get estimates of a negative relation between stock returns and expected inflation at short horizons and estimates of a positive relation at long horizons even if the Fisher relation holds. This is because expected inflation may be partly proxying for expected future real rates. Regressing stock returns on expected inflation, the coefficient on expected inflation is shown to equal one plus the covariance between expected inflation and future dividend growth rates and price dividend ratios. Even in a money-neutral setting this covariance need not be zero and it need not be the same for different horizons.

Ely and Robinson (1997) use a different approach to investigating the relation between stock returns and inflation at long horizons. Using stock return, inflation, real output, and money supply data from 16 industrialized countries, they estimate vector error correction (VEC) models to assess the response of stock and goods prices to money supply and real output shocks. With a few exceptions, they conclude that stocks maintain their value relative to goods prices following both real and monetary shocks.

2.2.6. The Inflation Risk Premium

Malkiel (1979) addressed the question of why real capital investment was so weak during the 1970's. He suggested that higher risk premiums in this decade, compared to those in previous decades, could be the explanation. He claimed that the reason for the high premiums was a high level of inflation with an associated high variability in the inflation rate. Volatile inflation lead to large relative price changes, which make long-run planning very hazardous. Also, a tax system that favored debt financing over equity financing contributed in encouraging firms to use highly levered capital structures. When a regime with high and volatile inflation is introduced into such a tax environment investors will naturally demand an inflation risk premium. Malkiel offers the change over time in the spread between the yields of medium quality corporate bonds and yields of long-term government bonds as a crude measure of the risk premium. The spread is shown to have increased from a low in 1965, thus supporting his hypothesis. Constructed direct measures of the risk premium in the equity market are shown to tell the same story, lending additional support to the hypothesis of an inflation risk premium.

Chen, Roll, and Ross (1986) tested whether innovations in macroeconomic variables represent risk factors that are priced in the stock market. They identified five potential factors: industrial production, expected inflation, unexpected inflation, the spread between high grade and low grade bonds, and a term spread. They ran cross-sectional regressions of stock returns on measures capturing the sensitivity of a particular stock to innovations in a particular macroeconomic variable. They found a significant (negative) risk premium for exposure to inflation risk during the high inflation period 1968-77, but no significant inflation premium in the periods before and after this period. Thus, in periods of high inflation investors require a lower risk premium for assets that are positively correlated with (are good hedges against) inflation.

As an illustration of the Chen, Roll, and Ross model consider the simpler one-factor model,

$$R_{it} = a + b_i \left(\pi_t - \pi_t^e\right) + \varepsilon_t, \tag{2.5}$$

where the nominal return on asset $i = 1, 2, ..., N$ is regressed on the only factor: unexpected inflation.The estimated factor sensitivities, b_i, are then used in the cross-sectional regression

$$\bar{R}_i = \beta_0 + \beta_1 b_i + \eta_i, \tag{2.6}$$

where $\bar{R}_i$ is the average return on stock i over the sample period. We would expect $\beta_1 < 0$, i.e. the better the stock hedges against unexpected inflation (the higher b_i is) the smaller the inflation risk premium should be. Going in the other direction, a large negative b_i implies that the stock is a very poor hedge against inflation and it will therefore require a large positive risk premium.

A factor model was also employed by Lajeri and Dermine (1996) to investigate what factors determine the returns on stocks of French banks listed on the Paris stock exchange 1977-91. The factors considered were a market index and innovations in interest rates and inflation. For the more volatile period 1977-87 they found a significant (negative) inflation risk premium. Hence, this result supports the finding of Chen, Roll, and Ross (1986) that there is a significant inflation risk premium in times of high and variable inflation.

Corkish and Miles (1994) tested if the real return on equity (and a number of other assets) is linearly related to the variability in inflation. A pedagogically simplified version of their analysis would be to regress real stock returns on unexpected inflation and inflation variability,

$$r_{it} = \alpha_0 + \alpha_1 (\pi_t - \pi_t^e) + \alpha_2 h_{\pi t} + \xi_t, \tag{2.7}$$

where $h_{\pi t}$ is the conditional variance of inflation in period t (estimated from an ARCH model). For assets that are poor hedges against inflation, $\alpha_1 < 0$, we would expect $\alpha_2 > 0$, i.e. the higher the variability in inflation is the higher should be the risk premium demanded by investors. Corkish and Miles did not find a significant relation between real stock returns and the conditional variance of inflation for their U.K. data. Kronblad (1997) replicated Corkish and Miles (1994) study on Swedish data. Contrary to Corkish and Miles, he did find a positive and significant relation between inflation variability and returns on all of the stock indices he used (as well as for most individual stocks).

Grande, Locarno, and Massa (1997) used the linearized nominal present value relation,

$$e_{t+1} - E_t e_{t+1} = (E_{t+1} - E_t) \sum_{i=0}^{\infty} \rho^i (\Delta d_{t+1+i} - r_{t+1+i} - \pi_{t+1+i} - e_{t+1+i}), \tag{2.8}$$

where e_t is the real stock return in excess of the riskfree interest rate r_t, d_t is the real dividend, π_t is the inflation rate, and ρ is a parameter of linearization. Excess returns can be forecast using a VAR model of state variables, which include the excess return on the market, a short-term interest rate, the dividend yield, the slope of the term structure, and the default spread. There are two sets of VAR coefficients representing two regimes between which the economy can switch. These regimes will partly reflect changes in monetary policy but could also pick up other sources of instability. The model was estimated on Italian data for the period 1979:Q2 to 1997:Q1. Grande, Locarno, and Massa (1997) found that unexpected inflation resulted in a (small) positive risk premium under both regimes, although it was higher in the regime that has prevailed since 1989. However, this regime was not characterized in monetary policy terms but rather in terms of a greater openness of the economy.

2.3. Monetary Policy Announcement Effects

The problems with endogeneity of money, discussed in Section 2.1., led some researchers to consider using an event-study methodology. This involves looking at the effects immediately after a monetary policy announcement. It was argued that these announcements, using daily or weekly data, could be viewed as exogenous to the subsequent market reactions on (and possibly immediately after) the event day. These studies have been performed almost exclusively on U.S. data. Monetary policy has been measured using money supply announcements (Berkman (1978), Lynge (1981), Cornell (1983), Pearce and Roley (1983)), discount rate changes (Waud (1970), Smirlock and Yawitz (1985), Jensen and Johnson (1993, 1995)), money supply announcements and discount rate changes (Pearce and Roley (1985), Hafer (1986), Hardouvelis (1987)), changes in the Fed funds rate target (Thorbecke and Alami (1994), Thorbecke (1997)), and open market operations (Tarhan (1995)).

Berkman (1978) and Lynge (1981) found that stock prices reacted negatively to money supply announcements. Lynge (1981) did not distinguish between anticipated and unanticipated changes while this was a major point of Berkman's study. Berkman showed that stock prices only react to unanticipated changes. Pearce and Roley (1983) reexamined the question of how stock prices react to unanticipated money supply announcements. Using weekly data 1977-82, they estimated the following model,

$$\Delta P_t = a + b\,(\Delta M_t^a - \Delta M_t^e) + \epsilon_t, \tag{2.9}$$

where ΔP_t is the percentage change in the stock price, ΔM_t^a is the announced change in the money stock, and ΔM_t^e is the expected change in the money stock. The expected change in the money stock was obtained from survey data. They estimated the model for three subperiods and obtained a negative estimate of the b parameter in each subperiod (statistically significant in two of the subperiods).

An explanation of the announcement effect should take into account the point made by Cornell (1983), that the Fed's money supply announcements can *only* affect asset prices by altering agents' information set. This is because what the Fed announces is its estimate of the money stock for the reserve week ending *nine days earlier*. Cornell (1983) discusses and tests three hypotheses suggested in the literature as well as a fourth hypothesis which he proposes. The *expected inflation hypothesis* focus on the most obvious link between money supply announcements and nominal returns. However, in a perfect market expected future cash flows and the rate at which they are discounted should be adjusted for changes in expected inflation by offsetting amounts. Thus, an effect on stock returns through changes in expected inflation would have to rely on some type of market imperfection. The *Keynesian hypothesis* is based on a sticky-price model. Since the price level does not respond to a monetary shock in the short run, the interest rate will have to adjust to equilibrate the money market. A money supply announcement will have an effect on asset prices if it alters expectations about future Fed policy. A positive money supply shock will lead agents to anticipate a tightening of monetary policy. The ensuing bidding for funds will drive up the current rate of interest. Hence, an announcement of a bigger money supply will lower stock prices because of (i) a higher discount rate, and (ii) lower expected future cash flows resulting from lower future economic activity. The *real activity hypothesis* asserts that an announcement of a bigger money supply provides information about future money demand (accomodated by the Fed), which in turn is caused by higher expected future output. Higher expected future output means higher expected future cash flows, which causes stock prices to rise. This is Fama's "proxy hypothesis" discussed in Section 2.2.2. above. In addition to these hypotheses, Cornell (1983) proposes the *risk premium hypothesis*. With a precautionary motive for holding real balances, money demand will be an increasing function of risk aversion and risk. An unexpected money supply increase reveals that aggregate risk aversion and/or risk is higher than previously (for a given level of real income). Under these circumstances investors will require a higher risk premium, causing equity prices to fall. Cornell's finding of a drop in equity prices following a positive money supply announcement is inconsistent with the real activity hypothesis. Taking into account the predicted effects on other asset prices none of the hypotheses were found to be consistent with the data. However, Cornell pointed out that a number of different combinations of all four hypotheses would be consistent with his findings.

Pearce and Roley (1985) investigated the effects on equity prices from unanticipated changes in money, inflation, and output, as well as from changes in the discount rate. Their 1977-82 sample straddles the period October 1979 to October 1982, when the Fed targeted nonborrowed reserves. Before October 1979 the Fed followed an interest rate targeting procedure and after October 1982 it deemphasized this procedure in favor of a borrowed reserves procedure. Pearce and Roley found that money surprises had a negative and statistically significant effect on equity prices in both the pre-October 1979 and the post-October 1979 periods. Inflation and output surprises had at best a limited effect on stock prices. Hafer (1986) found a significant effect from money announcements on equity prices only in the post-1979 period. Hardouvelis (1987) considered the period 1979-84 and found a significant negative effect for both of the subperiods 1979-82 and 1982-84. More generally, he found that monetary variables (e.g. the money supply) matters while non-monetary variables (e.g. output) do not. A negative effect of unexpected innovations in money for the whole period 1977-88 was documented by McQueen and Roley (1993), in a study mainly concerned with output surprises. They explained the previous findings, by Hardouvelis and others, of insignificant non-monetary variables as the result of a differential stock price reaction to output surprises depending on the state of the economy. In an overheated economy a positive output surprise is bad news for the stock market, while it is good news in a slump.

In the early 1970's evidence was presented that showed interest rates and stock prices responding to announcements of discount rate changes (Waud (1970)). However, Santomero (1983) and references given in that paper describes the discount rate as being set in response to market interest rates with a lag. But if this is the case and the stock market nevertheless responds to such changes, then this indicates that the market is inefficient. Technically this would of course also lead to an endogeneity problem in using changes in the discount rate as an explanatory variable. Smirlock and Yawitz (1985) adress these problems by trying to distinguish between 'technical' discount rate changes that are endogenous and 'nontechnical' changes that contain some information about monetary policy. They found no evidence of announcement effects for the pre-1979 period, regardless of whether the change was classified as technical or nontechnical. On the other hand, for the post-1979 period they found significant negative announcement effects, but only for nontechnical discount rate changes. Hence, they were able to reconcile the findings of significant announcement effects with market efficiency. In contrast to Smirlock and Yawitz (1985), Jensen and Johnson (1993) found significant effects of both technical and non-technical discount rate changes, although the effects of the non-technical changes were found to be stronger. The results also holds irrespective of the monetary regime. The discrepancy compared to previous results can be explained by a more careful choice of announcement period and the fact that they analyze increases and decreases separately.

Pearce and Roley (1985) found that changes in the discount rate had a negative effect on equity prices, but significant only in the post-1979 period. Hafer (1986) found a negative effect of discount rate changes on equity prices only during the period October 1979 to October 1982 of nonborrowed reserves targeting. Before and after this period he found a positive but statistically insignificant effect on equity prices. Hardouvelis (1987) likewise found a negative effect during the 1979-82 period but no effect after 1982. These findings are consistent with the idea that the discount rate is more informative about future monetary policy under a regime of nonborrowed reserves targeting.

The study by Jensen and Johnson (1995) is different from the previous studies in that they considered the *long-term* returns surrounding a change in the discount rate. They investigated the effect of a discount rate change on the preannouncement (day -15 through -1) returns , the announcement period (day 0 and 1) returns, and the postannouncement (day 2 through 16) returns. There was a negative effect on stock returns in all three periods. The preannouncement returns indicated that the stock market anticipates the change in the discount rate. The postannouncement reaction was interpreted by Jensen and Johnson not as a delayed reaction, since there are few significant returns on the days immediately following the announcement, but rather as a sign that reinforcing events tend to follow the rate change. They also considered announcement to announcement returns with the same basic results.

Tarhan (1995) examined the impact of Federal Reserve open market operations on financial asset prices (in a study mainly focusing on interest rates). He found no evidence that the Fed influences stock prices. Thorbecke (1997), on the other hand, found a significant negative effect on the percentage change in the Dow Jones Industrial Average from policy-induced changes in the federal funds rate. The different choice of policy instrument in these two studies follow naturally from the choice of sample period. Tarhan studied the period October 2, 1979 to December 31, 1984 when the growth rate of money was the target. Thorbecke focused attention on periods when the federal funds rate was targeted. He used Cook and Hahn's (1989) 1974-79 fed funds data and added a similarily constructed series for the period August 11, 1987 to December 31, 1994. An earlier study by Thorbecke and Alami (1994), that used the original Cook and Hahn data for the 1974-79 period, also found significant negative responses in stock returns to changes in the Fed funds rate target.

In Sellin (1997) I analyzed the impact of the Sveriges Riksbank policy announcements on the stock market. I simultaneously considered a whole set of instruments. The Swedish system for the practical management of monetary policy provides one deposit and one lending facility. The deposit rate and lending rate form a corridor within which the repo rate is set. The interest rate corridor provides the Riksbank with a tool for signalling its long term intentions concerning the repo rate. In order to assess any effect from inflation reports and speeches by the governor and deputy governors of the Riksbank, these were coded 1(-1) if the report/speech was interpreted (by me) as foreboding monetary tightening (easing) and the value zero if the report/speech was neutral. The following statistically significant effects were found. A change in the repo rate had the expected negative impact on equity returns. There was a positive effect on volatility from the announcement of a change in the repo rate and a negative effect from changes in the lending rate and from speeches. I interpreted the latter results as saying that changes in the lending rate and speeches by the governor and deputy governors remove some of the uncertainty about the future path of monetary policy, which results in lower volatility.

A summary of the findings of the empirical studies cited above are presented in Table 1. Considering the money supply as a measure of monetary policy one reaches the complete opposite conclusion compared to using an instument rate of interest. Almost all of the money supply studies have used M1 to measure changes in the supply of money. The exception is Tarhan (1995) who use open market operations. Tarhan's results also differ from the other studies in not finding a negative effect on equity prices from easier money. The problem with using M1 as a measure of monetary policy is that changes in it are equally likely to reflect changes in money demand as changes in money supply. Then, as the Keynesian hypothesis suggests a positive money shock could lead agents to expect a tightening of monetary policy which in turn would lead to a fall in equity prices. An alternative explanation is the risk premium hypothesis suggested by Cornell (1983). Using an interest rate as the measure of monetary policy, the evidence indicates clearly that a tighter monetary policy results in lower equity prices.

2.4. What Have We Learnt From the Empirical Evidence?

From the empirical studies of money/monetary policy and stock returns it seems clear that money can help predict stock returns to some (small) extent. While the findings of the earlier studies were ambiguous later studies, that have made an effort to measure the actual monetary policy stance, have found unambiguous evidence that monetary easing leads to higher equity prices (Lastrape (1996), Thorbecke (1997), Patelis (1997)). Monetary policy also seems to exert an influence on stock prices both independently of and together with the state of the business cycle (Jensen, Mercer, and Johnson (1996), Patelis (1997)).

The empirical evidence suggest that real stock returns are adversly affected by both the expected and the unexpected rate of inflation. Several explanations for the negative relation have been put forward. The evidence that some form of market imperfection could be the explanation seem to be quite weak, especially considering Amihud's (1996) findings. The hypothesis that the empirical relation between inflation and stock prices is the result of inflation proxying for real activity has received support in a number of studies (e.g. VanderHoff and VanderHoff (1996), Chang and Pinegar (1987), Lee (1992)) even though his theory of money demand has been severely critized (Ram and Spencer (1983), Benderly and Zwick (1985)). The important connection between the negative inflation-stock returns relation and the stance of monetary policy was made by Geske and Roll (1983) and extended by Kaul (1987). If the monetary authority conducts a counter-cyclical monetary policy this will result in a negative relation between expected inflation and stock returns (Geske and Roll (1983)), while if it conducts a pro-cyclical monetary policy we could see a positive relation between expected inflation and stock returns (Kaul (1987)). Tests of the debt-monetization hypothesis of Geske and Roll (1983) have given ambiguous results. For example James, Koreisha, and Partch (1985) find support for the hypothesis while Ely and Robinson (1992) reject it.

Stocks seem to be a good hedge against both expected and unexpected inflation at longer horizons (Boudoukh and Richardson (1993), Frennberg and Hansson (1993), Ely and Robinson (1997)). There is also evidence to suggest that in times of high and variable inflation investors receive a risk premium for holding equity (Malkiel (1979), Chen, Roll, and Ross (1986), Lajeri and Dermine (1996), Kronblad (1997), Grande, Locarno, and Massa (1997)).

Earlier studies, using changes in M1 as a measure of monetary policy, found that an announcement of easier monetary policy had a negative impact on stock prices. But changes in M1 could reflect changes on money demand as well as in supply, which makes the interpretation of the results difficult. More recent studies, which have measured changes in monetary policy more carefully, have found that announcements of easier monetary policy have a positive impact on equity prices (see the studies listed in Table 1). The theoretical reasons for expecting to find this to be the case will be looked into more carefully, along with other theoretical considerations, in the next section of this paper.

3. Theoretical Models of Money and Stock Prices

Theoretical models of money and stock prices fall into two broad categories. The first approach is the utility maximizing representative agent framework, which is the workhorse of financial economics and modern macroeconomics. The other approach is that of structural macroeconomic models, employed in more traditional macroeconomics. The first approach includes some frequently used *real* consumption-based asset pricing models (Lucas (1978), Breeden (1979), and Cox, Ingersoll, and Ross (1985)). Introducing money in a nontrivial way in such a model poses a subtle problem. In order for money to be held in a general equilibrium asset pricing model it will have to yield a nonpecuniary return greater than zero. If it did not it would be dominated by interest-bearing assets. A number of different approaches to introducing money have been developed. We are going to survey papers from a closely linked group of models in subsections 3.1 to 3.3: money-in-the-utility-function (MIUF) models, cash-in-advance (CIA) models, and transaction cost models. In the structural macroeconomic models aggregate relationships among variables are postulated rather than derived from microeconomic fundamentals. The application of these models to the question of money and stock prices is discussed in subsection 3.4. Finally, a summary of the theoretical studies are given in subsection 3.5.

3.1. Money in the Utility Function Models

LeRoy (1984), Danthine and Donaldson (1986), Stulz (1986), Boyle (1990), and Bakshi and Chen (1996) place real money balances directly in the utility function. Bakshi and Chen (1996) start out with a discrete-time version of their model which they then take to its continuous-time limit. The representative agent, endowed with a logarithmic period utility function, chooses paths of consumtion, c_t, and real money balances, $m_t = M_t/P_t$, so as to maximize

$$\sum_{t=0}^{\infty} e^{-\rho t} \left[\phi \ln c_t + (1-\phi) \ln m_t\right] \Delta t \tag{3.1}$$

with $0 \leq \phi \leq 1$, and subject to the budget constraint[10]

$$M_t + (Q_t + P_t y_t \Delta t)\, z_t = P_t c_t \Delta t + Q_t z_{t+\Delta t}, \tag{3.2}$$

where Q_t is the stock price and z_t is the number of shares held. In equilibrium markets are required to clear, i.e. $c_t = y_t$, $M_t = M_t^s$, and $z_t = 1$ (the number of shares available is normalized to equal one).

In a first step Bakshi and Chen (1996) consider an economy driven by i.i.d. (Brownian Motion) processes for output and money,

[10] The model has been simplified somewhat here to focus on stocks. Bakshi and Chen (1996) also include real and nominal bonds in their analysis and derive some interesting results for the real and nominal term structures.

$$\frac{dy_t}{y_t} = \mu_y dt + \sigma_y d\omega_{y,t}, \tag{3.3}$$

$$\frac{dM_t}{M_t} = \mu_M dt + \sigma_M d\omega_{M,t}. \tag{3.4}$$

where μ_y and μ_M are the expected growth rates of output and money respectively, while the last terms represent the white noise innovations. In this i.i.d. economy the real equity price, q_t, is found to be proportional to real output,

$$q_t = \frac{y_t}{\rho}. \tag{3.5}$$

The real rate of return on equity is equal to the growth rate of output,

$$\frac{dq_t}{q_t} = \mu_y dt + \sigma_y d\omega_{y,t}. \tag{3.6}$$

The price level is determined by the exchange equation with constant velocity of money,

$$P_t = \frac{\phi}{1-\phi}\left(\rho + \mu_M - \sigma_M^2\right)\frac{M_t}{y_t}, \tag{3.7}$$

and inflation is driven by both real and monetary shocks,

$$\frac{dP_t}{P_t} = \pi_t dt + \sigma_M d\omega_{M,t} - \sigma_y d\omega_{y,t}. \tag{3.8}$$

From (3.6) and (3.8) it follows that

$$cov_t\left(\frac{dq_t}{q_t}, \frac{dP_t}{P_t}\right) = cov_t\left(\frac{dy_t}{y_t}, \frac{dM_t}{M_t}\right) - var_t\left(\frac{dy_t}{y_t}\right),$$

which will be negative unless monetary policy is procyclical to the extent that the covariance term dominates the variance term. It also follows from (3.6) that the covariance between real equity returns and money growth is equal to the covariance between output growth and money growth,

$$cov_t\left(\frac{dq_t}{q_t}, \frac{dM_t}{M_t}\right) = cov_t\left(\frac{dy_t}{y_t}, \frac{dM_t}{M_t}\right),$$

which is positive if monetary policy is procyclical and negative if monetary policy is countercyclical. Hence, this model is consistent with the empirical findings of Kaul (1987).

3.2. Cash in Advance Models

Lucas (1982) develops a model where agents have to meet a cash-in-advance constraint for purchasing the consumption good, as suggested by Clower (1967). This type of model has been used and extended by Day (1984), Lucas (1984), Svensson (1985), Lucas and Stokey (1987), Labadie (1989), Giovannini and Labadie (1991), and Boyle and Peterson (1995).

The basic model due to Lucas is set up in the following way. The representative agent enters a period with money and equity shares carried over from the previous period. He receives a helicopter drop of money and the securities market opens for trading. The security market closes and the goods market opens for trading. Goods must be bought with money (currency). The goods market closes and the agent collects dividends in the form of currency, which is carried into the next period.

The agent's problem is to choose consumption, c_t, money holdings, M_t, and equity shares, z_t, given the price of the good, P_t, and the real price of equity, q_t, so as to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t\right) \tag{3.9}$$

subject to a budget constraint,

$$\frac{M_t}{P_t} + q_t z_t \leq \left(q_t + y_{t-1}\frac{P_{t-1}}{P_t}\right) z_{t-1} + \frac{M_{t-1} - P_{t-1}c_{t-1}}{P_t} + \frac{M_t^s - M_{t-1}^s}{P_t}, \tag{3.10}$$

and a cash-in-advance constraint,

$$M_t \geq P_t c_t. \tag{3.11}$$

for every $t \geq 0$. The restrictions will be binding at the optimum solution.

The exogenous variabes evolve according to

$$y_t = \eta_t y_{t-1}, \tag{3.12}$$

and

$$M_t^s = \mu_t M_{t-1}^s, \tag{3.13}$$

where η_t and μ_t are the stochastic growth rates of output and money respectively.

In equilibrium we require that for every $t \geq 0$,

$$c_t = y_t, z_t = 1, M_t = M_t^s. \tag{3.14}$$

Using the binding cash-in-advance constraint and the equilibrium conditions, we can derive a quantity theoretically determined price level with unit velocity,[11]

$$P_t = \frac{M_t^s}{y_t}. \tag{3.15}$$

Substituting this price level and the equilibrium condition for consumtion into the Euler equation for the equity price, we end up with the equilibrium price of equity

$$q_t = \beta E_t \left[\frac{u'(y_{t+1})}{u'(y_t)} \left(q_{t+1} + \frac{y_{t+1}}{\mu_{t+1}} \right) \right], \tag{3.16}$$

where μ_{t+1} is the growth rate of money.

Assuming that the money supply process is independent of the endowment process, we get

$$q_t = \beta E_t \left[\frac{u'(y_{t+1})}{u'(y_t)} q_{t+1} \right] + \beta E_t \left[\frac{u'(y_{t+1})}{u'(y_t)} y_{t+1} \right] E_t \left[\frac{1}{\mu_{t+1}} \right] \tag{3.17}$$

From this equation it is clear that the effect of increased expectations of a (temporary) monetary tightening will have a positive effect on the real equity price,

$$\frac{\partial q_t}{\partial E_t \left[1/\mu_{t+1} \right]} > 0.$$

A monetary tightening is expected to lead to lower inflation and a higher purchasing power of the dividend sum carried over to the next period. This makes equity more valuable and results in a higher real equity price.

In a recent article Boyle and Peterson (1995) extend the above framework to address the question whether monetary *policy* matters, as distinct from the question whether money matters. They do this by assuming that the monetary authority targets the growth rate of money. We will present a somewhat simplified version of the Boyle and Peterson model here, assuming that monetary policy is perfectly implemented.

[11] Svensson (1995) shows how it is possible to get a velocity different from one by changing the timing in the model and thereby introducing a precautionary motive for holding money.

In the Boyle-Peterson model utput evolves according to

$$y_t = \lambda_t y_{t-1}, \tag{3.18}$$

where the growth factor λ_t has a known distribution. The reaction function of the monetary authority is given by[12]

$$\mu_t = k\lambda_t^{\epsilon} \tag{3.19}$$

where $k > 0$ is a constant and ϵ is the elasticity that measures the monetary response to an output shock

Boyle and Peterson show that under the assumption of Constant Relative Risk Aversion and if $\beta E\left[\lambda_t^{1-\gamma}\right] < 1$, then the equilibrium real price of equity can be written as

$$q_t = \frac{\beta y_t E\left[\lambda^{1-\gamma-\epsilon}\right]}{k\left(1-\beta E\left[\lambda^{1-\gamma}\right]\right)}, \tag{3.20}$$

where E is the unconditional expectations operator and γ is the coefficient of relative risk aversion (and the inverse of the intertemporal elasticity of substitution). Note the dependence of the real equity price on the monetary policy parameter ϵ.

A central result in Boyle and Peterson (1995) concerns how the correlation between equity returns and inflation depends on monetary policy. From (3.20) we have that the capital gain factor, q_t^*, is equal to the output growth factor,

$$q_t^* \equiv q_t/q_{t-1} = y_t/y_{t-1} = \lambda_t \tag{3.21}$$

Using (3.15) and (3.19) we see that the inflation factor, Π_t, is a nonlinear function of the output growth factor,

$$\Pi_t \equiv P_t/P_{t-1} = \left(M_t^s/M_{t-1}^s\right)(y_{t-1}/y_t) = \mu_t\lambda_t^{-1} = k\lambda_t^{\epsilon-1} \tag{3.22}$$

Hence,

$$cov\left(\ln q_t^*, \ln \Pi_t\right) = cov\left(\ln \lambda_t, (\epsilon-1)\ln\lambda_t\right) = (\epsilon-1)\, var\left(\ln\lambda_t\right).$$

Thus, if monetary policy is strongly procyclical ($\epsilon > 1$) equity returns are positively correlated with inflation. But if monetary policy is weakly procyclical

[12] In the original Boyle and Peterson (1995) model there is an additional stochastic factor, an exogenous disturbance to the money stock, which is supposed to capture the imperfect implementation of monetary policy.

$(0 \leq \epsilon < 1)$ or countercyclical $(\epsilon < 0)$ returns will be negatively correlated with inflation. Monetary policy could thus explain the observed negative correlation between equity returns and inflation. Note that this is actually one formalization of the explanation given in Geske and Roll (1983) and Kaul (1987).

3.3. Transaction Cost Models

In Marshall (1992) money reduces the cost of consumption transactions.[13] The agent's problem is to choose consumption, c_t, money holdings, M_t, and equity shares, z_t, given the price of the good, P_t, and the real price of equity, q_t, so as to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^i u(c_t) \tag{3.23}$$

subject to a budget constraint,

$$c_t + \varphi(c_t, m_t) + \frac{M_{t+1}}{P_t} + q_t z_{t+1} \leq (q_t + y_t) z_t + m_t + \frac{M_t^s - M_{t-1}^s}{P_t}, \tag{3.24}$$

for every $t \geq 0$. The function $\varphi(c_t, m_t)$ represents the real transactions cost. It is a positive function of consumption and a negative function of real balances, $m_t = M_t/P_t$. The last two terms on the right hand side represent real balances available for transactions in period t. It is made up of real balances acquired in the previous period plus a lump-sum transfer. The budget restriction will be binding at the optimum solution. In equilibrium we also require that for every $t \geq 0$,

$$c_t = y_t - \varphi(c_t, m_t), z_t = 1, M_t = M_t^s. \tag{3.25}$$

Marshall derives the real price for equity,

$$q_t = E_t \left[\rho_{t+1} (y_{t+1} + q_{t+1}) \right], \tag{3.26}$$

where

$$\rho_{t+1} = \frac{\beta u'(c_{t+1})}{u'(c_t)} \cdot \frac{1 + \varphi_1(c_t, m_t)}{1 + \varphi_1(c_{t+1}, m_{t+1})}$$

[13] Feenstra (1986) has shown that there is a functional equivalence between these types of transaction costs models and the money in the utility function approach. Bekaert, Hodrick, and Marshall (1997) use this type of transaction cost technology in a two-country model.

is the intertemporal marginal rate of substitution in wealth and the market clearing equations (3.25) are assumed to hold.

The expected excess return on an asset i can be expressed in terms of a conditional single-beta model,

$$E_t r_{t+1}^i - r_t^f = -\beta_t^i \left[\frac{var_t \left(\rho_{t+1}\right)}{E_t \rho_{t+1}} \right], \tag{3.27}$$

where r_{t+1}^i is the real return to asset i, r_t^f is the real risk-free rate, and $\beta_t^i = cov_t(r_{t+1}^i, \rho_{t+1})/var_t(\rho_{t+1})$. This equation holds for example for the real return on equity, $r_{t+1}^q = (y_{t+1} + q_{t+1})/q_t$, and for the real return to money, $r_{t+1}^m = [1 + \varphi_2(c_{t+1}, m_{t+1})]/\pi_{t+1}$. Assuming that there is little variation in the ratio β_t^i/β_t^m, the single-beta representations for these two assets together implies the relation

$$sign \left[cov \left(E_t r_{t+1}^q - r_t^f, E_t \pi_{t+1}\right)\right] = sign \left[\beta_t^q/\beta_t^m\right] \cdot sign \left[cov \left(E_t r_{t+1}^m - r_t^f, E_t \pi_{t+1}\right)\right]. \tag{3.28}$$

The covariance term on the right-hand side of (3.28) should be negative, since the direct effect of inflation on the real return to money should dominate the indirect effect through changes in the marginal transaction cost, φ_2. Thus, the expected excess return on equity will covary negatively with expected inflation (as found empirically) if the ratio β_t^q/β_t^m is positive. Since equity should yield a positive excess return, implying that β_t^q is negative, the ratio will be positive if β_t^m is also negative. Negative values of β_t^m are more likely if inflation innovations are primarily caused by output shocks rather than money shocks. This is because an output shock causes the intertemporal marginal rate of substitution to fall (due to concave utility) and causes inflation to fall (to equilibrate the quantity relation). The fall in inflation translates into an increased real return to money. Thus, the real return to money and the intertemporal marginal rate of substitution covary negatively implying a negative β_t^m. On the other hand, when money growth shocks are the main influence on inflation the sign of β_t^m will depend in a very complicated way on the derivatives of the transactions cost function rendering the sign indeterminate. In a simulation study the model is shown to generate negative correlations between inflation and real equity returns of approximately the magnitude observed in the data. Note that these results were generated from a model that deviates from the usual ideal assumptions only in assuming a transactions role for money. Marshall concludes that "the Fisher hypothesis does not generally describe the implications of dynamic economic equilibria when the transactions role of money is explicitly taken into consideration." (p. 1339). In the present framework real returns and inflation are not independently determined as Fisher (1930) assumed.

3.4. Structural Macroeconomic Models

Lächler (1983) uses a simple neoclassical model to conduct a comparative-statics analysis of the short-run impact of an increase in anticipated inflation on the real price of equity. The reason for the non-neutrality of inflation is that the effective tax rates on security returns change with changes in the inflation rate. This study differs from previous similar studies (e.g. Feldstein(1980)) in that, rather than just model the relevant security markets, it in addition explicitly takes into account the government's budget constraint within the framework of a simple macroeconomic model. How the inflation tax revenue is used proves to be crucial to the results. Lächler distinguishes between different cases depending on whether, and if so how, the tax revenue from increased inflation is offset by reductions in other taxes. He shows that if the inflation tax is offset by a lower income tax rate then (for all reasonble parameter values) higher inflation leads to lower real equity prices. The negative tax effect will be mitigated to some extent by a substitution effect going in the other direction, as investors substitute alternative assets (equity among them) for money. On the other hand, if the inflation tax is offset by a lower corporate tax rate higher inflation will instead lead to higher real equity prices. If the inflation tax is not offset the effect should also be positive (for reasonable parameter values). There is an additional wealth channel at work here. Public expenditures are allowed to crowd out private expenditures through a decline in private wealth.

Groenewold, O'Rourke, and Thomas (1997) use a portfolio-balance approach in order to investigate whether the negative relation between equity returns and expected inflation can be the result of omitted variables in the estimated stock return equation. The idea is to incorporate all the relevant variables in the real equity equation by deriving a reduced form equation from a simple structural macroeconomic model. They postulate four real asset demand functions for money, domestic bonds, foreign bonds, and equity:

$$m^d = m^d\left(-\pi^e, i-\pi^e, i^f + \overset{\bullet}{e}^e/e - \pi^e, i^s - \pi^e, y\right),$$

$$b^d = b^d\left(-\pi^e, i-\pi^e, i^f + \overset{\bullet}{e}^e/e - \pi^e, i^s - \pi^e, y\right),$$

$$b^{fd} = b^{fd}\left(-\pi^e, i-\pi^e, i^f + \overset{\bullet}{e}^e/e - \pi^e, i^s - \pi^e, y\right),$$

$$s^d = s^d\left(-\pi^e, i-\pi^e, i^f + \overset{\bullet}{e}^e/e-\pi^e, i^s-\pi^e, y\right),$$

where the arguments are the expected real returns on the four assets as well as real income, y. π^e is expected inflation, i (i^f) is the nominal interest rate on domestic (foreign) bonds, $\overset{\bullet}{e}^e$ is the expected rate of exchange rate depreciation, and i^s is the return on equity. Real income is endogenized by the product market clearing condition,

$$y = c(y-u) + v\left(i-\pi^e\right) + t\left(eP^f/P\right) + g,$$

where $c(\cdot)$ is real consumption, u is real tax collections, $v(\cdot)$ is real investment, $t(\cdot)$ is the real trade balance, eP^f/P is the real exchange rate, and g is real government expenditure. The expectations variables, π^e and $\overset{\bullet}{e}^e$, are derived by estimating general forcasting equations including only lagged variables of the model as regressors. From this model Groenewold, O'Rourke, and Thomas (1997) derive a reduced form equation for the real stock return,

$$i_t^s = \delta_0 + \delta_1\left(i_t^f + \overset{\bullet}{e}_t^e/e_t\right) + \delta_2 g_t + \delta_3\left(e_t P_t^f/P_t\right) + \delta_4 u_t + \delta_5 \pi_t^e + \delta_6 m_t. \quad (3.29)$$

Before estimating this reduced form Groenewold, O'Rourke, and Thomas regress stock returns on expected inflation as the only explanatory variable for a set of Australian data for the period March 1960 to September 1991. They find a negative but insignificant relation between stock returns and expected inflation. When they instead go ahead and estimate the reduced form in (3.29) the anomalous result becomes *larger* and statistically significant. Hence, they conclude that the anomaly is not the result of a misspecified estimating equation. They next proceed to estimate the structural model (by 2SLS to take account of the simultaneity problem). Different versions of the model are then simulated to try to locate the source of the negative correlation between stock returns and expected inflation. They find that the link, through real income, between the IS-LM part of the model and the stock returns equation is crucial for the finding of a negative correlation between real stock returns and expected inflation. They conclude that the negative relation is not a puzzle in the framework of their simple macroeconomic model.[14]

[14] Klotz and Meinster (1986) also employ a simple IS-LM model. They combine an IS-LM model with the Capital Asset Pricing Model. However, they do not analyze the relationship between equity returns and inflation, but suggest this application of their framework for future research.

3.5. What Have We Learnt From the Theoretical Models?

The empirical findings of a negative relationship between money and real stock returns are easily explained in a theoretical model. Thus, the negative relationship is not a puzzle. This conclusion is reached regardless of the modeling approach used: money-in-the-utility-function, cash-in-advance, transactions technology, or structural macroeconomic model. Several of the theoretical models also show the connection between a negative money-stock return relationship and a counter-cyclical monetary policy, while a pro-cyclical monetary policy can lead to a positive relationship. This is consistent with the empirical findings of Kaul (1987) and others.

4. Conclusion

The present paper presents a comprehensive review of the literature on the interaction between real stock returns, inflation, and money growth, with a special emphasis on the role of monetary policy. This is an area that has interested monetary and financial economists for a long time. Monetary economists have tended to focus on the question whether money (or monetary policy) has any effect on real stock prices, while financial economists have have been more interested in the question of whether equity is a good hedge against inflation.

It seems clear from a number of empirical studies that money can help predict stock returns to some (small) extent. While the findings of the earlier studies were ambiguous later studies, that have made an effort to measure the actual monetary policy stance, have found unambiguous evidence that monetary easing leads to higher equity prices. Monetary policy also seems to exert an influence on stock prices whether or not business cycle variables are included in the analysis.

The empirical evidence suggest that real stock returns are adversly affected by both the expected and the unexpected rate of inflation. Several explanations for the negative relation have been put forward. The evidence that some form of market imperfection could be the explanation seem to be quite weak. The hypothesis that the empirical relation between inflation and stock prices is the result of inflation proxying for real activity has received support in a number of empirical studies and is also explained in this way in a number of theoretical models. Thus, the negative relationship can no longer be said to be a puzzle.

The important connection between the negative inflation-stock returns relation and the stance of monetary policy has also received support in both empirical and theoretical studies. If the monetary authority conducts a counter-cyclical monetary policy this will result in a negative relation between expected inflation and stock returns, while if it conducts a pro-cyclical monetary policy we could see a positive relation between expected inflation and stock returns. At longer horizons, stocks seem to be a good hedge against both expected and unexpected inflation. There is also evidence to suggest that in times of high and variable inflation investors receive a risk premium for holding equity.

As should be evident from this survey there remains much research to be done in this area. The empirical analyses using VAR models could be further refined and more studies could be performed on non-US data. It would be of interest to see more work done on the relation between stock prices and monetary *policy* - theoretical and empirical. One idea would be to take as a point of departure the literature on optimal monetary policy rules.[15] That type of framework would also lend itself to analyzing the important issue of if and how the central bank should react to changes in stock prices.

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[15] See for example Rudebusch and Svensson (1998) and the references listed therein.

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