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MACROECONOMICS AND FINANCE:  
THE ROLE OF THE STOCK MARKET

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Macroeconomics and Finance: The Role of the Stock Market

ABSTRACT

The treatment of the stock market in finance and macroeconomics exemplifies many of the important differences in perspective between the two fields. In finance, the stock market is the single most important market with respect to corporate investment decisions. In contrast, macroeconomic modelling and policy discussion assign a relatively minor role to the stock market in investment decisions. This paper explores four possible explanations for this neglect and concludes that macro analysis should give more attention to the stock market. Despite the frequent jibe that "the stock market has forecast ten of the last six recessions," the stock market is in fact a good predictor of the business cycle and the components of GNP. We examine the relative importance of the required return on equity compared with the interest rate in the determination of the cost of capital, and hence, investment. In this connection, we review the empirical success of the Q theory of investment which relates investment to stock market evaluations of firms. One of the explanations for the neglect of the stock market in macroeconomics may be the view that because the stock market fluctuates excessively, rational managers will pay little attention to the market in formulating investment plans. This view is shown to be unfounded by demonstrating that rational managers will react to stock price changes even if the stock market fluctuates excessively. Finally, we review the extremely important issue of whether the market does fluctuate excessively, and conclude that while not ruled out on a priori theoretical grounds, the empirical evidence for such excess fluctuations has not been decisive.

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MACROECONOMICS AND FINANCE:  
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Although most would agree that corporate investment and financing decisions along with the study of the behavior of financial markets and institutions are within the sphere of finance, the boundaries of this sphere, like those of other specialities, are both permeable and flexible. A broader description of the subject would be the study of individual behavior of households in the intertemporal allocation of their resources in an environment of uncertainty and of the role of private-sector economic organizations in facilitating these allocations. Macroeconomics analyzes the behavior of the entire economy, and hence, by definition, encompasses and draws upon the field of finance.

Macroeconomics has traditionally had a common interest with finance in the modeling of financial markets and asset pricing. Some clear examples are the theories of the term structure of interest rates, portfolio demand functions, and corporate investment decisions. Models of intertemporal optimization are widely used in both fields. The emphasis in the use of these models in macroeconomics has been to analyze consumption and investment decisions; in finance, they provide the basis for asset demands, equilibrium capital asset pricing, and corporate investment decisions.

While the role of risk and uncertainty is central in each of these areas, it is perhaps not surprising that finance with its focus on security pricing and corporate investment decisions has placed greater emphasis on the explicit analysis of risk than does macroeconomics. Indeed, in the absence of uncertainty, much of what is interesting in finance disappears. Under certainty, all securities are perfect substitutes (except for different tax treatments) and therefore, only one financial market is required for the economy. Corporate investment decisions moreover, require nothing more than a net present value calculation of known future net cash flows discounted at the known risk-free interest rate. It is the complexity of the interaction of time and uncertainty that provides intrinsic excitement to the study of finance.

To help locate the distinction between the treatment of uncertainty in traditional macroeconomics and finance, consider the role of regression models which are, of course, used in both fields. In traditional macro, the emphasis is on the explanatory variables and the residuals are treated as simply noise which preferably should not be there. By contrast, in finance, it is precisely the noise (or as it is formally described, "the non-forecastable components" of the relevant economic variables) that represent the uncertainties which significantly influence economic behavior. In short, if there were no residuals, then there would be no subject of finance.

The differences between the two fields in making explicit the treatment of risk is no doubt in part, a function of the difficulty in doing so. To develop the risk analysis of assets (as, for example, in the Capital Asset Pricing Model in finance), it is necessary only to specify the stochastic structure of asset returns. In a complete macroeconomic model, the implied

distributions of asset returns must be derived from the stochastic structure of preferences, technology, and policy. The last fifteen years have nevertheless seen a significant development of stochastic macroeconomics. Following the early unpublished work by Mirrlees (1965), Brock and Mirman (1972; 1973), Bourguignon (1974) and Merton (1975) among others extended the neoclassical growth model to include uncertainty about technological progress and demographics. The role of stochastic disturbances in business cycles was long ago recognized by Slutsky (1937), and it has in the last decade become common to include these disturbances explicitly in theoretical models of the business cycle. It is also becoming standard in econometric studies to provide a model of the error term rather than simply tack an error term onto a deterministic equation.

Exemplifying the two-way direction of the flow of ideas between finance and macroeconomics are models by Lucas (1978), Brock (1982) and Merton (1984), that explicitly connect the distribution of financial asset returns with real sector production techniques. Brock (1979) and Malliaris and Brock (1982) represent more ambitious attempts to integrate the two fields.

The notion that arrangements for dealing with risk may have important macroeconomic consequences is reflected in one strand of the analysis of labor contracts. In the Azariadis (1975)-Baily (1974) approach, labor contracts with constant real wages are a mechanism by which risk neutral firms provide insurance to risk averse workers. Such contracts have been taken as providing a rationalization for stickiness of wages, though it should be noted that the model is one of real rather than nominal wage rigidity. The inclusion of capital markets in the Azariadis-Baily analysis provides an alternative source of diversification for workers.

Information is a second general heading under which much that is common to the two fields falls. The concept of efficient capital markets and the question of the extent to which prices reveal information provided the impetus for analytical and empirical developments in this area. Both fields have drawn on information to provide explanations of basic puzzles. In finance, signalling theory has been used as a possible explanation for the payment of dividends by firms. Determinacy of the corporate debt structure under conditions in which the Modigliani-Miller theorem would otherwise hold if there were perfect information can be obtained by viewing the firm's management as the agent of the principal (stockholders).

The rational expectation equilibrium approach to macroeconomics developed in the past fifteen years is an information-based attempt to explain the business cycle and the nonneutrality of money. In the original Lucas (1972) model, individuals use observed local prices to make inferences about the unobserved aggregate price level, thus producing a nonexploitable Phillips type tradeoff. Subsequent extensions (for example Lucas (1975), Kydland and Prescott (1982)) in which error terms are sums of unobserved components of differing degrees of serial correlation permit the basic approach to generate persistent, and thus business-cycle like, deviations of output from the full information equilibrium level.

Incomplete information has also been used as the basis for the alternative view of labor contracts, in which the form of the contract depends on the firm having better information about the state of the world than do workers (Hart, 1983). With risk averse firms, such contracts can generate states in which there is underemployment when the firm has a low marginal revenue product.

Information can also be used to explain asset price dynamics. Huang (1983) has shown that if the arrival of information in the economy can be modeled by a finite-dimensional diffusion process, then security returns will follow the Ito processes which are widely used to model these returns in finance models. Duffie and Huang (1983) were able to show that with continuous trading, a finite number of securities (and therefore, in this case, an incomplete market) is a perfect substitute for complete Arrow-Debreu markets. That is, they have shown that frequency of trading (which appears to be satisfied by real world financial markets) is a substitute for large numbers of state-contingent securities (many of which are obviously missing in the real world).

As is readily apparent from even this cryptic survey, there is much to be discussed in detailing the links between the fields, tracing both the direct influence of each field on the other, and the extent to which the fields have simultaneously drawn on and contributed to developments in economic theory. The dynamic developments underway in both fields would quickly render obsolete any single attempt to do so. Rather than attempt such a survey, we, therefore, focus the paper on a single theme--the role of the stock market in macroeconomics, and particularly in the investment decision--with the hope that this teaser will encourage both financial and macroeconomists to explore and keep up with further developments in each other's fields.

The treatment of the stock market in finance and macroeconomics exemplifies many of the important differences in perspective between the two fields. The stock market is the single most important market in finance. Although firms finance a significant portion of their investments by debt, stock prices are seen as providing the key price signals to managers regarding

corporate investment choices. These prices also serve as a measure of performance for past investment decisions. In contrast, macroeconomics assigns a relatively minor role to the stock market in investment decisions. Despite the contributions by Tobin, Brunner and Meltzer (1976) and others that give the stock and other asset markets at least an equal claim for attention, the important financial markets in macroeconomics have traditionally been the money and debt markets. This focus, especially with respect to policy, is underscored by the current discussions of the effects of fiscal and monetary policy on investment that are dominated by the high levels of real interest rates in the bond market.

The balance of the paper is organized around four possible explanations for the lack of emphasis on the stock market in macroeconomic analyses of the business cycle. First, there may be a widespread belief that, as an empirical matter, the stock market is a poor predictor of the rate of investment and other components of GNP. We examine the predictive abilities of the market in Section 2.

Second, it may be believed that "the" interest rate is the appropriate indicator of the cost of capital, even in an uncertain environment. Such a belief could stem from the habit of formulating models in a (quasi) certainty environment. The emphasis on the interest rate as the cost of capital would also be justified if changes in the cost of capital were perfectly correlated with changes in the interest rate. We examine the question of the appropriate discount rate for investment in Section 3. Because the appropriate cost of capital includes stock market variables, we continue the discussion of the role of stock prices in affecting investment in Section 4, using the framework of "Q" theory.



A third possible reason to ignore the stock market arises from a view held by some macroeconomists that the focus of business cycle analysis should be on the "deep" parameters of tastes and technology, and the economic policies and disturbances that interact with tastes and technology to produce the cycle. On such a view, the stock market is, at most, simply a passive predictor of subsequent economic events. In a general equilibrium sense, all prices are of course endogenous, and such a narrow focus would therefore rule out interest in any financial market variables. Presumably even those who want to focus on the structure of the economy should also be interested in the mechanisms by which the "truly" causal economic variables affect the business cycle. In Section 5, we consider exogenous events that primarily affect stock prices and describe the mechanism by which the resulting stock price changes can affect investment. We then address the issue of whether these events are any less significant in their impact on investment than those that transmit their effects primarily through interest rates.

A final explanation for the lack of emphasis on the stock market may be a widespread distrust of the reliability of stock prices as indicators or causes of investment because it is believed that stock market participants are rather poorly informed and/or that stock prices are significantly influenced by irrational waves of optimism and pessimism among investors. Keynes' description of the stock market as a casino struck this chord, which continues to vibrate sympathetically among macroeconomists even today. The critical question of stock market rationality with its wide-ranging implications for both finance and macroeconomics is the topic of discussion in our concluding Section 6.

## 2. The Stock Market as a Predictor of the Business Cycle

Economic theory tells us that in a well-functioning and rational stock market, changes in stock prices reflect both revised expectations about future corporate earnings and changes in the discount rate at which these expected earnings are capitalized.<sup>1</sup> Corporate profits are an important part of GNP and are also likely to be positively correlated with other components of GNP. The forward-looking property of stock prices would, therefore, appear to qualify the stock market as a predictor of the business cycle. If, moreover, the information reflected in stock prices is of high quality, then stock prices should provide accurate predictions.

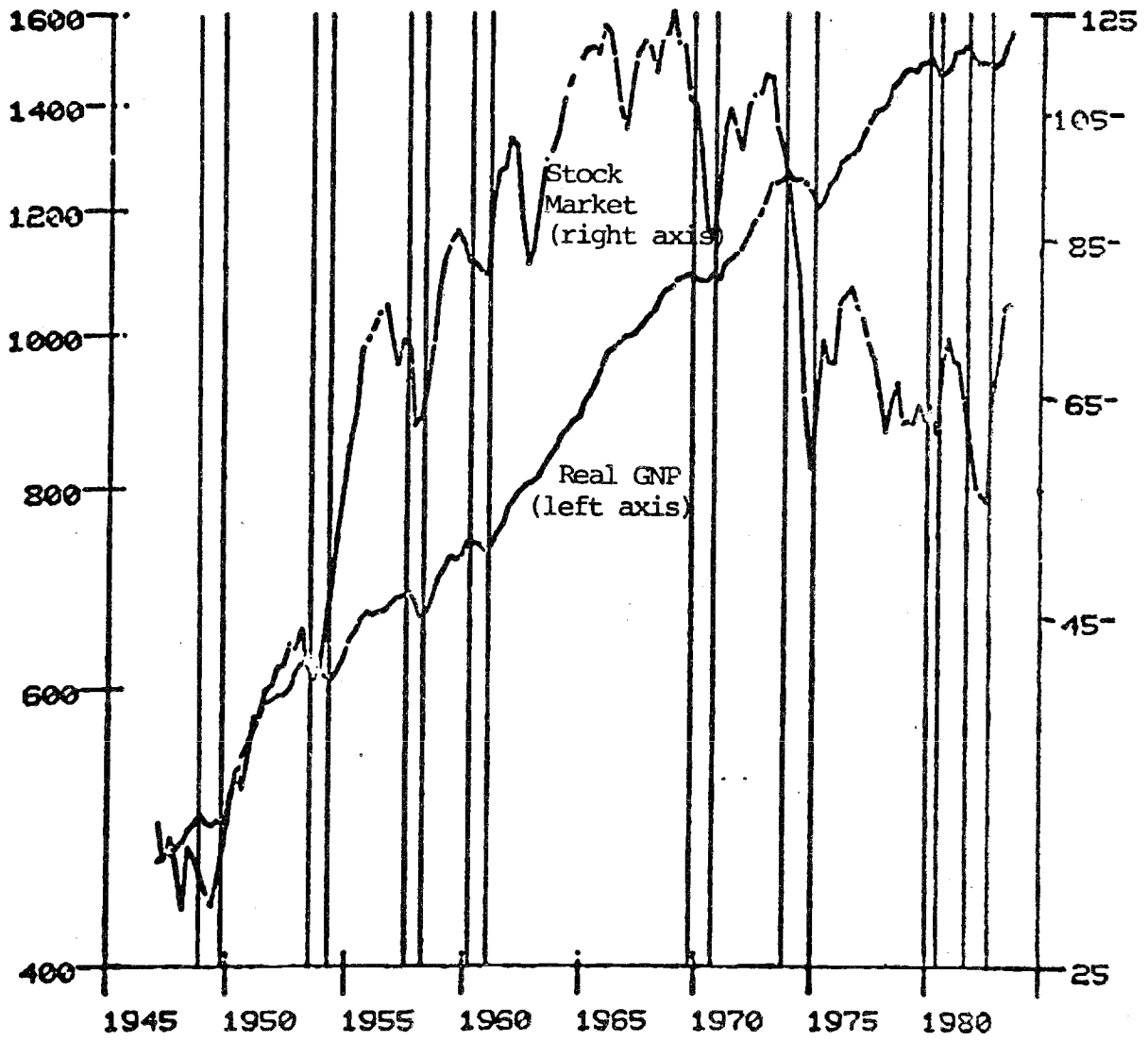
While the stock market has long been recognized as a predictor of the business cycle in theory, macroeconomic forecasters have hesitated to attach significance to its predictions. In the 1920s, stock prices were the main component of the (leading) "A" curve in the Harvard ABC system developed by Warren Persons to track the business cycle. The original Mitchell-Burns list of leading indicators (1938) included an index of stock prices. While Standard and Poor's 500 Index of stock prices is currently among the Commerce Department's leading indicators (see Moore (1983, Chapter 25)), it receives rather modest attention by comparison with other indicators such as interest rate and money supply changes which are frequently highlighted in business cycle forecasts by macroeconomists. Although many forecasters do use stock prices as an important input in their business cycle predictions, the predictive ability of the stock market as perceived by macroeconomists generally is probably well-described by the often-quoted remark that "the market has forecast ten of the last six recessions."

Moore (1983, Chap. 9) reviews and interprets the evidence from 1873 through 1975 on the stock market as a business cycle indicator. Writing in 1975, he noted that since 1873, stock prices had led the business cycle at eighteen of twenty three peaks and at seventeen of twenty three troughs. For the post-World War II period, the "only instances since 1948 of an economic slowdown where there was no substantial decline in stock prices were in 1951-1952 [and 1980]." (p. 147, material in brackets added by Moore.)

Figure 1 shows the Standard and Poor's 500 index (deflated by the GNP deflator) and the real GNP for the period since 1947, with recessions marked off by vertical lines. The stock market falls in the quarter before each of the eight recessions, except in 1980, and typically continues falling well into the recession. On several occasions (1962; 1966; 1971, and 1977-1978), the market fell sharply without being followed by a recession. Thus, the standard comment about the market would appear to be accurate. It is perhaps not appropriate, however, to count all these "false" predictions against the market since in both 1962 and 1966 output did grow less rapidly following the stock price decline. That is, the market should have predicted eight of the last six recessions.

A more relevant question is, of course, whether there are better business cycle predictors than the stock market. Moore's (Chap. 25, p. 386) tabulation of the forecasting record for 1873-1975, measuring success by the percentage of turning points (up as well as down) predicted, has the stock market narrowly edging out the liabilities of business failures as the best leading indicator. By this criterion, the stock market is therefore, the best single leading indicator.

FIGURE 1  
REAL OUTPUT AND THE STOCK MARKET



Note: Stock Market is the S&P 500, deflated by the implicit GNP deflator.

Table 1: Variance Decomposition for Real GNP Forecasts,  
Ten Variable Monthly Vector Autoregression Model.

<u>Innovations in:</u>	<u>Percentage of Variance Accounted for at Specified Horizon (in Months)</u>		
	1	13	48
M1	.03	6.6	8.5
Standard and Poor's 500	.63	16.4	35.7
Three month TB rate	.25	10.2	32.7
Total nonfinancial debt	0	0.2	0.3
GNP deflator	.09	0.1	0.4
Change in business inventories	47.5	22.2	4.4
Real GNP	51.5	42.7	13.5
Federal outlays	0	0.2	0.6
Federal receipts	0	1.3	3.0
Exchange rate	0	0.2	0.9

Notes: 1. Model is described in Doan, Litterman and Sims (1983).

2. Variance decompositions are based on ordering of variables shown above.

3. Interpretation of variance decomposition is, e.g. that 6.6% of the variance of GNP forecast for 13 month horizon is accounted for by innovations in M1 over the next twelve months.

Table 2: The Stock Market as Predictor of Real GNP Growth and its Components Annual Data, 1950-1982

Regression #	Dependent Variable	Independent Variable										Statistics			
		CONST	STOCK <sub>-1</sub>	DRAAAX <sub>-1</sub>	DRTBX <sub>-1</sub>	DINF <sub>-1</sub>	GNPGR <sub>-1</sub>	RHO	R <sup>2</sup>	SER	DW				
R1	GNPGR	3.16 (3.85)					0.08 (0.43)						-0.03	2.84	1.62
R2		3.09 (4.81)	0.11 (6.62)								0.50 (2.98)		0.54	1.90	1.97
R3		3.19 (6.58)	0.09 (5.36)	-0.51 (-2.49)	0.01 (0.08)	-0.17 (-1.53)					0.41 (2.29)		0.64	1.68	1.94
R4	IGR	2.67 (2.10)	0.27 (4.85)								0.21 (1.14)		0.39	5.79	1.79
R5		3.07 (3.01)	0.16 (4.16)	-1.79 (-3.63)	0.54 (1.48)	-1.21 (-4.60)					0.35 (1.80)		0.73	3.85	1.96
R6	CONGR	2.37 (9.82)	0.06 (5.32)								0.21 (1.14)		0.45	1.09	1.99
R7		2.38 (9.08)	0.05 (4.39)	-0.06 (-0.41)	0.06 (0.58)	-0.05 (-0.63)					0.26 (1.31)		0.43	1.12	1.98
R8	CDGR	3.75 (3.05)	0.067 (3.22)								0.00 (0.02)		0.21	6.91	1.86
R9		4.43 (4.73)	0.089 (1.57)	-0.93 (-1.07)	-0.22 (-0.34)	-1.63 (-3.84)					0.02 (0.09)		0.57	5.09	1.95
R10	GGR	3.52 (2.65)	0.03 (0.43)										-0.03	7.48	1.24

Table 2 (continued)

Note: t-statistics in parenthesis.

Variable Definitions:

GNPGR is the percentage annual growth rate of real GNP.

IGR is the percentage annual growth rate of real total investment.

CONGR is the percentage annual growth rate of real nondurable consumption expenditures.

CDGR is the percentage annual growth rate of real durable consumption expenditures.

GGR is the percentage annual growth rate of real government purchases.

STOCC is the percentage annual growth rate of real value (deflated by CPIU) of the Standard and Poor's 500 index, December to December.

DRAAAX is the change in the real AAA bond rate, December to December, where the real rate is equal to nominal rate minus CPI inflation over the subsequent 12 months.

DRTBX is the change in the real Treasury bill rate, where the real Treasury bill rate is the average of realized real rates for each quarter, defined as the rate in the last month of the greater minus the CPIU inflation rate over the subsequent three months.

DINF is the change in the CPIU inflation rate, December over December.

Table 3: Financial Variables as Predictors of the Growth Rates of the Components of Real Investment, Annual Data, 1950-1982

Regression #	Dependent Variable	Independent Variable							Statistics			
		CONST	STOCX <sub>-1</sub>	DRAAAX <sub>-1</sub>	DRTBX <sub>-1</sub>	DINF <sub>-1</sub>	GNPGR <sub>-1</sub>	RHO	R <sup>2</sup>	SER	DW	
R11	BFIGR	3.24 (2.42)	0.26 (5.33)						0.36 (1.96)	0.47	4.96	1.76
R12		1.50 (0.91)	0.27 (5.61)				0.49 (1.49)		0.30 (1.40)	0.49	4.86	1.89
R13		3.55 (2.93)	0.21 (4.80)	-1.74 (-3.39)	0.42 (1.11)	-0.28 (-1.01)			0.41 (2.17)	0.63	4.17	1.81
R14		1.27 (0.86)	0.21 (5.30)	-1.38 (-4.11)		-0.69 (-2.69)	0.64 (2.32)		0.41 (2.22)	0.67	3.89	2.05
R15	RFIGR	1.29 (0.53)	0.31 (2.33)							0.12	13.84	1.61
R16		2.45 (0.94)		-0.28 (-0.23)						-0.03	14.99	1.67
R17		2.46 (1.30)	0.08 (0.71)	-1.22 (-0.87)	-0.39 (-0.34)	-3.54 (-4.67)				0.49	10.56	1.69
R18		7.60 (2.02)	0.14 (1.34)			-2.27 (-3.63)	-1.67 (-2.26)		0.37 (1.70)	0.54	10.02	1.71
R19	IICG	-0.05 (-0.39)	0.03 (3.82)							0.30	0.78	1.53
R20		0.03 (0.32)	0.015 (2.50)	-0.25 (-3.29)	0.01 (0.09)	-0.16 (-3.97)				0.64	0.56	2.14
R21		0.37 (2.36)	0.016 (3.01)	-0.25 (-5.64)		-0.12 (-3.53)	-0.10 (-2.64)			0.71	0.50	2.18

Note: t-statistics in parentheses.  
 Variable Definitions: BFIGR is the percentage growth rate of business fixed investment.  
 RFIGR is the percentage growth rate of residential fixed investment.  
 IICG is the percentage ratio of the change in inventory investment to lagged GNP, i.e.,  $GNP_{-1}$  where ICH is the real change in inventories. (Division by GNP is used rather than division by  $ICH_{-1}$  because ICH is sometimes negative.)



Regression analysis, which provides more formal measures of predictive power, also shows that the stock market helps predict GNP. As part of his explanation of the negative relationship between stock returns and inflation, Fama (1981)<sup>2</sup> showed that stock returns are positively related to the subsequent rate of growth of real GNP. Fama also showed that the stock market predicts a measure of the average rate of return on physical capital. He described his evidence as suggesting "a 'rational expectations' or 'efficient markets' view in which the stock market is concerned with the capital investment process and uses the earliest information from the process to forecast its evolution." (p. 555) Fama did not make any more specific claims about the role of the stock market in the business cycle. In particular, he chose not to distinguish between the stock market as predictor of the cycle and the stock market as possibly a causal factor in the cycle.<sup>3</sup>

Doan, Litterman and Sims (1983) in their ten variable vector autoregressive model, find the stock market playing a prominent forecasting role. Table 1 shows, for different forecast horizons, the share of the variance of GNP accounted for by innovations in the specified variables.<sup>4</sup> After one year, stock returns and changes in business inventories are the leading variables whose innovations account for movements in GNP. Over the longer four year horizon, innovations in stock prices are the single most important factor accounting for the variance of GNP.

Tables 2 and 3 present regressions that show the stock market as a predictor of the growth rate of GNP and its major components. The data are annual. Regression R2 confirms that the stock market contributes substantially to the prediction of the growth rate of real GNP. The stock market variable used is the increase in the real value of the Standard and

Poor's 500 index over the twelve months preceding the year for which the GNP growth rate is being forecast. Regression R3 suggests that the stock market is the most powerful single forecaster of the growth rate of real GNP. This claim is further supported by separate regressions of the growth rate of real GNP on each of the other financial independent variables in R3.<sup>5</sup>

The remaining regressions in Table 2 show that the stock market's forecasting ability of GNP can be traced to the fact that stock prices lead both investment and consumption expenditures. Stock prices and the inflation rate provide strong predictive power for investment although the long term real interest rate also has a significant coefficient. In the case of durable consumption, stock prices by themselves are a significant predictor of consumption; in a multiple regression the lagged change in the inflation rate is the single most powerful predictor, with changes in stock prices (a distant) second and other financial variables trailing. Stock prices are the only financial variable that help predict the growth rate of real nondurable consumption expenditures.<sup>6</sup> A 20% increase in the real value of the Standard and Poor's 500 index implies that the annual growth rate of consumption should be expected to rise by about 1.0%, for example, from a growth rate of 3% per annum to 4.0%. With both consumption expenditures and household (including non-profit organization) equity ownership at about two trillion dollars, a 20% increase in the real value of the stock market would be expected to increase consumption expenditures by about \$20 billion.<sup>7</sup> The stock market is a poor predictor of government expenditures, as are apparently all other financial variables.<sup>8</sup>

Table 3 examines the relationship between stock price returns and other financial variables and the growth rates of the three major components of

investment. In univariate regressions, R11, R14, and R17, the stock market helps predict each of the components of investment. The inclusion of lagged GNP growth in R12 and R14, and the introduction of other financial variables in R13 and R14, have very little effect on the coefficient of lagged stock prices.

The picture for residential fixed investment is mixed. The predictive power of stock prices disappears when other financial variables are introduced: the change in the inflation rate in particular appears to have power in predicting residential investment.<sup>9</sup> Lagged GNP growth enters R18 with a negative coefficient. Stock prices continue to play a role in forecasting inventory investment, as do real AAA bond rates and the inflation rate. Once again, lagged GNP growth enters with a negative coefficient, in R21.

In summary, Table 3 shows, using annual data, that the change in stock prices taken by itself has predictive power for each component of the change in investment, and that it retains its power to predict (especially) business fixed investment and inventory investment even when other financial variables and lagged real GNP growth enter the regression equations.

In Table A1 in the appendix, we present quarterly regression results for equations like those in Table 2. The quarterly results are similar to those for the annual data, with the stock market appearing if anything as a more powerful predictor in the quarterly data. The predictive power of the stock market can be gauged by comparing the standard error of the regression in A2 of 3.82% per annum, with the standard error obtained by Litterman in his six variable quarterly vector autoregressive model estimated over approximately the same period, of 3.58%.<sup>10</sup>

We do not, of course, claim that the stock price changes are the only predictors of business cycles. Indeed, even if stock prices were known to reflect all available information, we would not expect this to be so because the market is not directly in the business of predicting GNP. As noted, rationally-determined stock prices should be estimates of the present discounted value of expected future dividends or earnings. As shown in Marsh and Merton (1983), the one-year lagged percentage change in stock price is a strong predictor of the subsequent year's percentage change in dividends. Further evidence for this view can be found in Kleidon (1983) and Marsh and Merton (mimeo) where it is shown that price changes also predict subsequent changes in aggregate corporate profits. The correlation between changes in current stock prices and future changes in GNP therefore, arises from the market's attempt to forecast future earnings, which are correlated with GNP. This view is consistent with the evidence presented here. Stock prices were the best predictor of the business fixed component of investment and consumption and a poor predictor of government expenditures and residential housing investment.

Although our regression evidence, the work on leading indicators, and the Doan et al. study appear to suggest that stock price changes are the best single variable predictor of the business cycle, it is possible that an expanded study including more variables with a range of lags would uncover a better predictor.<sup>11</sup> It is however unlikely that the result of such an expanded study would be to eliminate the significance of stock price changes. It is a well-known empirical fact that there are no lagged variables which explain a meaningfully-large part of subsequent stock market returns. There are, moreover, few, if any, variables (other than speculative price changes)

which have high contemporaneous correlation with stock returns. Thus, in those cases where the stock market predicts a large proportion of the subsequent variation in economic variables, it is unlikely that the stock price changes are merely a proxy for some other observable variables. It seems, therefore, that our regression analysis provides impressive evidence to reject the belief that stock price changes are a poor predictor of the business cycle.

### 3. Measuring the Discount Rate for Investment

As noted in our introduction, the determination of the cost of capital or required expected return for corporate investment is a central issue common to both macroeconomics and finance. If pressed, both macroeconomists and financial economists would probably agree that the required expected return on aggregate investment is the weighted average of the expected return on equity and the interest rate where the weights are the market proportions of equity and debt outstanding. Despite this apparent agreement, even a casual inspection of the macroeconomics and finance literature reveals that the methods used in the two fields for measuring the aggregate cost of capital are widely different. In this section, we summarize the key differences in methodology between the fields and explore some of the possible explanations for these differences.

In discussing the discount rate for investment, macroeconomists traditionally focused on the real interest rate as determined from the bond market, while financial economists place most of their attention on the real expected return in the stock market. As already noted, the emphasis by macroeconomists on the interest rate may in part be due to the historical use of models of the financial markets derived in a certainty environment. In such models, and ignoring transaction costs, all securities are perfect substitutes, and therefore, the required return on equity is the same as the return on debt.

While the existence of uncertainty is, of course, recognized by macroeconomists, the common practice in their models was either to assume that investors were risk-neutral or simply to replace the economic variables assumed to be known for certain in the formal model structure by their

expected values. The existence of risk on some investments would be accounted for simply by adding a constant risk premium to the base risk free interest rate. There has also been a tendency to rely on nonrisk explanations of differential expected returns on securities such as differential tax treatments or transactions costs as in the Baumol-Tobin theory of the transactions demand for money.

Early empirical work in investment used interest rates as the cost of capital (for example, Hall and Jorgenson 1967). Soon thereafter, it became common to recognize explicitly the role of securities other than bonds in measuring the cost of capital (for example, Jorgenson and Stephenson, 1967). Initially, the dividend-to-price or earnings-to-price ratio was used as the equity rate component of the cost of capital. More recently, the Q theory of investment (to be discussed in Section 4), uses stock prices as one of its principal variables.

Even with these more recent developments, there are nevertheless, still considerable differences between the macroeconomic and finance approaches to measuring the cost of capital. While financial economists would surely accept different tax treatments and transactions costs as a reasonable explanation for the return differential between a short-term municipal bond and a treasury bill or a T-bill and a demand deposit, they would probably treat these nonrisk reasons as second order in explaining the expected return differential between debt and equity. Because dividends reflect only a portion of the total return on equity and because dividend changes are "sticky," financial economists generally attach little significance to changes in the dividend-to-price ratio as an indicator of the change in the equity component of the cost of capital. Because earnings are an accounting variable which reflects primarily

current-transactions cash flows of firms, they may not be a good proxy for "long-run" or permanent earnings which presumably is what is being capitalized by rational stock prices. Hence, financial economists would tend not to accept changes in the earnings-to-price ratio as a reliable indicator of changes in capitalization rates. While finance provides a number of strong arguments against using changes in these variables as proxies for changes in the aggregate cost of capital, it has, until recently, had relatively little to say about what are the good proxies to use to measure these changes. The reason is that finance has tended to focus on the relative pricing of financial and capital assets and therefore, unlike macroeconomists who are more concerned with changes in the aggregate cost of capital over time, financial economists in their models have concentrated more on measuring the cross-sectional differences in equilibrium expected returns among securities.

The best-known finance model of equilibrium expected returns is the Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM) which was developed almost twenty years ago and is derived by applying market clearing conditions to the Markowitz-Tobin mean-variance theory of portfolio selection. While there have been many subsequent improvements and extensions of the CAPM (e.g., Arbitrage Pricing Theory of Ross (1976); the Intertemporal CAPM of Merton (1973), and the Consumption CAPM of Breeden (1979)), it will suffice, for the purpose at hand, to limit the discussion to the original CAPM.

In these models, differences in equilibrium expected returns among assets are treated as being entirely due to differences in risk. An asset is said to be "riskier" than another if its equilibrium required expected return is larger. If one further defines "uncertainty about the return on an asset" so that it is measured by the amount of dispersion of the asset's return around



it means, then the CAPM provides a conceptual and specific quantitative distinction between "risk" and "uncertainty." That is, the only risk in the capital market is the macro uncertainty about the return on the aggregate market (which contains all assets held in proportion to their market values). Since all other uncertainties associated with individual assets can be eliminated by diversification, no investor is required to bear these uncertainties and therefore, in a well-functioning capital market, there will be no compensation in terms of a higher equilibrium expected return for bearing these risks. The risk of an individual security is measured by its marginal contribution to aggregate or market risk and the equilibrium expected return on each security  $i$ ,  $\hat{R}_i$ , will satisfy the Security Market Line (SML) condition:

$$\bar{R}_i - R = \beta_i (\bar{R}_M - R) \quad (1)$$

where  $\bar{R}_M$  is the expected return on the market portfolio;  $R$  is the interest rate; and  $\beta_i \equiv \text{Cov}(R_i, R_M) / \text{Var}(R_M)$ . "Beta" is the measure of a security's (relative) risk and it can be estimated reasonably accurately by using past time series and cross-sectional data.

While the CAPM is a rather attractive and practical model for evaluating differences in relative risk among assets, it has nothing to say about the determination of the risk-free interest rate (or, alternatively, the zero beta rate of return when there is no safe interest rate). It is because the CAPM is short of one rate of return, that it is a theory of relative rates of return. Macroeconomists who have been more concerned with changes in the rate of return over time have concentrated on theories of the rate of interest, which can be thought of as the rate of return missing from CAPM.

Before turning to the determination of the aggregate cost of capital, ( $\bar{R}_M$ , in the CAPM), we digress to point out one important insight provided by the SML relative pricing relationship which can be directly applied in macroeconomics. In discussing cost-benefit analysis and the evaluation of public investments and expenditures, it is commonplace to talk about the "social discount rate." As in the private market, there will not in general be a single rate which can be applied to the evaluation of all public investments because the risks of these investments will be different. An extended version of the CAPM can be used to determine these rates. Let  $\bar{R}_S$  denote the expected return on the combined private sector-public sector "market" portfolio, which takes into account assets held in both the public and private sectors. If there are adequate trading opportunities in the private markets so that the public sector does not provide significant additional risk-sharing opportunities, and if the risk characteristics of (nontraded) public investments are not significantly different from those in the private sector, then the required expected social return on a project in excess of the interest rate is proportional to  $(\bar{R}_S - R)$  where the proportionality factor is its beta measured now with reference to this broader market portfolio.<sup>12</sup>

If these conditions are not met, then a generalized form of the Security Market Line relation can be derived along the lines of Mayers (1972) who examines the effects of nontraded assets on capital market equilibrium prices. In this model, as with the more general intertemporal asset pricing models, which have more than one dimension of risk, aggregate market risk as measured by the variation in  $R_S$  is likely to be the most important systematic source of risk. The simple CAPM function is, therefore, likely to

provide a good approximation of the appropriate discount rate to be applied to most projects.

If individuals are risk averse and if there is aggregate uncertainty for the whole private-cum-public sector economy, then  $\bar{R}_S - R$  will be positive, and public investments with different "betas" will have different social discount rates. For example, in evaluating the present value of the costs associated with a government unemployment benefits program, the proper discount rate to apply to the expected costs is likely to be lower than the riskless interest rate, and therefore, the present value of the cost of the program will be higher than if the interest rate were used. We say this because these costs are likely to be negatively correlated with the general economy and therefore, the "social beta" will be negative. The common sense of this analysis is that expenditures are likely to be higher than expected if the economy is weak and therefore, taxes will be higher or expenditures on other programs will be lower, precisely when the economy is less wealthy. Similarly, the benefits of public investments whose returns are also likely to be counter-cyclical (and therefore, have negative social betas) should be discounted at a rate below the interest rate producing a correspondingly higher present value.<sup>13</sup> In summary, pro-cyclical (with positive social betas) investments and costs should be discounted at a rate higher than the risk free interest rate and counter-cyclical projects should be discounted at a rate lower than the interest rate.

As indicated in this digression, the aggregate cost of capital for either public or private investments will not equal the risk free interest rate unless all uncertainty can be diversified away. Despite the large number of people and firms in the U.S. (or for that matter, the World) economy, the Law

of Large Numbers cannot be validly applied to make this diversification argument because the economic activities of these entities are interdependent. Thus, as both an empirical and theoretical matter, there exists significant macro uncertainty.

As already noted, the focus of financial economists has been on the relative riskiness of capital assets. Their empirical research on the cost of capital has, therefore, emphasized the measurement of betas for individual firms and industries. In this endeavor, they have developed sophisticated time series-cross section estimation techniques which take into account changes in betas over time. Hence, these finance models capture the dynamic changes in the relative costs of capital among assets. The estimation techniques for determining the aggregate cost of capital are, in contrast, quite primitive. In principle, the aggregate expected excess return on the market,  $\bar{R}_M - R$ , is determined in the CAPM as a function of aggregate risk preferences of investors and the variance of the return on the market. Although, as an empirical matter, the variance rate on the market changes substantially over time, the traditional practice in finance is to assume that  $\bar{R}_M - R$  is a constant and to use a long time series (typically fifty years) average of the realized excess returns on the market to estimate it. It is also not uncommon to assume that the real risk free interest rate is a constant as well.<sup>14</sup> While such estimates may provide a reasonable assessment of the long-run level of the real cost of capital, they provide little help to macroeconomists who are more concerned with the short and intermediate runs and therefore, with transient changes in the cost of capital.

Although it might appear tempting to use the change in aggregate stock

prices as an indicator of the change in the cost of capital in a fashion analogous to the change in bond prices, stock price changes--unlike bond price movements--reflect both the change in assessments of expected future cash flows and the change in the rate at which these cash flows are discounted. Stock price changes are likely, therefore, to be a very noisy estimator of the change in the cost of capital. Some recent work in finance may, however provide a means for measuring such changes.

In the CAPM or for that matter, in a number of other models of capital market equilibrium, the expected excess return on the market will satisfy the condition  $\bar{R}_M - R = g(\sigma^2)$  where  $\sigma^2$  is the variance of the return on the market and  $g$  is an increasing function of  $\sigma^2$  with  $g(0) = 0$ . Hence, if changes in  $\sigma^2$  can be reasonably well estimated, then these changes can be used to estimate changes in  $\bar{R}_M - R$ . Estimation of models of this sort are presented in Merton (1980). As discussed there, it is much easier to obtain accurate estimates of  $\sigma^2$  and its changes from the past time series data of stock returns than it is to estimate  $\bar{R}_M - R$  from these data directly. The central importance of volatility in the Black-Scholes (1973) option pricing theory and its many extensions, has stimulated considerable research by finance academics and practitioners to improve the techniques of estimating variance rates of speculative prices.<sup>15</sup> As these techniques develop, they may provide a significant tool for the macroeconomist who requires estimates of the cost of capital.

Motivated by the Breeden (1979) model of asset pricing, others (cf. Grossman and Shiller (1981)) have attempted to use the variation in consumption as an indicator of changes in the cost of capital. Although

appealing in theory, the use of accounting and other nonspeculative price series to estimate the volatility and required economic returns on assets may have severe empirical problems. As numerous studies in finance have shown, the variations in firms' accounting returns and dividends are considerably smaller than the variation in the market returns of the corresponding firms' equities and other liabilities. Hence, techniques which use the volatility of such nonsecurity price variables are likely to understate the level and the changes in the cost of capital.

Perhaps notable by its absence from our discussion is the role of taxes in influencing the cost of capital. While macroeconomists appear to see the effects as complicated, but still clear-cut, financial economists who have also devoted considerable effort to studying these effects find greater ambiguity. Ranging from the early Modigliani-Miller work through the more-recent Miller "Debt and Taxes" paper (1977), and Modigliani (1982), there appears to be no theory of taxes which is consistent with rational behavior by corporate managers and the observed financing policies of firms. For example, virtually every model of taxes implies that firms should prefer to make share repurchases instead of paying dividends. (This conclusion is further reinforced when transactions costs are considered.) Yet, few firms undertake to repurchase their stock and most firms pay dividends. Even if the IRS limits on substituting share repurchase for dividends are taken into account, it is clearly the case that firms are, in practice, nowhere near the margin. Similarly, it is difficult to reconcile a tax-advantage to debt financing with the observed debt-equity mixes chosen by firms. Moreover, firm's investment and funding practices of their pension funds also appear to be inconsistent with most theories of taxes.

The different reactions of some macroeconomists and finance economists to these difficulties illustrate their different attitudes to the stock market and firm behavior. Public finance economists see the tax issue as clear-cut and concentrate on explaining an apparent "irrationality" in firm behavior. Finance economists assume that firm behavior is well understood and that tax incidence needs to be explained.

The empirical work attempting to identify from security returns whether changes in the level of tax rates or differences in the rates applied to the returns on securities (e.g., capital gains vs. ordinary income) significantly affect the cost of capital, have generally produced ambiguous results. There is, for example, considerable controversy over whether or not firms with a higher dividend-component of total return have higher required expected returns. Upon closer inspection of the details of the tax law, it becomes apparent why such an empirical ambiguity might be found. For example, because of the 85-percent dividend exclusion, corporations would prefer to receive dividend income over capital gains. Under the current law, the firm can undertake a form of tax arbitrage by purchasing shares of other firms sixteen days prior to the ex-date and selling the shares for a capital loss on that date. These "dividend-roll" transactions are further facilitated by the options markets. Because dividend payments made by short-sellers of stock are investment expenses which can be used to offset ordinary income (without the interest deduction limitation), it pays for high-bracket individuals to take the "other side" of the "dividend-roll" transaction. There are, of course, a number of tax-exempt institutions including more than \$800 billion in pension funds who presumably are indifferent to the form in which returns come. In this light, what would one predict about the magnitude of the differential

effect of paying dividends on the cost of capital? While we surely do not have the answer, we do believe that both macroeconomics and finance will gain much from further theoretical and empirical study which carefully takes into account the more detailed structure of the tax code.

To conclude, we briefly indicate why changes in the real interest rate may not be a reliable indicator of the change in the cost of capital. If, for example,  $R$  rises at the same time that  $\sigma^2$  falls, then it is entirely possible that  $\bar{R}_M = R + g(\sigma^2)$  may remain unchanged or even fall. Black (1976) has found empirical evidence that stock price changes are negatively correlated with changes in the variance rate of stock returns. Therefore, one should be particularly careful about using the change in the interest rate as a proxy for the change in the cost of capital in periods when both the stock market and the real interest rate rises, as appears to be the most recent experience. Moreover, as explained in the section to follow, it is entirely possible that a rise in both  $\bar{R}_M$  and  $R$  (which implies an increase in the cost of capital), may nevertheless be accompanied by an increase in the rate of investment.



#### 4. The Cost of Capital, Q, and Investment

In the previous section, we noted that the rates of return on both stocks and bonds determine the cost of capital, or the hurdle rate that investment projects have to meet. Although this point is well understood both in principle and in modern empirical analyses of the determinants of investment spending, the tendency in policy discussion has nevertheless been to concentrate on the real interest rate (perhaps but not usually tax adjusted) as the measure of the cost of capital. To take only the most obvious example, the major concerns about the current state of the economy are that the high real interest rate will cut short the recovery and, by keeping investment low, cause continued low secular productivity growth.

To understand the concentration on the real interest rate on bonds, consider the general formula for the price of equity:

$$p(t) = E_t \left\{ \sum_{i=0}^{\infty} \frac{D_{t+i}}{(1 + rc_{t+i})^i} \right\} \quad , \quad (2)$$

where  $E_t$  is the conditional expectation operator; the term  $D(t + i)$  is the cash flow available for distribution to current stockholders in period  $(t + i)$  and  $(1 + rc(t + i))$  is the (possibly stochastic) discount rate applied to such flows. Because stock prices may rise either because estimates of future earnings increase, or because the discount factor or the cost of capital decreases, it is difficult to deduce changes in the cost of equity capital from stock price movements. Despite its shortcomings as an indicator of the cost of capital, the interest rate, because it is observable, appears to be a "hard number" which makes it attractive as an estimate of the cost of capital and thus of investment prospects. However, this seemingly attractive aspect of the interest rate may be somewhat illusory. First, the real

interest rate on nominal bonds is not a hard number--and this is particularly true for the long-term real rate which is presumably more relevant to investment. Second, even if the real investment rate were observable and even if it were the appropriate measure of the cost of capital, changes in this rate--like changes in stock prices--can occur either because earnings prospects have changed, with a consequent shift in the demand for funds, and/or because the quantity of funds supplied at a given interest rate has changed. An improvement in investment prospects will lead firms to increase borrowing, and thereby drive up the real rate of interest. If changes in the real interest rate are primarily a result of shifts in the demand for funds, caused for instance by changes in estimates of future earnings, high real interest rates will be associated with high rather than low investment.

Researchers who work on the relation between investment and the cost of capital typically try to avoid the identification problem by asserting that the supply of funds to the corporate sector is infinitely elastic and therefore independent of shifts in the corporate demand for funds. This argument is not entirely persuasive given that net corporate investment is on average more than 50% of net domestic saving.<sup>16</sup> An appeal to the rest of the world as a source of unlimited capital at a real interest rate independent of the demand for corporate investment in the United States is also less than convincing because the demands for capital are likely to be highly correlated across countries and the U.S. is a large component of the World market.

Thus, to use the real interest rate as an indicator of investment prospects can be misleading. Indeed, precisely because stock prices can move as a result of changes in both expected earnings and discount rates, stock prices are likely to provide a better indicator of investment prospects than

do interest rates. For instance, an improvement in investment opportunities, and hence, earnings prospects, that raises the demand for funds and thus the cost of capital, will nonetheless result in a rise in stock prices, which will appropriately signal an increase in investment.

The Q theory of investment centers around the relationship between investment and stock prices. Tobin and Brainard (1977) quote Keynes to give the essence of the approach:

[The] daily revaluations of the Stock Exchange, through they are primarily made to facilitate transfers of old investments between one individual and another, inevitably exert a decisive influence on the rate of current investment. For there is no sense in building up a new enterprise at a cost greater than that at which a similar existing enterprise can be purchased; whilst there is an inducement to spend on a new project what may seem an extravagant sum, if it can be floated off on the Stock Exchange at an immediate profit.<sup>17</sup>

Q theory, associated particularly with James Tobin, and which has been developed more by macroeconomists than finance theorists, is now the preferred theoretical description of investment. The rate of investment is determined by the condition that the marginal cost for the firm of adding to its capital stock is equal to the price at which it can sell a weighted average package of equity and debt claims on that capital.

Empirically Q has generally been calculated as the ratio of the stock plus bond market valuations of firms to the estimated reproduction costs of their capital.<sup>18</sup> Although Q typically enters regression equations for the rate of investment significantly,<sup>19</sup> the empirical success of the Q theory is generally regarded as mixed. There are two main difficulties. The first is that the residuals from the investment (relative to capital stock) on Q equation are heavily serially correlated.<sup>20</sup> Because the standard form of the adjustment cost function used in developing the theory implies that the

rate of investment is determined solely by current Q, the serial correlation is inconsistent with the simplest forms of the Q theory. But modification of the adjustment cost function to incorporate lags in the investment process implies that lagged Q also affects current investment (Fischer (1984)).

Alternatively, the serial correlation may simply reflect errors in measurement caused by accounting measures of investment. Second, despite the implication of existing forms of the Q theory that Q is a sufficient statistic for the rate of investment, other variables, particularly GNP and/or profits, appear to affect investment over and above the effects of Q. However, provided these additional variables are instrumented to remove simultaneity bias, Q still has explanatory power for investment.<sup>21</sup>

These difficulties in the empirical implementation of the Q theory of investment should not however obscure the main point, which is that there are good theoretical reasons and, as we have seen, convincing empirical evidence to suggest that the stock market should be a predictor of the rate of corporate investment. Further, because the real interest rate may be high either because of demand or supply conditions in the market for debt finance, it is not surprising that—as in the results presented in Section 2—the real interest rate is a less good predictor of corporate investment.<sup>22</sup>

We are not here arguing that estimated real interest rates do not function as predictors of corporate investment, nor that they should not be considered, along with equity capital, as a component of the cost of capital. Rather we are arguing against the practice in policy discussions of considering only the real interest rate as the cost of capital and predictor of investment. If indeed, it were necessary to consult only one piece of financial information, then we believe that it would be preferable to look at stock prices, instead

of interest rates—but of course there is no need to consider only a single indicator.

Although it would not be appropriate in this paper to undertake an extended discussion of the current (November 1983) economic outlook, a brief discussion is in order. The stock market is at a high level relative to recent years.  $Q$  is currently at about 0.9, compared with an average of 0.76 over the 1974 to 1982 period, and 0.68 for 1980-1982.<sup>23</sup> Short-term and possibly even long-term real interest rates are, however, at unprecedentedly high levels. The stock market looks good for investment; real interest rates look bad. What should be the overall assessment? There is no avoiding the fact that the signals conflict. Nevertheless, we place great weight on the stock market as a signal that earnings prospects for corporate capital are good. Changes in depreciation and other investment related allowances in the 1981 and 1982 tax bills reduced the after-tax cost of capital to corporations<sup>24</sup> and thus effectively offset part of the increase in the cost of debt capital produced by higher real interest rates. This factor may further reduce the weight that should be given to high real interest rates as predictors of low corporate investment.

The situation is different for residential investment. The tax changes of 1981 and 1982 reduced the cost of capital for corporate relative to residential investment; the prospects for residential investment indeed are worse than they were in the seventies. But there is no reason to think that this change in the relative cost of capital for housing and corporate investment is inconsistent with the objectives of policymakers.

To say that the stock market is signalling good investment prospects is not, of course, to assert that policy measures that reduce the cost of capital

would not increase investment, or that lower real interest rates would not significantly reduce the problems of debt-burdened developing countries. There are good reasons to think that policy actions that lower real interest rates would have some desirable consequences. But it is not obvious that the current unprecedented high real interest rates are signalling a period of unprecedentedly low corporate investment in the United States.

Why, despite the theoretical and empirical case for treating the stock market as an indicator of future investment, is the interest rate nonetheless still the focus of policy discussions? Perhaps Bosworth's (1975, p. 286) comment on Q summarizes best what many macroeconomists still regard as the main difficulties with investment theories based upon stock values:

The most serious problem with the approach [Q theory] as a vehicle for understanding investment behavior is that it shifts the focus from what determines a firm's investment to what determines values in the stock market. It does not seem practical to focus upon responses in the stock market to measure the impact on investment of a change in the tax law. Nor does it seem reasonable to believe that the present value of expected corporate income actually fell in 1973-1974 by the magnitudes implied by the stock-market decline of that period, when q declined by 50 percent. Of course, an equilibrium relationship must exist between the market value of a firm and the replacement cost of its capital. But it is quite another thing to infer a causal mechanism from this relationship and to allege that changes in stock prices reflect only revised evaluations of the discounted value of prospects for corporate earnings. As long as management is concerned about long-run market value and believes that this value reflects 'fundamentals,' it would not scrap investment plans in response to the highly volatile short-run changes in stock prices.

Bosworth's criticism can be partitioned into four assertions: 1) There is a distinction between the determinants of investment and the determinants of stock values. 2) It may be difficult to infer the effects of policy changes, such as tax incentives, using Q theory. 3) There is no useful sense in which the stock market can be said to cause investment. 4) Because the market

fluctuates excessively, and investment takes time to plan and bring on line, firm managers will pay little attention to  $Q$ .

In concluding this section, we respond briefly to the first two of these assertions, which relate to  $Q$ , and leave to the sections to follow a more extensive response to the last two. First, stock prices and investment may indeed move in opposite directions in response to events that have differential effects on average and marginal  $Q$ . For instance, an oil price shock, that reduces the productivity of existing capital will reduce average  $Q$ , but marginal  $Q$  will be high for investment in fuel-efficient capital. Or, an increase in the investment tax credit for new investment accompanied by a decline in depreciation allowances for capital already in place might reduce average  $Q$  while increasing marginal  $Q$ . Because average and marginal  $Q$  may move in opposite directions, it is preferable where possible to work with marginal  $Q$ , for instance by attempting directly to estimate marginal  $Q$ , or by trying to find stock values for firms whose values depend to differing degrees on existing capital and prospective investment. As noted above, there is evidence both that marginal and average  $Q$  tend to move in the same direction and that investment and average  $Q$  are closely related.

In arguing that the determinants of investment and stock values may differ, Bosworth may also mean that market participants are subject to bursts of animal spirits that have little to do with rational expectations of the prospects for the outcomes of investment projects—and that investment decisions are not affected by such animal spirits. This interpretation is similar to his assertion 3, and it presumes that stock market prices reflect either irrationality or relatively low-quality information when compared with our macroeconomic models. We therefore delay further comment until Section 6,

which addresses the issue of stock market rationality.

Bosworth's second point is that it may be more difficult to infer the effects of policy measures on  $Q$  than on the cost of capital. Provided that stock prices are rationally determined, use of the fundamental valuation formula for equity makes it possible to determine the effects on  $Q$  of tax changes that affect both the cost of capital and expected future profits. Both must, of course, be determined to predict the effect on investment. Further, modern econometric methods aim at estimating adjustment cost functions, so that the relationship between  $Q$  and investment can also be predicted.<sup>25</sup>



## 5. Stock Prices As a Cause of Investment

As mentioned in the introduction, one possible explanation for the neglect of the stock market in business cycle studies is the view held by some macroeconomists that the only variables worth examining are those that "cause" the business cycle. The analysis in Section 2 shows that stock prices Granger cause investment, which is to say that given past rates of investment, stock prices help predict investment. However, this notion of causation is presumably not the one used by those who question whether stock prices cause investment. In the general equilibrium sense, all prices are endogeneously determined, and therefore, changes in stock prices cannot be exogenous. By such a demanding criterion, it may, however, be difficult to identify any "truly" exogenous economic variables. Thus, changes in preferences may at least in part be determined by economic events. The development of new technologies as well as the discovery of natural resources are surely influenced by economic activity. Pollution from industry and air travel call into question the exogeneity of even the weather. Further, even if such exogenous variables were identified on a priori grounds, their changes may not be directly observable as is generally the case for preferences. If so, then economists will have to use endogeneous but predetermined variables for prediction, policy, and theory-testing purposes.

Is there any way of determining whether or not stock prices cause investment in this more limited "surrogate" sense? One apparently simple method for doing so is to estimate a vector autoregressive model that includes stock prices together with other observable variables, such as interest rates and profits, whose forecasts may determine stock values. If a component of innovations in stock prices that is orthogonal to other innovations were

found, then we would conclude that stock prices are predetermined with respect to these other variables. If, further, this orthogonal component Granger causes investment, we might then conclude that it is, at least, a proxy for some of the otherwise unobserved causal variables. We are, moreover, confident that this procedure would find such a causal role for stock prices. A first indication is provided by the results in Table 1 of Doan et al. who find a significant orthogonal component in stock price innovations in a model which includes many of the relevant variables. A second, but not independent, indication comes from the repeated failures to produce good explanatory equations for stock prices using nonspeculative price variables. Given that stock prices reflect expectations and are, therefore, forward-looking variables, we are, however, doubtful that vector autoregressions, which rely on timing to identify causation, can ever determine decisively the issue of whether stock prices are exogeneous, even in this surrogate sense.

Since this issue is not likely to be resolved without some degree of a priori economic reasoning, we now turn to a brief theoretical analysis of whether or not exogeneous events whose only direct effect is to change stock prices, can also indirectly cause corporate investment to change through the stock price mechanism. This analysis also addresses the validity of the previously-quoted Bosworth claim that rational managers will not change their investment plans in response to what they may perceive as short run changes in stock prices.

Suppose that investors make their consumption and portfolio decisions so as to maximize  $\sum_i \Pi_i^{k,k} U_i^k$  where  $\Pi_i^k$  is investor k's estimate of the probability of state i and  $U_i^k$  is the utility of investor k in state i. Firms hold assets already in place (i.e., the

capital stock) and their managers make their investment decisions to add to the capital stock so as to maximize economic profits. Consider an equilibrium set of prices and investment plans where the equilibrium expected return on the market is 15 percent and firms' marginal new investment projects yield 15 percent. Suppose there is an exogeneous increase in aggregate risk aversion which causes stock prices to decline to the point where shares on the existing capital stock yield an expected return of 20 percent. Since there has been no change in technology or in the probabilities of future states, the marginal investments planned in the "old" equilibrium will still only yield 15 percent in the new. Managers of firms that had planned to finance these marginal investments through retained earnings will now see that these resources can be used to earn a higher return by purchasing either their own or other firms' shares. Those that had planned to finance their 15-percent investments externally by issuing additional corporate liabilities will surely not do so if these securities are priced to yield 20 percent. By this mechanism which is similar to the one described in the previously-cited Keynes quotation, lower stock prices and higher yields caused by the change in risk aversion lead to the cancellation of all planned investments with expected returns below 20 percent.

Whether the net resources released by this change result in higher current consumption or additional investment in the noncorporate sector is not important. The point is that corporate investment plans change as a result of the change in preferences. While there are perhaps other paths for the "message" of this exogeneous change in preferences to be transmitted to firms, the change in stock prices is surely the fastest and most direct. Especially in a large, diverse and decentralized economy, it is difficult to identify

what other observable economic variables would be likely to reflect this change in risk preferences. There is, for example, no reason to believe that the riskless interest rate observed in the debt market will be higher in the new equilibrium. The increase in risk aversion may indeed make investors willing to pay a larger premium (in terms of a reduced expected return) to receive a sure return in which case the equilibrium interest rate could even be lower in the new equilibrium than in the old.

There is nothing controversial in this textbook type illustration of how prices in a well-functioning market transmit information which leads to a change in the allocation of physical resources. Indeed, most would agree that in the Pareto optimum sense, there should be a reduction in corporate investment as a result of this change in preferences--provided, of course, that there is agreement on the probabilities of the states and these common assessments are objectively correct. Suppose however that stock prices do not reflect the objectively correct probabilities. Suppose, as apparently some believe, that investors' animal spirits cause stock prices to be significantly affected by irrational waves of optimism and pessimism. Does this mean, as Bosworth suggests, that firm managers will ignore stock prices in making their investment decisions? Should economists, therefore, ignore alleged irrational changes in stock prices much as they would ignore a poor tout whose inaccurate predictions have no impact on the outcome of Sunday's football game?

To address these questions, consider once again an equilibrium set of rational prices and investment plans where the equilibrium expected return on the market is 15 percent. Instead of a change in preferences, suppose now that there is an exogenous and completely irrational change in investors' perceptions of the probabilities of the future states. Suppose further that

this revision in probability assessments causes stock prices to fall to the same level as in our first analysis where preferences changed. Now, however, from the perspective of the investors'  $\{\Pi_i^k\}$ , the expected return on the market in the new equilibrium is still 15 percent. To make our point, we further assume the wholly unrealistic polar case where firm managers' assessments are completely unaffected by such animal spirits and they know with certainty the true objective probabilities of the states. Thus, from the managers' perspective, stock prices are too low because they have an expected return of 20 percent when all that investors require is 15.

In this posited environment, would one expect rational managers to ignore this irrational change in stock prices and continue with the investments planned prior to this change? We think not. By the same mechanism described in our first analysis, rational managers could earn a higher 20 percent return by using retained earnings to purchase their own or other firms' shares than by investing in new physical capital which would earn only 15 percent. Similarly, they would be reluctant to issue equity at these "depressed" prices to finance new investments with expected returns of less than 20 percent. Why not borrow in the meantime to undertake the physical investment that will later be worth more? If riskless debt capital were available to the firm, then, as with the internally generated funds of the firm, it would still make sense to use the cash to buy underpriced shares rather than to invest in physical capital. Moreover, unlike the arbitrages in models of certainty, firms are limited as to the amount of (virtually) riskless debt they can issue. As a firm issues more debt, that debt will be seen as increasingly more risky and therefore, the same irrationality that caused equity rates to be too high will also cause risky debt rates to be too high.<sup>26</sup> Thus,

actions by rational and informed managers will not offset the effects of irrational investors on investment.

The impact of investors animal spirits on investment is basically symmetrical. If managers believe that equity prices are high relative to the fundamentals, then they will increase the rate of investment. Since the main reinvestment opportunities for stockholders receiving dividend payments would be in financial securities at inflated prices (and therefore, low rates), rational managers would retain more instead of increasing dividend rates. By selling new equity at a high price, the firm could increase its capital stock cheaply and thereby, profitably undertake projects which would not otherwise be justifiable. Existing shareholders would benefit from future revenue streams associated with the capital financed by today's irrationally low equity yields.<sup>27</sup>

Thus, managers will adjust investment expenditures in response to stock price changes even in the extreme case where managers hold their beliefs with certainty and the stock price changes are inconsistent with these beliefs. The mechanism by which changes in stock market prices lead to changes in investment works whether the reasons underlying the price changes are rational or irrational. While this nondistinguishing mechanism may under some conditions be a curse, for others it can be a blessing. If, for example, managers' assessments are that their stock prices are too low, but in fact they are wrong and the market's assessment is correct, then this mechanism leads managers to make the right investment decisions (albeit, for the wrong reasons).

In his previously-quoted statement, Bosworth (1975) asserts that management "...would not scrap investment plans in response to the highly

volatile short-run changes in stock prices." If the market "corrects" itself so quickly that managers do not have time to react to irrational changes in prices, then there would, of course, be no effect on investment. Unless this is the "short-run" to which Bosworth refers, the mechanism we describe is strengthened by the belief that irrational price changes are likely to be corrected sooner instead of later. Indeed, financial economists would argue that such predictably "short-lived" aberrations provide the greatest profit opportunities for both rational managers and investors. An extension of that argument leads them to conclude that such opportunities, if they exist at all, will be rare.

Unlike in our polar example, managers (and for that matter, we economists) do not know for certain whether a particular change in stock prices reflects rational changes in tastes and expectations or irrational animal spirits. Consider, for instance, the 1973-1974 stock market decline cited by Bosworth as an apparently obvious example of the latter. Even if the premise of stock market irrationality were granted, it is not clear that this seemingly unwarranted decline ended with stock prices at an irrationally low level. Under this same premise, the decline could have instead been a rational correction of too high stock prices caused by an earlier (perhaps long) wave of optimistic animal spirits. Hence, even if he believes that the market can fluctuate excessively, a rational predictor of investment values knowing that the market may have information about investment prospects and future earnings that he does not, will use stock prices changes to modify his priors. Thus, the uncertainty about whether or not a particular stock price change is warranted serves to strengthen further the effect of stock price changes on investment. We therefore conclude that investment plans of rational managers

will react to stock price changes even if managers have good reason to believe that stock prices fluctuate excessively.

We end this section with a provocative question: "Is there a case for conducting open market operations in equities?" Although the question cannot be adequately dealt with here, in the spirit of much of this paper we offer some remarks in the hope of stimulating further discussion.

As has been shown, changes in stock prices predict changes in investment considerably better than real interest rates. To the extent that either have causal effects, this empirical finding is consistent with the a priori economic reasoning that the influence of stock price changes on investment is more predictable and stronger than that of debt market interest rates. If, therefore, the monetary authorities are concerned with investment, then intervention in the stock, rather than debt, market would seem to be a more effective way to move investment in the direction they desire. While making this point, Tobin (1977, p. 439, originally published in 1963) argued that direct Fed purchases of equity would be out of the question because of the arbitrary allocative effects of the Fed's choice of particular stocks to buy. While Tobin's view that the Fed would not undertake equity transactions is probably still correct, the particular objection that the Fed would affect relative stock prices could be avoided if it conducted its operations in indexed mutual funds composed of the entire market.

The case for Fed open market purchases in the stock market becomes stronger if stock prices could be shown to fluctuate excessively. Even if the Fed were merely causing the money supply to grow at a constant rate, a steady source of demand for equity could exercise a stabilizing influence on the market. Going further, if there were any confidence that under- or overvalued



prices could be detected, the Fed might improve resource allocation by sales or purchases designed to move the market back to its true value. It could be argued that it would be sufficient when the Fed views stock prices as too low merely to announce that fact. But because talk is cheap, it would probably be more effective for the Fed to put its money where its mouth was, and to intervene directly in the equity markets if there were times it had good reason to believe the market was unreasonably low or high. The Fed's profits in its portfolio activities would in addition provide a measure of its success at stabilizing the market.

How seriously should the possibility of open market operations in equity be taken? The answer comes back to two empirical questions. First, again, and fundamentally, is the stock market (at least at times) irrational, or at an inferior equilibrium? Second, if so, can those irrationalities or inferior equilibria be detected at the time?

The major focus of this section has been the demonstration of the mechanism by which stock prices affect investment, whether or not, as an empirical matter, the stock market is rational. Because stock prices affect investment even if they fluctuate excessively, the resolution of this empirical issue is of great significance for the efficient allocation of resources. We therefore discuss that issue in the next section.

## 6. On the Rationality of the Stock Market

Perhaps no single empirical issue is of more fundamental importance to both the fields of financial economics and macroeconomics than the question of whether or not stock prices are a well-informed and rational assessment of the value of future earnings available to stockholders. The Efficient Market Hypothesis that stock market prices are rational and reflect a high quality of information is one of the cornerstones of modern financial economic theory. Although often discussed in the context of profit opportunities for agile and informed investors, failure of the Efficient Market Hypothesis has implications far beyond wealth transfers between the quick-and-smart and the slow-and-not-so-smart. It implies broadly that decentralized production decisions based on stock prices as signals will lead to inefficient capital allocations.<sup>28</sup> Moreover, as was discussed in Section 5, irrational stock prices can cause inefficient corporate investment decisions even if managers are rational and do not rely on stock prices as an accurate assessment of future earnings.

The issue of stock market efficiency is of no lesser importance to macroeconomics. Many of the major developments in the field during the last decade--associated with the rational expectations-equilibrium framework--are based upon the assumption of efficient market allocations under imperfect information. Among major markets, the structure of the U.S. stock market most closely approximates the hypothesized conditions for a perfect market.<sup>29</sup> Even leaving aside the issue of allocative efficiency, if the application of rational expectations theory to the ideal conditions provided by the stock market fails, then what confidence can economists have in its application to labor and goods markets which are surely more imperfect? We need hardly

mention the implications of this question for the debate over the dual issue of whether government intervention in the financial markets can have an effect and whether it should be undertaken.

Given the import of the stock market information efficiency issue and the substantial and growing theoretical and empirical literature on the topic, we can do little more here than briefly touch on the empirical evidence.

Financial economists as a group are reasonably uniform in their deep attachment to the view that financial markets are essentially efficient at processing information. This view is in part based on the large number of empirical studies which have failed to reject the Efficiency Market Hypothesis; in part on a "folk" theorem to the effect that if the markets were not efficient, then there must necessarily be vast profits to be made by making them efficient; and in part to the sheer intellectual difficulty of knowing how to begin analyzing markets that are not efficient.<sup>30</sup>

The empirical studies fall into three categories: i) Searches for mechanical trading rules (using past data and sophisticated filtering techniques) which beat the market. ii) Tests of whether or not publicly available accounting and other nonmarket information can be used to beat the market. For example, is the market "fooled" by cosmetic accounting changes which affect reported earnings per share, but do not affect the firm's cash flows? iii) Tests of whether or not professional money managers who might have proprietary techniques for superior stock selection beat the market. An example of this class of studies would be the classic study of mutual fund performance by Jensen (1968). While some of these studies have produced anomalies, based on a pure "body count," the overwhelming majority of these studies are consistent with the Efficient Markets Hypothesis.<sup>31</sup> The

empirical evidence presented here and elsewhere that stock price changes are among the better forecasters of future changes in earnings, dividends, and other business cycle variables might also be counted in the support of the hypothesis of stock market rationality.

It is unlikely however that empirical evidence alone will ever resolve the market rationality issue. Every one of the empirical studies is a joint test of market rationality and at least one other condition. The other condition may be, for example, that the expected real return on the market is a constant or that futures prices are unbiased estimates of future spot prices. Thus, rejection may occur because of the failure of these other conditions and not market rationality. To decide the likelihood of which condition to reject requires a priori economic reasoning. In making this assessment, financial economists tend to rely heavily on the folk theorem restated more graphically as the rhetorical question, "If you are so smart, why aren't you rich?" And if that is not enough, the follow-up question, "If you're rich, how do you know that you weren't just lucky?" Perhaps the only empirical test which would reject market rationality is the existence of persistent and true arbitrage. Since such evidence is unlikely to be found (even if the market is indeed irrational), one might almost conclude that market rationality is a postulate that cannot be tested. Nevertheless, as will be discussed, it is a folk theorem in the sense that it is possible to have an irrational stock market where there is no private market opportunity to make a profit.

Like "linear," "competitive markets," and "equilibrium," "market information efficiency" is a well-defined concept. Like "nonlinear," "noncompetitive markets," and "disequilibrium," "market information inefficiency" is merely the complement to a well-defined set, and therefore,

there is little content to the concept of a "general theory of market irrationality." Thus, the intellectual difficulty faced by financial economists in analyzing inefficient markets is much the same as that faced by economists generally in developing a disequilibrium theory. It is perhaps not surprising that they are reluctant to undertake such an analysis unless definitive evidence rejecting market efficiency is presented.

The view among macroeconomists on market information efficiency is less uniform. As discussed, it is difficult to reconcile having a belief in the rational expectations equilibrium approach to models and a disbelief in stock market rationality. We therefore presume that those macroeconomists who support such models support stock market efficiency. There is an alternative long-standing tradition among macroeconomists dating back at least to Keynes' (1936) famous pronouncements on the American stock market, that the stock market is dominated by psychological games-playing with only a modest relation to rational phenomena. More generally, macroeconomists tend to believe that stock prices fluctuate far too much to be justified by rational economic assessments.

While often quite colorful, until recently, the evidence provided by macroeconomists for stock market irrationality was mostly anecdotal. However, the empirical studies by Shiller (1981) and LeRoy and Porter (1981) have been interpreted by some to imply that the market fluctuates excessively. If so interpreted, these studies imply a serious challenge to market efficiency because the apparent violations are so large and because their data sets extend over a long past history. These studies measure stock price volatility relative to the movements in an estimate of "true" stock prices based on fundamentals. Such studies are, therefore, tests of the joint hypothesis that

stock prices are rational and that the model of the fundamentals (in these particular cases, that dividends and earnings follow stationary processes) is correct. Thus, to interpret rejection as implying stock market irrationality requires that one have more faith in the model's assessment of the fundamentals than the market's.

Because their belief in market efficiency is so strong, it would take a substantial amount of evidence to persuade most finance economists that the market was not pricing assets on the basis of fundamentals. Hence, despite the apparent sharpness of the challenge to this viewpoint posed by Shiller (1981), LeRoy and Porter (1981) and others, there was hardly a rush by finance theorists or empiricists to the barricades to defend market efficiency. Instead, it was apparently taken for granted that the invaders' weakness would soon be discovered and the nuisance go away. As exemplified by these studies, a priori economic reasoning plays a crucial role in interpretation. Thus, Kleidon (1983) and Marsh and Merton (1983a; 1983b) reexamine these same variance-bound tests and conclude that the seeming "violations" are entirely consistent with market efficiency.

Is there any a priori reason to believe that the stock market could fluctuate excessively? As noted, that the market prices assets efficiently is close to being an article of faith among finance economists. In addition to empirical evidence, this belief is based on the assumption that any violations of efficiency would imply that individuals or firms could make large profits by trading on the inefficiency, and in the process would restore efficiency. There is as yet, however, no theorem that shows there are profits to be made any time animal spirits affect stock prices. There are, moreover, examples in the literature of models with multiple rational expectations equilibria where

each equilibrium corresponds to a different set of expectations held by economic agents. These are so-called sunspot equilibria. If the economy is in one sunspot equilibrium, there is not necessarily a profit to be made by a single investor or firm who tries to move the system to a better equilibrium. In this sense, the market could be inefficient.<sup>32</sup>

There are also models of speculative bubbles, including probabilistic bubbles in which individuals buy an asset whose price is expected to continue rising fast even though there is a chance that the price will return to its fundamental level.<sup>33</sup> Such speculative behavior produces excess volatility of asset prices relative to their fundamental values.

What goes wrong with the notion that there are excess profits to be made in these two cases? When there are speculative bubbles, the probability of a return to fundamentals is just sufficient that the capital loss that will occur if the stock price falls is offset by the complementary probability of the gain obtained by the rapidly rising asset price. In the case of multiple equilibria, changes in expectations by market participants cause resource reallocations and move the economy to a new equilibrium in which there are no excess profits. For instance, an increase in investor pessimism could result in lower investment rates that produces the lower output levels that generate the lower profits that justify the pessimism. Although excess volatility could in principle, be detected if actual equilibria were not rational, such tests would not detect a case in which investors' expectations move the economy between different rational equilibria. The possibility of multiple rational expectations equilibria, one of which is superior in a welfare sense to the others, highlights the important distinction between stock market information efficiency and pareto optimality. An informationally-efficient

market can settle at one of the inferior equilibria.

It is thus not possible to dismiss the argument that stock prices could fluctuate excessively entirely on a priori grounds. The empirical evidence against efficiency, while hardly predominant, cannot always be trivially disposed of. Because of its importance to both macroeconomics and finance, the issue of stock market information efficiency should continue to occupy the research efforts of both financial and macro-economists.



Table A1: The Stock Market as Predictor of Real GNP Growth and Its Components, Quarterly Data, 1950:1 to 1983:2.

Regression #	Dependent Variable	Independent Variable										Statistics			
		CONST	STOCK <sub>-1</sub>	STOCK <sub>-2</sub>	STOCK <sub>-3</sub>	STOCK <sub>-4</sub>	$\Sigma$ DRTBX <sub>-1</sub>	$\Sigma$ DINF <sub>-1</sub>	$\Sigma$ GNPGR <sub>-1</sub>	RHO	R <sup>2</sup>	SER	DW		
A1	GNPGR	2.35 (4.49)									0.35 (3.24)		0.15	4.27	1.80
A2		2.46 (4.51)	0.046 (4.01)	0.046 (4.06)	0.015 (1.27)							0.33 (3.98)	0.32	3.82	2.02
A3		2.69 (4.84)	0.049 (3.92)	0.041 (3.18)	0.009 (0.74)	-3.33 (-1.62)	0.79 (0.73)	-1.80 (-1.02)				0.27 (2.96)	0.32	3.83	1.99
A4	IGR	0.67 (0.25)	0.20 (3.00)	0.34 (5.10)	0.036 (0.53)							0.18 (2.11)	0.26	22.59	1.84
A5		-0.13 (-0.05)	0.19 (2.78)	0.33 (4.57)	0.035 (0.46)						0.23 <sup>1</sup> (0.40)		0.24	22.91	1.56
A6		1.88 (0.63)	0.23 (3.18)	0.30 (3.90)	-0.00 (-0.00)	-15.10 (-1.29)	6.10 (1.00)	-6.97 (-0.69)				0.18 (1.90)	0.26	22.64	1.82
A7	CONGR	2.04 (6.69)	0.048 (4.87)	-0.005 (-0.55)	0.016 (1.65)							-0.05 (-0.58)	0.14	3.24	1.99
A8		2.32 (6.72)	0.042 (4.17)	-0.015 (-1.42)	0.015 (1.44)	-1.98 (-1.35)	0.86 (1.10)	-1.41 (-1.12)					0.21	3.09	2.00
A9	CDGR	1.96 (1.23)	0.16 (2.80)	0.11 (1.88)	0.03 (0.49)								0.13	18.65	1.96
A10	GGR	1.07 (1.40)	-0.016 (-0.75)	-0.016 (-0.73)	0.043 (1.98)						0.69 <sup>2</sup> (11.03)		0.48	7.28	1.90 (H=0.83)

- Notes:
1. Only first two lagged GNPGR<sub>t</sub> included.
  2. Only first lagged GNPGR included.
  3. Variable definitions as in Table 2 of the text, except DRTBX is the change in the three month real (using actual inflation) Treasury bill note. Bill rate is average for last month of quarter.

FOOTNOTES

- 1 Strictly, it is not "corporate earnings" but "net cash flow available for distribution to the current stockholders" which is capitalized in stock prices. The two are, of course, closely related, especially at the aggregate level.
- 2 Regression 4, Table 5.
- 3 As noted, we discuss this distinction in Section 5.
- 4 We are grateful to Robert Litterman for making these data available.
- 5 Equivalently, the stock market variable on the right hand side of R3 has the highest simple correlation with the growth rate of real GNP of all the independent variables.
- 6 Hall (1978) noted that lagged stock values helped predict consumption; he took this to be a rejection of the permanent income theory of consumption.
- 7 The implied coefficient on stock market wealth in the consumption function of 0.05 is close to that reported for the MPS model, for instance by Bosworth (1975).

- 8 The regressions that demonstrate the lack of predictive power of other financial variables are not shown in Table 2.
- 9 This finding might suggest that nominal interest rates rather than real rates are good predictors of residential investment, which would be consistent with the focus on nominal interest rates in modelling housing market demand. However, nominal interest rates did not enter prediction equations for residential investment with significant coefficients.
- 10 We are grateful to Robert Litterman for providing this information. Translating the standard errors into  $\bar{R}^2$ , the  $\bar{R}^2$  for Litterman's GNP equation would be 0.40 compared with 0.32 for regression A2.
- 11 We have checked the possibility that the growth rates of M1 and M2 are such variables; they are not.
- 12 See Bailey and Jensen (1972) for further discussion including arguments for using the private market  $\bar{R}_M$  for  $\bar{R}_S$ .

- 13 Neglecting any fixed costs associated with the program, it may appear that such transfer programs always have a zero net present value. This is tautologically true for all discount rates if costs and benefits are both defined to be equal to expenditures. If, however, costs are measured by expenditures and benefits (both positive and negative) measure all the utility and externality effects of the program, then a dollar's worth of expenditures need not imply a dollar's worth of benefits, and the net present value of the project will not be invariant to the discount rate.
  
- 14 This contention was advanced by Fama (1975), with--to the amazement of many macroeconomists--some empirical success over the 1951-1971 period. Ex ante real bill rates do not appear to have been constant over other periods. Macroeconomists' reactions to this paper were similar to the reactions of finance economists to the claim that the stock market fluctuates excessively.
  
- 15 Although outside the mainstream theme of our paper, option pricing theory has been demonstrated to have applicability in the analysis of a wide range of economic problems. For an extensive bibliography and a survey of its application to corporate finance and investment decisions, see Mason and Merton (1984).
  
- 16 Data presented in Chapter 4 of the 1983 Economic Report of the President show net domestic saving (adjusted for inflation) to have averaged 6.8% of GNP over the period 1951-1981. Over the same period, net business fixed investment plus inventory investment averaged 3.8% of GNP.

- 17 Keynes (1936), p. 151. See also p. 188 of the General Theory for further discussion of investment along the lines of the Q theory.
  
- 18 See Cicollo (1977), von Furstenberg (1977), and for a tax-adjusted Q series, Summers (1981). Abel and Blanchard (1983) construct direct estimates of Q by predicting future earnings and discount rates associated with increased investment, thus bypassing the stock market. The reason to make a direct calculation is that the stock market gives an average Q value, while their calculation in principle calculates marginal Q, the measure relevant to investment. They find a .971 correlation of their (marginal) Q with von Furstenberg's stock market based estimate.
  
- 19 Given that the estimated reproduction cost of capital varies slowly, movements in estimated Q result predominantly from changes in stock prices. Accordingly, the regression results reported in Section 2 in which changes in stock prices predict changes in investment are consistent with the empirical results obtained by researchers using the Q theory of investment.

A general question arises with Q theory of whether properly measured marginal Q should not be equal to one for firms that are investing, and less than or equal to one for firms that are not investing. Provided it is understood that estimated Q measures the reproduction cost of capital at some normal level of investment, it is not necessary that marginal Q, as measured, need be unity. Alternatively, it is possible for there to be an aggregate relationship between Q and investment even if the above

relationship does hold at the individual firm level: in this case increases in aggregate investment correspond to more firms investing, and therefore more firms having marginal  $Q$  at unity rather than below. In this latter case, properly measured (aggregate) marginal  $Q$  would be less than or equal to unity.

20 See for example Summers (1981), Tables 4 and 5, pp. 93-94.

21 See for example, Blanchard and Wyplosz (1981, p. 15). We should note also that the possible difference between average and marginal  $Q$  is sometimes cited as a potential cause of the empirical difficulties encountered by the theory. Hayashi (1982) discusses conditions under which average and marginal  $Q$  are equal. As noted above, Abel and Blanchard, did not find significant differences between their marginal  $q$  and stock-market based measures on average  $q$ .

22 It might be argued that the weaker relation we find for the real interest rate is a result of our using an inappropriate estimate of the expected inflation rate—but that only reinforces the point that the real interest rate is not in practice an observable number.

- 23 Averages for recent periods calculated from Economic Report of the President, 1983, p. 263; current value estimated from Q value for fourth quarter of 1982 of 0.80 given on p. 92 of ibid., adjusted for cumulative increase in real value of Standard and Poor's index of close to 20% since the beginning of 1983, and assuming no change in bond values since the beginning of the year.
  
- 24 See Economic Report of the President, 1983, p. 93 for some estimates of the investment incentives created by the tax bills.
  
- 25 See Summers (1981) for use of the Q theory to analyze the effects of tax policy changes on investment.
  
- 26 See Merton (1974) for a discussion of the riskiness of debt.

27 The argument here is less compelling, since there is a question of which shareholders the managers should look out for. Pre-existing shareholders will benefit by obtaining low-cost equity. The people who buy the equity in the mistaken belief that earnings will be high, suffer for their mistake if the firm goes ahead and invests. Thus a manager concerned with their interests might abstain from investing. This argument suggests, incidentally, that investment might be more sensitive to falls in stock prices below "true" values than to increases above "true" values. We have run preliminary time series regressions that indeed show investment to be more sensitive to falls in stock prices than to increases. But these preliminary results could also be a result of an asymmetry in the speed with which firms can adjust their investment expenditures to stock prices: existing projects can be cut more quickly than the new projects can be initiated.

28 As we will elaborate below in our discussion of multiple equilibria models, satisfaction of the Efficient Market Hypothesis is not a sufficient condition to ensure Pareto efficiency in the production and consumption allocation of resources. It is, however, a necessary condition if market prices are to be equal to the nowhere-to-be-observed shadow prices of the benevolent and informed hypothetical central planner associated with this optimal allocation. While the two different uses of the term "efficiency" may be confusing at times, it is likely to be equally confusing to change a terminology which has been used for more than twenty years.



- 29 It is an enormous market with centralized trading of standardized instruments with continuously-quoted prices. The scale is such that huge rewards can be earned by beating the market. There are many participants including individuals, corporations and financial institutions from throughout the world. Transactions costs are low and short-sales are permitted. Entry and exit from managing money or providing investment advice is virtually free. There are available huge quantities of data over a long past history which permit "low cost" learning (without doing).
- 30 Cohn and Modigliani (1979) provide one hypothesis about a possible market irrationality.
- 31 See Journal of Financial Economics (June-September 1978); Summers (1982) presents a skeptical, but not atypical, macroeconomics view.
- 32 Early examples of multiple equilibria are in Shiller (1978) and Taylor (1977). More recent examples constructed assuming maximizing agents in an overlapping generation model are in Azariadis (1981) and Cass and Shell (1983).
- 33 Blanchard (1979). For a description of the classic South Sea bubble, John Law, and the tulip mania, see MacKay (1841). Of course, some investment activities that have been labeled "speculative bubbles" with the benefit of ex post hindsight, may not have been ex ante.

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