



Firms' fundamentals, macroeconomic variables and quarterly stock prices in the US



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ABSTRACT

This paper modeled the effects of firms' fundamentals such as total assets and long-term debt and of macroeconomic variables such as unemployment and interest rates on quarterly stock prices of over 3000 US firms in the period 2000–07. The merged CRSP/Compustat database was augmented by macroeconomic variables and comprehensive dynamic models were estimated by maximum likelihood taking into account heterogeneity across firms. Likelihood ratio statistics were developed for sequentially testing hypotheses regarding the adequacy of macroeconomic variables in the models. The main findings were that the estimated coefficients of lagged stock prices in simple dynamic random effects models were in the interval 0.90–0.95. Second, comprehensive dynamic models for stock prices showed that the firms' earnings per share, total assets, long-term debt, dividends per share, and unemployment and interest rates were significant predictors; there were significant interactions between firms' long-term debt and interest rates. Finally, implications of the results for corporate policies are discussed.

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1. Introduction

The frequently observed fluctuations in stock prices were addressed in the economics literature by Keynes (1936) who argued that the limited information possessed by traders was partly responsible, though certain factors tend to exert “compensating effects” for reducing price swings. While Keynes did not elaborate on the compensating effects especially from an empirical standpoint, Graham and Dodd (1934) approached these issues from an accounting perspective arguing that investors buy stocks when prices were below some “intrinsic” values and sell them as prices approached the perceived maximum levels. Owing to the stock market crash in the United States, Tinbergen (1939) subsequently estimated models explaining annual share prices by firms' earnings, dividends, and previous price levels using data from the U S, UK and Netherlands. However, Tinbergen's estimation techniques were rather elementary and the time series data were available only for a small number of firms.

While Tinbergen's analysis inspired later studies enlarging the model (e.g. Gordon, 1959), Granger and Morgenstern (1970) were critical of the approach and argued that stock prices follow a martingale or a random walk process and were less amenable to statistical modeling. The random walk model for stock prices

complicates forecasting of future prices since current price levels are the optimal predictors. The random walk hypothesis was also appealing to the proponents of “efficient market hypothesis” (e.g. Fama, 1970; Fama and French, 1988) because stock prices are argued to embody all the available information so that investors may not earn higher returns than by holding the “market portfolio” (e.g. Thompson et al., 2003). Such formulations are in stark contrast with Keynes' characterization of stock markets where traders are continually trying to “beat the gun” (Keynes, 1936, p. 155) for outperforming the market.

The stochastic properties of stock prices are important for formulating empirical models and there have been attempts to test the random walk null hypothesis using data on US firms. For example, Lo and MacKinlay (1988) tested for linear increases in variances of weekly stock prices implied by the random walk model. However, their *two-sided* tests were likely to have low power since the alternative hypotheses were not well-formulated; the test would reject the random walk null hypothesis if stock prices followed an explosive process. Similarly, Fama and French (1988) imposed the random walk hypothesis on share prices and explored autocorrelation patterns in monthly returns for 17 broad groups of firms. A more general approach, encompassing contributions of Keynes (1936), Graham and Dodd (1934), Tinbergen (1939), and Granger and Morgenstern (1970), would be to estimate dynamic models using longitudinal (panel) data and explain stock prices as functions of firms' fundamentals, and test if coefficients of lagged

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dependent variable are unity. Moreover, one can begin with simple dynamic models and test the random walk null hypothesis for stock prices against *one-sided* stationary alternatives in the random or fixed effects frameworks (Bhargava and Sargan, 1983; Bhargava et al., 1982) that allow for between-firm heterogeneity.

Further, high variability in stock prices in daily or weekly data is known for many countries (e.g. Engle and Rangel, 2008). However, data on firms' fundamentals such as assets and debt are typically compiled at quarterly intervals. While some variation in stock prices in high frequency data can be attributed to investor behavior, frequent trading of stocks is often driven by investors' expectations of firms' fundamentals that are announced at the end of quarters. In addition, macroeconomic variables such as unemployment rates in different sectors of the economy reflect the demand for firms' products and services. Also, higher interest rates increase the costs of borrowing especially for firms with high debt levels. Thus, discrepancies in traders' forecasts of firm-level variables and the actual realizations, and shocks to the economic system reflected in macroeconomic variables are likely to play an important role in explaining stock prices. As shown in Section 3.3, the work by Wald (1947, 1950) is useful for devising statistical tests for assessing the adequacy of macroeconomic variables in longitudinal models.

The estimation of comprehensive models for stock prices taking into account the stochastic properties and firms' fundamentals and macroeconomic variables is facilitated by availability of data at quarterly intervals. For example, if daily, weekly or monthly stock prices were modeled, then it would be difficult to investigate the role of firms' fundamentals. While the effects of macroeconomic variables on daily stock prices can be investigated to a certain extent (Cutler et al., 1989; Caginalp and De Santis, 2011), such effects are likely to be transitory since investors update their expectations as information on fundamentals becomes available. It is evident that empirical models explaining quarterly stock prices by firms' fundamentals and macroeconomic variables can provide useful insights on a range of issues.

The structure of this paper is as follows: the conceptual framework is developed in Section 2.1 and the empirical models are outlined in Sections 2.2 and 2.3. Section 3.1 describes the merged quarterly CRSP/Compustat/Datastream database for the period 2000–07, i.e., for 32 quarters. The econometric methods for estimating dynamic models from longitudinal data are described in Section 3.2. In Section 3.3, sequential likelihood ratio statistics are developed for assessing the adequacy of macroeconomic variables that are constant across firms. The results from estimating simple dynamic random effects models for quarterly stock prices for testing the random walk hypotheses are presented in Sections 4.1 and 4.2 for the pooled sample and for ten Global Industrial Classifications Standards (GICS) groups, respectively. Section 5.1 presents the results from comprehensive dynamic and static models explaining stock prices by firms' fundamentals and macroeconomic variables; results from models including lagged values of firm-level explanatory variables were similar. The results from estimating the models separately for eight GICS groups are in Section 5.2; results for Telecommunications and Utilities are not reported due to the small numbers of firms. Finally, the conclusions are summarized in Section 6.

2. The analytical framework for modeling quarterly stock prices

The models employed for predicting stock prices will depend on the frequency at which the data are available. For example, stock prices can change dramatically during a trading day due to investors' expectations of firms' earnings or from information on macroeconomic variables such as interest rates. By contrast,

annual stock prices exhibit gradual trends and will be influenced to some degree by firms' fundamentals and demand for their products. Because data on fundamentals are available at quarterly intervals, it is appealing to develop comprehensive models for quarterly stock prices.

2.1. Some conceptual aspects

There are several approaches for explaining movements in stock prices beginning with Keynes (1936, Chapter 12) who viewed the stock exchange as a medium for continually re-evaluating investment decisions. Investors' expectations of future stock prices, based on incomplete information, were likely to lead to frequent trading that can increase returns as well as the amplitudes of price fluctuations. Keynes did not view these phenomena as resulting from "waves of irrational psychology" (cf. Arrow, 1982) though he was ambiguous about the "compensating effects" that may bring prices to some form of equilibrium levels. The gradual evolution of stock prices over a long time frame, however, suggests that firms' fundamentals and macroeconomic variables will ultimately tend to align stock prices with the underlying economic factors.

Second, the accounting approach to stock prices (Graham and Dodd, 1934) underscored the effects of quantitative factors such as firms' market capitalization, earnings, dividends, assets, and liabilities. Moreover, seemingly qualitative aspects such as quality of management and "economic outlook" were postulated to affect stock prices. This approach recognized the phenomenon that investors seek to purchase stocks priced below their intrinsic values and sell them when prices are high. Thus, there are commonalities between Keynes' behavioral and the accounting approaches; it is important to quantify the effects of sector-specific macroeconomic variables reflecting the economic outlook on stock prices.

Third, while the supply and demand for firms' shares determine prices during trading, the supply of shares is relatively inflexible in a short time frame and can be increased mainly via issuance of new shares. By contrast, the demand for firms' shares is constantly changing due to investor perceptions of profitability from holding the stocks. Thus, at a given time point, aggregate demand for a firm's shares will determine the price; purchases or selling of large numbers of shares by investors often leads to price swings (cf. Cochrane, 2005, p. 5). Furthermore, demand for shares of firms in different economic sectors will be differentially affected by macroeconomic variables such as unemployment and interest rates. There may also be interactions between macroeconomic variables and firms' fundamentals that affect stock prices. Because macroeconomic variables assume the same values for most firms, such aspects can be investigated mainly in models estimated using longitudinal data (Section 3.3).

Fourth, the dynamic models for stock prices estimated by Tinbergen (1939) emphasized the importance of dividends and earnings per share using annual data on a small number of firms. However, important methodological issues such as the consistent estimation of model parameters and treatment of between-firm heterogeneity were not addressed due to the lack of estimation methods and electronic computers. Despite such a limitation, the empirical insights were useful; forecasters routinely predict quarterly earnings, and the discrepancies between earnings forecasts and realizations affect prices movements. Similarly, dividends are announced quarterly and convey useful information to investors (Bhargava, 2010). The comprehensive dynamic models in Section 2.3, explaining quarterly stock prices by variables such as earnings and dividends per share, long-term debt, and macroeconomic variables, will embody salient aspects from the previous literature.

Finally, the stochastic properties of stock price series are important for developing comprehensive models for quarterly stock

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