Pricing Firms on the Basis of Fundamentals

MARK KAMSTRA

The author is a financial economist in the Atlanta Fed's research department. *He is grateful for useful conversations with Lisa Kramer, Cesare Robotti, Tom Cunningham, and Paula Tkac and for extensive comments from Jerry Dwyer, Mark Fisher, and Larry Wall.*

People often speculate that a particular stock is overpriced, or underpriced, and analysts sometimes issue stock price targets followed abruptly by price "corrections." A natural question is, What is the right price for a stock? Mergers and acquisitions of firms rely heavily on determining the right or fair price of a stock. One set of strategies to find the right price is to forecast cash flows from a stock market investment and calculate what that income is worth. Roughly speaking, this strategy is what fundamental valuation is all about, and it is the focus of this article.

Beyond an overview and illustration of commonly used fundamental valuation techniques, the article will discuss a new valuation approach developed in Kamstra (2001). The discussion will also explore severe market turndowns, such as the tech "bubble" of the late 1990s, to see if market prices reflected gross overvaluation of various stocks compared to the estimated fundamental values. Application of Kamstra (2001) to both blue chip and dot-com firms improves the ability to track market price movements, as will be demonstrated below with applications to BellSouth, Starbucks, Sun Microsystems, Microsoft, Yahoo, and the S&P 500 index.

The article first describes fundamental valuation approaches and establishes links between these methods. This review of techniques will draw on practitioner and academic financial literatures as well as the academic accounting literature.

The Literature

A large literature deals with the issue of stock valuation as a function of future cash flows and discount rates. Valuation methods based on fundamental analysis—forecasting future cash flows and discounting them to estimate the value of this income stream—all face the common criticism that these forecasts can be unreliable. Together with assumptions about the firm's ability to borrow funds and about market efficiency, such forecasts depend on a company's maintaining its investment and business strategies. Pricing by discounting future cash flows is intuitive, however.

The literature on fundamental valuation includes studies from accounting that explore restatements of the discounted dividend model in terms of accounting information (see Feltham and Ohlson 1995; Penman 1996; Burgstahler and Dichev 1997) and finance papers that often start with or derive the discounted dividend model (see Gordon 1962; Rubinstein 1976; Barksy and DeLong 1993; Campbell and Kyle 1993; Donaldson and Kamstra 1996; Chiang, Davidson, and Okuney 1997; Bakshi and Chen 1998). Finally, a literature written largely by practitioners for practitioners typically starts with the discounted dividend model of Gordon (1962) and augments it to allow for more flexibility.

A related literature has focused on the question of market efficiency, documenting abnormal return predictability based on earnings, size, and financial statement ratios.[1] There is considerable ongoing controversy over the issue of market efficiency. The focus of the present work is not on market efficiency questions but rather on fundamental valuation *in the context of efficient markets*, though this study will comment on the efficient markets implications of the deviations observed between market and fundamental prices.

Contributions from the practitioner literature. The practitioner literature spans decades and provides a number of equity valuation approaches. There are somewhat indirect methods that are intended to rank stocks using price-earnings ratios (sometimes termed price relatives) or return-on-equity ratios combined with book-to-price ratios (see

Valuation methods based on fundamental analysis—forecasting future cash flows and discounting them to estimate the value of this income stream—all face the common criticism that these forecasts can be unreliable.

Beaver and Morse 1978; Wilcox 1984; Estep 1985; Peters 1991; Bauman and Miller 1997; Leibowitz 1999). There are equity valuation methods that use sales to calculate present value of future cash flows (see Leibowitz 1997). There are also methods based on the dividend growth model of Gordon (1962), or classic fundamental analysis.

The papers based on Gordon's method start with a model equating market price to the sum of discounted future dividends. To produce a tractable formula, a structure is imposed, such as constant growth rates of dividends and constant discount rates. Many articles extend the simplest Gordon growth model to allow dividend growth rates to have several stages—for instance, permitting growth firms to start with high dividend growth rates and then decelerate to a stable long-run rate. Some studies also propose random but independent dividend growth rates.[2] The variations of the discounted dividend growth model used in this literature are rarely more than ad hoc attempts to capture real-world phenomena such as time-varying dividend growth rates. Pricing firms that do not pay out dividends is not considered explicitly, or else dividends are proxied as a constant fraction of observed earnings or sales. A good example of valuation based on sales in the absence of dividends is Damodaran (1994, 244–48), and standard investments texts outline how dividends may be replaced by earnings and payout ratios (see, for instance, Sharpe and Alexander 1990, 474–76).

An often-mentioned financial measure of fundamental value in this literature is the price-to-earnings (P/E) ratio. A high P/E ratio is often taken to imply that investors expect a high dividend growth rate, a low risk in holding the stock, or a high payout of earnings together with an average growth rate. The valuation of stocks using P/E ratios, most often termed relative value pricing, is studied by both academics and practitioners. P/E ratios are typically compared across similar firms to formulate buy/sell recommendations and to forecast price by multiplying a forecast of earnings by the current P/E ratio. Shares of firms that are not actively traded are often priced by finding an actively traded firm with similar risk, profitability, and investment opportunity characteristics and multiplying the actively traded firm's P/E ratio by the inactively traded firm's earnings.[3]

Contributions from the accounting literature. Studies in the accounting literature begin with the assumption of the discounted dividend model, imposing constant discount rates. The focus is on relating accounting information, such as earnings and book value, to stock valuation. The most popular techniques are the residual income valuation method and the free cash flow valuation method (see, for instance, Feltham and Ohlson 1995; Penman and Sougiannis 1998; Lee, Meyers, and Swaminathan 1999). Residual income is typically defined as earnings generated by a firm in excess of a normal rate of return on the company's book value (also termed abnormal earnings in the literature on residual income models).[4] Free cash flows are cash flows that could be withdrawn from a firm without lowering the current rate of growth.[5] The residual income method requires positive earnings and book value, and the free cash flow method requires positive free cash flows. Many firms have negative free cash flows, negative book value, and negative earnings. Among firms that have been included in the S&P 500 index at some point over the last twenty years, 6 percent have recorded at least one year with nonpositive book value; 12 percent have recorded at least one year with nonpositive earnings before interest, taxes, depreciation, and amortization (EBITDA); 89 percent have recorded at least one year with nonpositive free cash flow; and 32 percent have never had positive free cash flow. Of the more than 19,000 firms tracked by Compustat over the last twenty years, over 20 percent have recorded simultaneous nonpositive book value, nonpositive free cash flows, and nonpositive

EBITDA for at least one year on record; 6 percent have never had a positive book value; 52 percent have never had a positive free cash flow; and 22 percent have never had a positive EBITDA.

Contributions from the finance literature. In the finance literature, one approach taken to the fundamental valuation problem has been to implement some variant of the Gordon (1962) model of discounted dividends, which uses essentially the same starting point as the accounting literature. Although more formal, this literature also has much in common with the practitioner literature on fundamental valuation. The models that have been proposed vary from the simplest Gordon model with constant dividend growth rates and constant discount rates to multistage models with the growth rates varying in a step-wise manner—constant for a period of time (a step) and then shifting to a new level for a period of time (see, for instance, Brooks and Helms 1990, Barsky and DeLong 1993). The literature following directly out of Gordon (1962) motivates restrictions on dividend growth and discount rates either in an ad hoc fashion or by arguments based on analytic tractability. Another approach makes use of option-pricing methods but also imposes ad hoc assumptions to make the methods more straightforward to apply.[6]

Both streams of this literature—that following the Gordon (1962) growth model and that exploiting option-pricing tools—are closely related to each other. Both seek to impose sufficient structure on the dividend growth and discount rate processes to permit an explicit computable expression for the present value of future dividends.[7]

Donaldson and Kamstra (1996) generalize the Gordon (1962) model to allow arbitrary dividend growth and discount rate processes. The point of Donaldson and Kamstra's procedure is to avoid imposing structure on the dividend growth and discount rate processes and to let the data speak for themselves.[8]

Most investment professionals view any algorithmic valuation model as only a starting point to pricing

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equity, whether the model is based on price relatives like the P/E ratio or on classic fundamental analysis. For instance, in the context of zero-income stocks,

1. An efficient market is one in which the price of assets reflects their fair value; that is, prices are unbiased. For work that presents evidence consistent with market inefficiency, see, for instance, Basu (1977), Jaffe, Keim, and Westerfeld (1989), Ball (1992), and Fama and French (1995). In contrast, Kirby (1997) demonstrates that the statistical significance of the evidence of market inefficiency from long-horizon returns is overstated.
2. A few examples include Hawkins (1977), Farrell (1985), Sorensen and Williamson (1985), Rappaport (1986), Hurley and Johnson (1994, 1998), and Yao (1997).
3. References to these sorts of rules can be found in textbooks like Brealey et al. (1992) and journal articles such as Peters (1991). See also Wilcox (1984), Estep (1985), Bauman and Miller (1997), and Campbell and Shiller (1998).
4. Preinreich (1938) derived that the stock price of a firm should equal the book value of the firm plus discounted abnormal earnings. Ohlson (1995) extends Preinreich and goes on to show the time period t stock price is a linear sum of time period t book value and abnormal earnings. This result assumes the discounted dividend model, constant discount rates, the clean-surplus relation, and linear autoregressive stochastic abnormal earnings. Ohlson also generalizes this relationship to admit information other than abnormal earnings. Feltham and Ohlson (1995) and Penman (1996), among others, extend Ohlson (1995). Feltham and Ohlson do so by focusing on the implications of conservative versus unbiased accounting for the Ohlson model while Penman focuses on the differential information contained in price-to-book versus price-to-earnings ratios in the context of the Ohlson model.
5. For a discussion of free cash flows and equity valuation, see Hackel and Livnat (1996) or Penman and Sougiannis (1998). Free cash flows are substantially different from accounting earnings and even accounting measures of the cash flow of a firm.
6. See Campbell and Kyle (1993), Chiang, Davidson, and Okuney (1997), Bakshi and Chen (1998), and Schwartz and Moon (2000, 2001) for examples of this approach. This literature starts with the representative consumer-complete market economic paradigm. Models are derived from primitive assumptions on markets and preferences, and the solution to the fundamental valuation problem is derived with the same tools used to price financial derivatives.
7. Even the solutions are often similar—the Gordon (1962) model is explicitly considered as a special case in the Bakshi and Chen (1998) option-pricing model.
8. The Donaldson-Kamstra methodology is similar to pricing path-dependent options because it involves a Monte Carlo simulation and numerical integration of the possible paths followed by the joint processes of dividend growth and discount rates, explicitly allowing path-dependence of the evolutions. See Donaldson and Kamstra (1996) for details.

Wilson (2000) argues that a practitioner should use discounted cash flow analysis together with scenario analysis, considering the fair value of a company under various possible scenarios and then judging which scenario is most likely to occur. If the market price is below the most likely fair value, he observes that it is appropriate to consider buying the stock. Wilson also points out the many difficulties involved in the simple application of discounted cash flow analysis, including the difficulty of determining the appropriate discount rate.

Fundamental Valuation

The fundamental value of a dividend-paying stock is merely the present value of the flow of

Practitioners use a variety of relative value models exploiting the notion that similar companies should have similar multiples of price to fundamental measures of value.

dividends that are expected into the future.[9] That is, fundamental valuation involves solving equations A1 and A2 (in the appendix) to yield the market price equal to the expected discounted value of future dividends. This result holds if the stock market price contains no bubble—no "irrational exuberance."[10] Although this approach suggests that one must look into the distant future in order to price firms, there are a number of ingenious solutions that do not require complex forecasting methods. Among these are methods that simplify the basic formula to solve for future dividends and discount rates directly, such as Gordon growth models, and methods that make use of known market prices of other firms, such as the relative valuation model.

The relative value model. Practitioners use a variety of relative value models exploiting the notion that similar companies (in the same industry, at the same point in their growth cycle, of similar size, and so on) should have similar multiples of price to fundamental measures of value. That is, if company A is similar to company B, and company A has a price that is ten times its earnings (reflecting a 10 percent return on investment, roughly speaking), then company B's price is expected to be roughly ten times its earnings as well. The price for company A reflects a risk-return trade-off for that company, with market participants satisfied with a 10 percent return for a company with the characteristics of either company A or B. If market participants suddenly reassessed these companies as less risky, then a 10 percent return would be considered rich, and the price of both companies would be bid up, lowering the return until market participants would no longer consider the return to be unusually good.

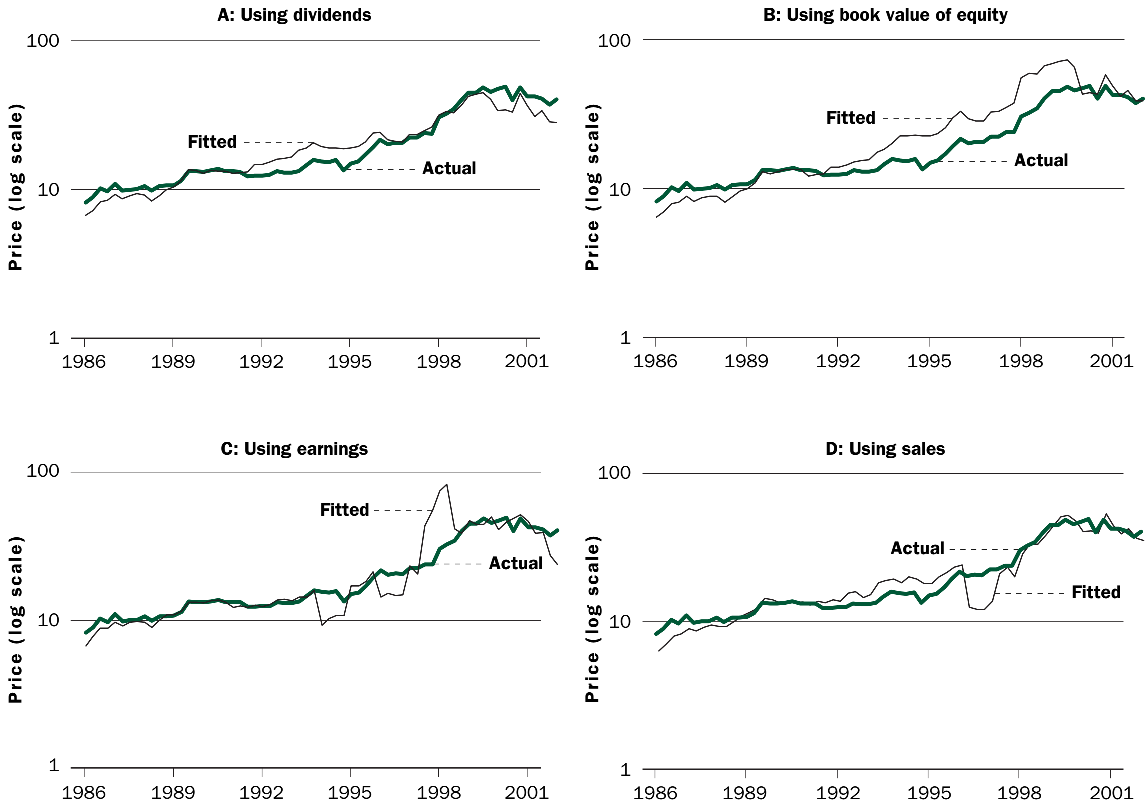
Relative value models do not require that firms pay out dividends. In the past, price-earnings multiples were most closely watched, but the advent of the technology boom in the 1990s led many to rely more on sales to price multiples because many companies did not have positive earnings (see, for instance, Leibowitz 1997). Other price relatives that are closely watched include the price-to-cash flow, the price-to-EBITDA ratio and the book-to-price (B/P) ratio. A B/P ratio of 1 is expected for relatively mature firms while growth firms are expected to produce lower ratios.

To illustrate relative value pricing, Figure 1 shows the price of BellSouth shares (NYSE:BLS), plotted quarterly, over the past sixteen years, using dividends, book value of equity, earnings, and sales of BellSouth and a similar firm, SBC Communications, another Baby Bell. In each panel the price scale is logarithmic, and the price is the closing price on the last day of trading in the first month of the quarter.[11] The respective relative value price is also plotted. The relative value price based on dividends for, say, the first quarter of 1985 is calculated by multiplying BellSouth's 1984 dividend by SBC Communications' 1985 price-dividend ratio.[12] The relative value prices based on earnings and on sales were calculated similarly. For the relative value price based on book value of equity, the book value for BellSouth reported for the fiscal year preceding a given quarter is multiplied by the price-to-book value reported for the same quarter for SBC; this calculation uses the closing price of SBC on the last trading day of the first month of the quarter and the book value reported for the fiscal year preceding the quarter.

A relative value model based on sales performs very well over most of the last sixteen years in this example; the relative sales price tracks the actual price very closely on average and in particular tracks actual market price remarkably well through the turmoil of the last three years. Relative valuation based on dividends also performs very well while relative valuation based on book value of equity or on earnings is much less reliable for the last sixteen years for BellSouth. More generally, relative

FIGURE 1

Relative Value Estimates of BellSouth Share Price



Note: Panels A through D present logarithms of the quarterly BellSouth share price level and the forecast price level from the relative value model. Panel A is based on dividends issued by BellSouth and the dividend yield of SBC Communications (SBC); panel B is based on the BellSouth book value of equity and the SBC book-to-market ratio; panel C is based on BellSouth earnings and the SBC earnings yield; panel D is based on BellSouth sales and the SBC sales yield.

valuation based on sales is attractive because most companies report sales while a great many companies issue dividends only rarely or have negative earnings or negative book value.

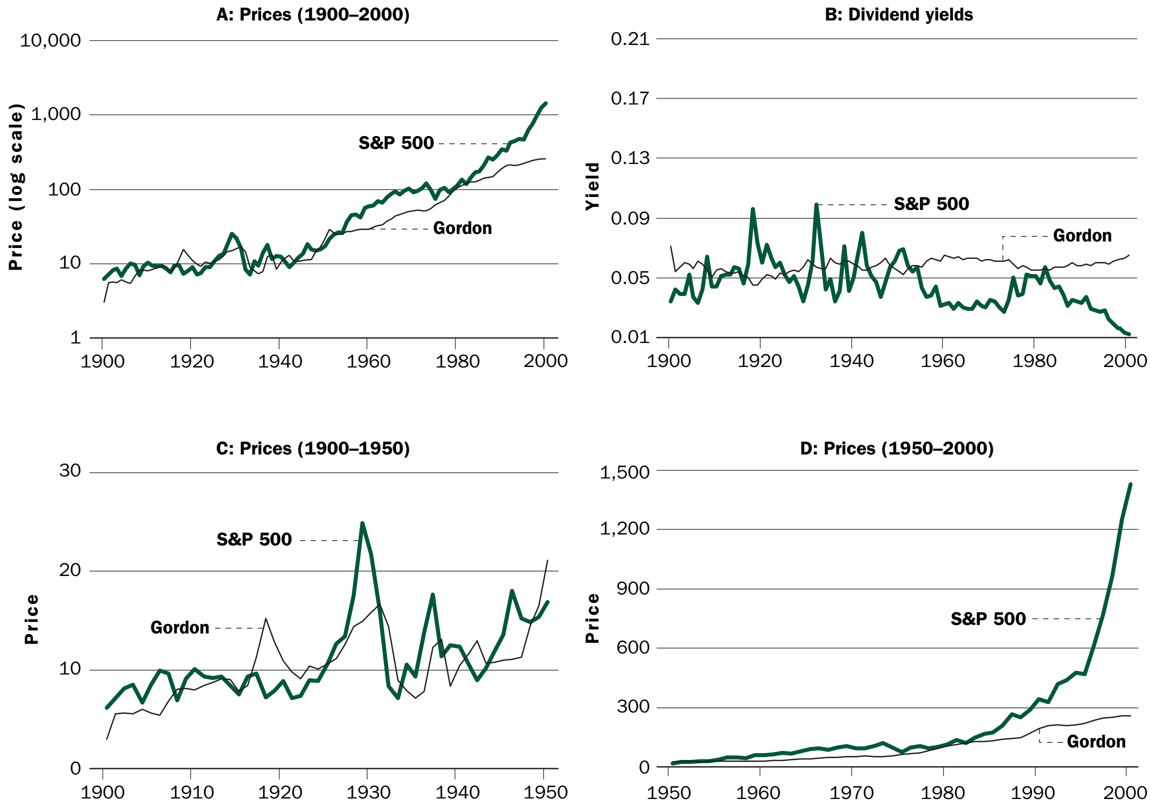
A word of caution—exploiting price relatives to value firms requires great care. Truly comparable firms must be found or the exercise is of little merit. Firms with advantages like a monopoly will be able to generate much higher profit margins and yields and will be grossly undervalued if benchmarked against otherwise similar firms. The best application of relative valuation is in valuing individual firms, provided a comparable firm can be found to the firm being valued. Pricing an index like the S&P 500 can be accomplished with relative valuation but only by using past values of the index. The classic dividend discounting valuation methods are easily applied to indices, however, as shown below.

The Gordon growth model. Perhaps the most widely used fundamental valuation method after relative valuation is the Gordon growth model. The Gordon fundamental price estimate does not, unlike relative valuation, require a comparable firm to the firm being valued and is derived with two simple assumptions: a constant discount rate and a constant growth rate of dividends. With these two assumptions, the valuation formula simplifies to a ratio involving the average dividend growth rate and the

9. The appendix provides technical descriptions of the valuation methods and models discussed in this article.
10. See Garber (1990), Kindleberger (1978), Shiller (1989), and White (1990) for a discussion of bubbles. Bubbles in asset prices are commonly defined as deviations of market prices from fundamental values.
11. The logarithm of price is presented to compress the scale of prices, making it possible to see detail throughout the period.
12. The SBC closing price used is that recorded on the last day of trading in January 1985, and the dividend used is the 1984 dividend.

FIGURE 2

The Gordon Growth Model for the S&P 500 Index



average discount rate multiplied by the most recent dividend (see equations A3 and A4 in the appendix).

To illustrate this pricing method, one can apply the Gordon growth model to the S&P 500 index over the past 130 years. During this time the S&P 500 index has enjoyed an average annual dividend growth rate of approximately 4 percent, and most measures of r, the average annual discount rate, would be close to 11 percent. The Gordon model price for, say, 1980 was calculated by estimating g as the average annual growth rate in dividends and r as the average annual return to holding the S&P 500 index for the 1871–1979 period and using dividends paid during 1979. This calculated Gordon price is then compared to the January 1980 price. Hence, the Gordon prices are all out-of-sample forecasts.

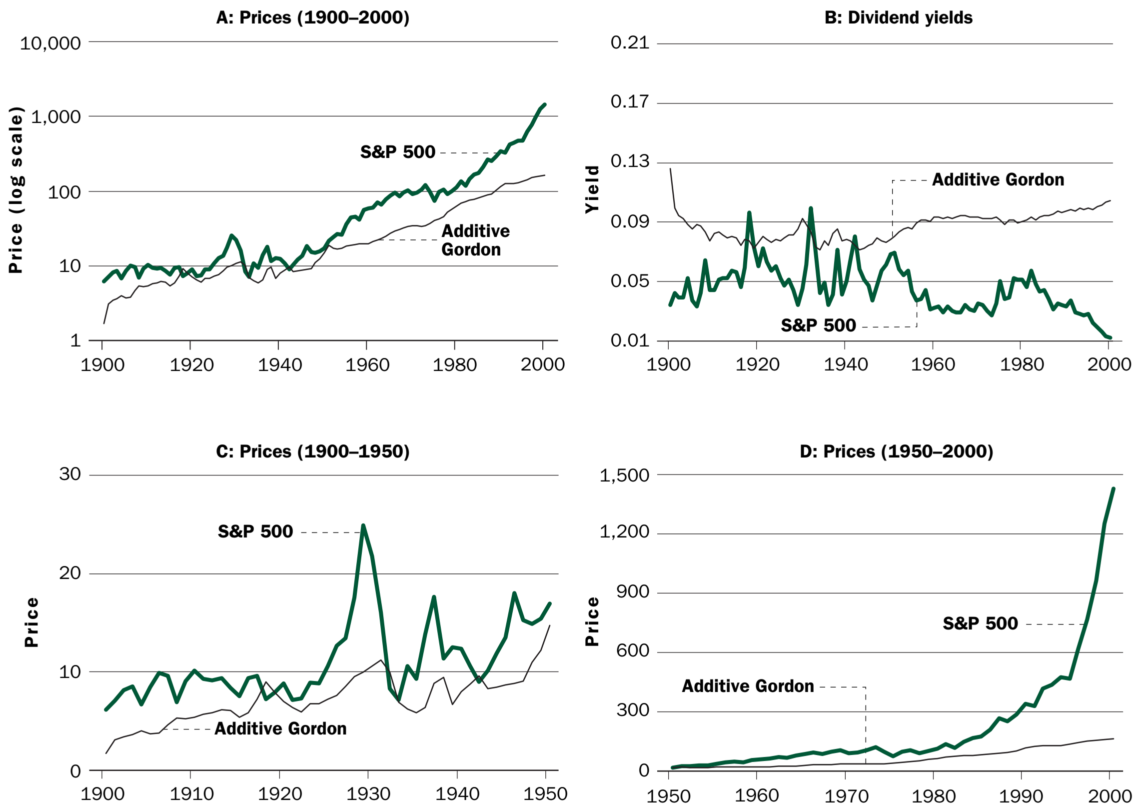
Figure 2 compares S&P 500 data with Gordon model estimates. Panel A shows prices and the Gordon model price for the period 1900 to 2000; a logarithmic scale makes it possible to see detail throughout the 100-year period. Panel B presents the market dividend yield (the S&P 500 index dividend divided by the market price) and the dividend yield using the Gordon price in place of the market price. Panels C and D present the actual market Gordon model prices (instead of the logarithmic values shown in Panel A) for the 1900–1950 and 1950–2000 periods, respectively. This display of fifty-year periods makes it easier to interpret deviations of the forecast and actual S&P 500 prices. The dividend yield shown in panel B highlights deviations of market and forecast prices. Evidence of large and persistent deviations between the market and forecast yields reveals whether the market is making systematic valuation errors or the forecasting model is performing very poorly.

Applying the Gordon model to the S&P 500 index annual data produces evidence of excessive market volatility (the forecast dividend yield is much less variable than the realized market yield) and of periods of inflated market prices—bubbles—in particular, during the 1920s, the 1960s, and the last half of the 1980s and 1990s. If the Gordon model is too simple, however—ignoring as it does changes in discount and dividend growth rates over time—this evidence may be misleading.

The additive and geometric Markov Gordon growth models. Hurley and Johnson (1994, 1998)

FIGURE 3

The Additive Markov Gordon Growth Model for the S&P 500 Index



and Yao (1997) develop Markov models—models that presume a fixed probability of, say, maintaining the dividend payment at current levels and a probability of raising it—to estimate dividends more realistically. These extensions of the Gordon growth model go back to the fundamental valuation equation, imposing less stringent assumptions. The simple Gordon growth model imposes a constant growth rate on dividends—dividends are expected to grow at the same rate every period—while these Markov models allow the probability of zero dividend growth. Two examples of these models found in Yao (1997) are the additive Markov Gordon model (equation 1 in Yao) and the geometric Markov Gordon model (equation 2 in Yao) (see equations A5 and A6 in the appendix).

For the S&P 500, over the last 130 years annual dividends have decreased 28.9 percent of the time and increased 71.1 percent of the time, the average absolute value of the change in annual dividends has been 0.161, and the average absolute value of the annual percentage change in dividends has been 9.2 percent.

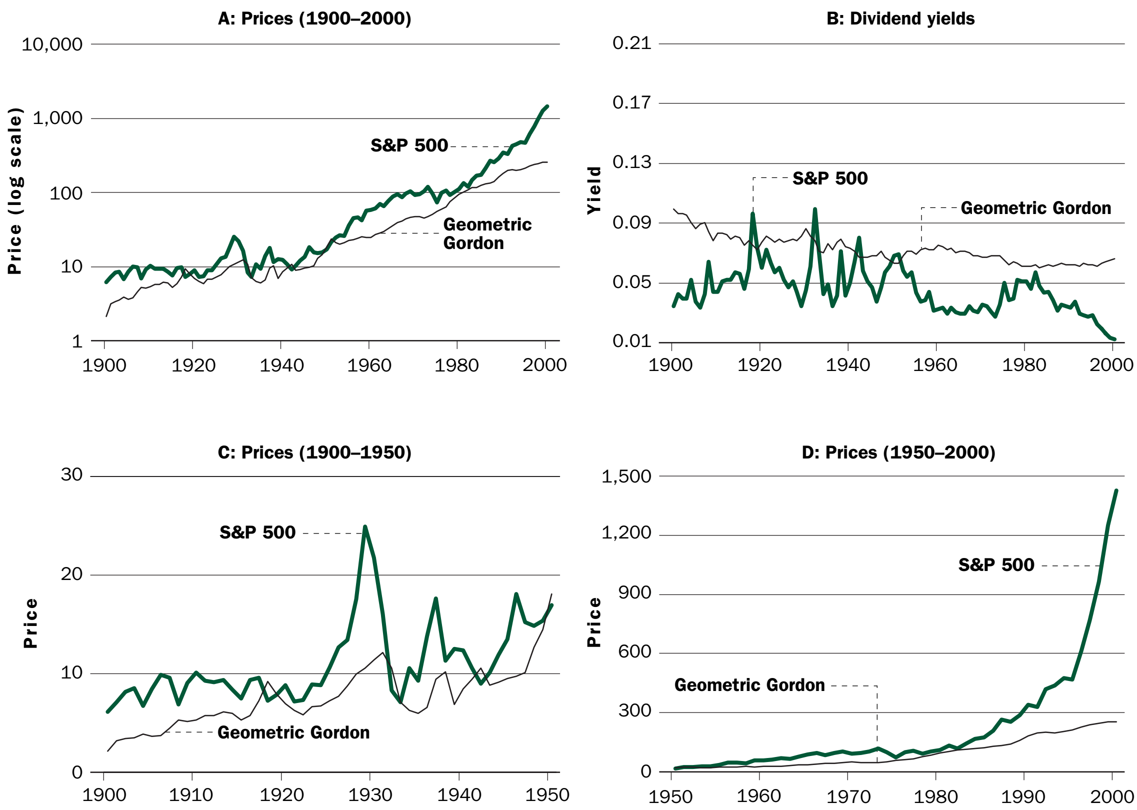
Figures 3 and 4 show prices and dividend yields from the additive and geometric Markov Gordon models versus the market price and dividend yield for the period 1900 to 2000. These models were implemented to produce out-of-sample price estimates just as the Gordon growth model was. The price for a given year was estimated using data up to but not including that year. Applying these two extensions of the Gordon model to the S&P 500 index annual data also produces evidence of excessive volatility and periods of inflated market prices—the 1920s, the 1960s, the 1980s, and the 1990s. Overall, the simplest Gordon model performs as well as the Markov model extensions, but none perform well.

Again, this poor performance could be the result of overly simple models that are not able to capture changes in value of the index or of a mispriced (irrationally priced) market.[13] The fact that the market price typically exceeds the forecast price from these models has led many to believe that the market has been overvalued at times, especially during

13. "Irrational pricing" can be defined as pricing based on expected price appreciation in the absence of expected cash flows.

FIGURE 4

The Geometric Markov Gordon Growth Model for the S&P 500 Index



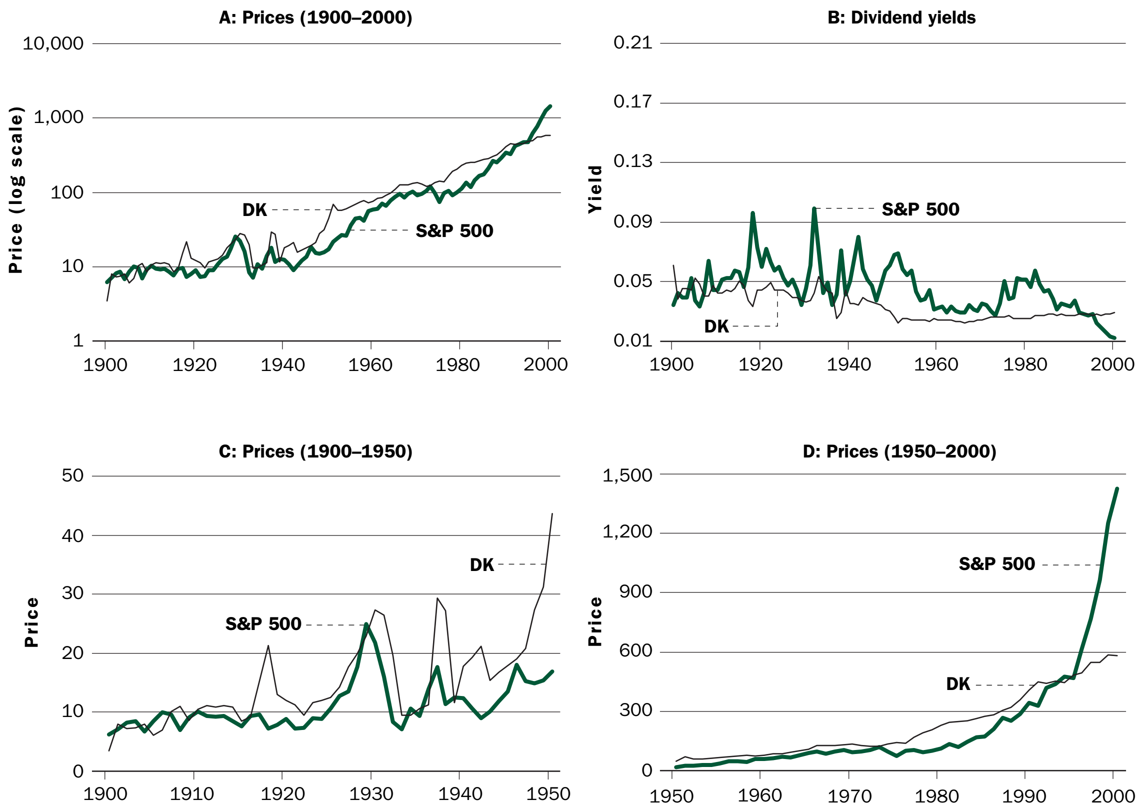
boom times like the 1920s, the 1960s, the 1980s, and the 1990s.

The Donaldson-Kamstra Gordon growth model. Donaldson and Kamstra (1996) further extend the Gordon model, imposing even fewer assumptions on the fundamental valuation equation than the Markov Gordon growth models and using statistical models of discounted dividend growth rates. The Donaldson-Kamstra model permits more flexible modeling of autocorrelation in growth rates than do simple Markov models. In the language of practitioners, this autocorrelation affects the fade rate: the speed at which company growth converges to its long-run stable growth rate (see, for instance, Wilson 2000). The greater the autocorrelation, the slower the fade to the long-run growth rate and the higher the value of a company enjoying temporarily high growth.

Why should one worry about autocorrelation? Take a simple example, a firm facing two equally likely scenarios for future discount rates. In one scenario, the discount rate decreases from its past average of 8 percent to a new average of 6 percent; in the other, the average rate increases to 10 percent. Once changed, the average rate remains fixed forever. The expectation before the rate change is for an average rate of 8 percent, just as in the past. Suppose dividend growth is expected to be 4 percent and the most recent dividend was $1. The Gordon growth model, applied blindly, would yield a price of $1/(0.08 – 0.04), or $25 per share. However, if interest rate changes are recognized as permanent (an extreme form of autocorrelation), then Gordon prices could be calculated separately for each scenario, and the two prices could be averaged to get a price that accounts for autocorrelation. The low discount rate case yields a price of $1/(0.06 – 0.04), or $50 per share, and the high discount rate case yields a price of $1/(0.10 – 0.04) or $16.67 per share, for an average price of roughly $33.33. Accounting for the autocorrelation dramatically changes the price estimate, increasing it by 30 percent. Although it is easy to adjust the Gordon model for a simple scenario like this one, the Donaldson and Kamstra technique makes it possible to perform extremely complex scenario analysis that is not feasible with simpler methods, such as scenarios in which the discount rate never settles to a constant, the dividend growth

FIGURE 5

The Donaldson-Kamstra Model for the S&P 500 Index



rate also moves around, and the two rates influence each other probabilistically.

Over the last 130 years the average annual value of discounted dividend growth rates has been 0.965 based on an equity premium of 3 percent, a premium recent research supports.[14]

Figure 5 presents the price and dividend yield for the Donaldson-Kamstra (DK) model versus the market price and dividend yield for the period 1900 to 2000. The DK model was implemented to produce out-of-sample price estimates as the Gordon models were. The forecasts of discounted dividend growth rates are based on the last year of rates.[15] Applying the DK model to the S&P 500 index annual data produces much less evidence of surprisingly high market prices although the late 1990s still exhibit higher prices than the DK model's price forecasts. The dividend yields in panel B also provide evidence of excessively volatile market price movements in the last fifty years.

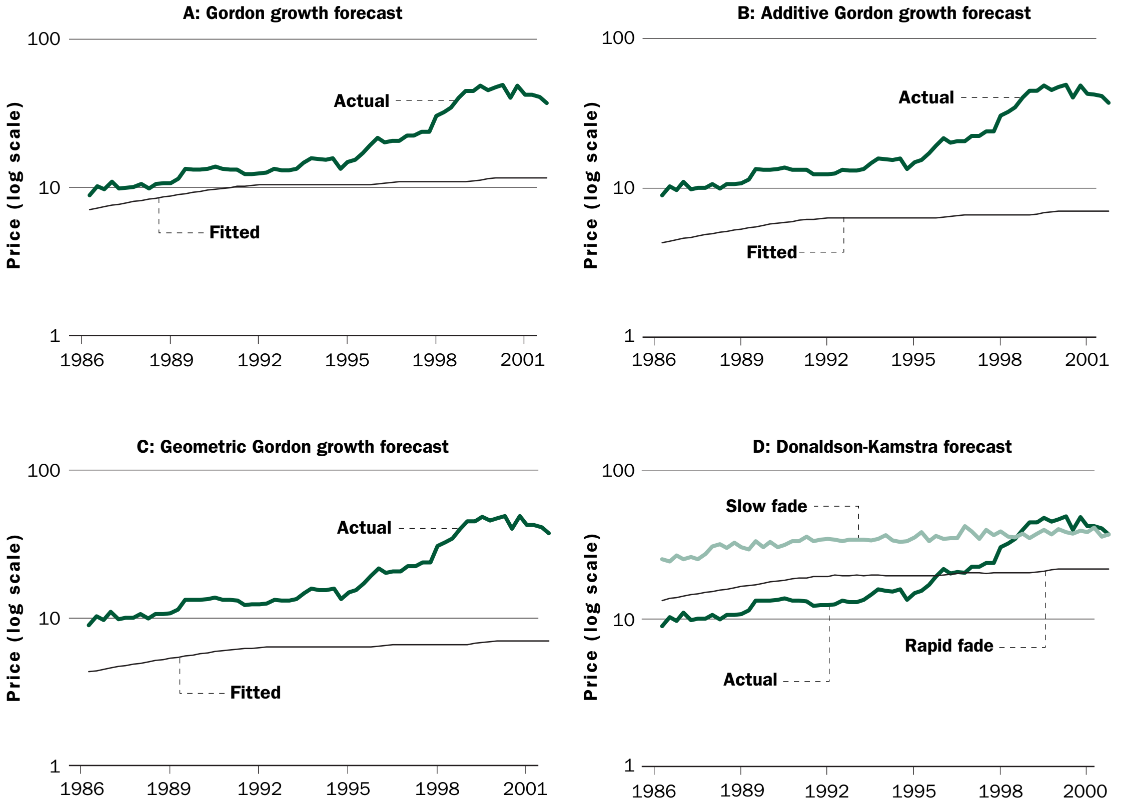
The ability of the DK model to capture much more market volatility, including the booms of the 1920s, the 1960s, and the 1980s, highlights the importance of accounting for the slow fade rate of dividend growth rates and discount rates. The continued failure to capture the height of the 1990s boom still leaves evidence of surprisingly high prices during the late 1990s. There is, however, still the question of a modeling failure; a large spike in prices could still be rationalized by a decrease in the fade rate during the 1990s.

14. The discounted dividend growth rate equals one plus the dividend growth rate divided by one plus the discount rate. This value should be close to, but less than, one. The equity premium is the extra return generated by stock market equity over relatively risk-free Treasury bills. The 3 percent premium is supported by, for instance, Fama and French (2002), Jorion and Goetzmann (1999), Jagannathan, McGrattan, and Scherbina (2001), and Donaldson, Kamstra, and Kramer (2003).

15. This forecasting model is an autoregressive model of order 1. The logarithm of discounted dividend growth rates was modeled for this exercise. The average value of the coefficient on the AR(1) term in the model was approximately 0.26, implying a fairly rapid fade rate. In as little as four years the impact from a change in the discounted dividend growth rate is expected to have virtually no remaining impact. An unexpected 10 percent increase in this growth would fade to less than 0.1 percent by year five. For implementation details, see Kamstra (2001) and Donaldson and Kamstra (forthcoming).

FIGURE 6

Forecasts of BellSouth Share Prices Based on Dividend-Forecasting Models



Note: Forecasts from the Donaldson-Kamstra model in panel D include models based on a rapid and a slow fade rate of growth in cash flows calibrated to the S&P 500 index over the last 100 years.

Application of Gordon growth models to BellSouth. It is interesting to apply the Gordon models based on dividends to the earlier example of BellSouth and explore how these models perform compared to relative valuation. A shortfall of the relative valuation approach is that a truly comparable firm may be difficult to find; great errors in valuation may follow an unwise choice of comparable firm. A model that does not look at prices, such as the Gordon growth models described earlier, should be immune to this problem.

The Gordon growth, additive and geometric Markov Gordon growth, and DK model price forecasts displayed in Figure 6 are formed using the same calibration used for the S&P 500 (BellSouth is, after all, a S&P 500 firm)—an average annual discount rate of 11 percent and an equity premium of 3 percent—and the same timing conventions used to form the relative value forecasts (so that all forecasts are out-of-sample).[16] For the DK model, price forecasts can be formed with the model described for the S&P 500 index, using the average annual estimated fade rate of dividend growth experienced by the S&P 500. This average fade rate is only an estimate, and plausible fade rates include slower and faster rates. These slower and faster rates allow bracketing high and low estimates of the share price. The low fade rate indicates a very slow reversion of growth to the long-term mean growth, implying high prices for fast-growing firms and low prices for firms that have experienced below-average or negative growth. A high fade rate indicates a very rapid reversion of growth to historic levels, so that price is not moved much by unexpected high or low growth.[17]

The simple Gordon growth model and the additive and geometric Gordon growth models all perform poorly, capturing neither the overall level of the share price nor the dramatic rise in share value in the late 1990s. Again, this performance is dramatic evidence of either irrational price setting or model failures. Allowing the Gordon models to incorporate larger dividend growth rates or smaller discount rates does not fix this problem—the

Gordon prices are not variable enough regardless of these settings. The DK model captures the average price level, reinforcing the notion that accounting for the fade rate matters, but the magnitude of the rise and fall of prices is not captured. The market prices start from below the lower bracket DK price and rise above the upper bracket DK price. Forecast prices are also much less volatile than actual market prices even when the fade rate is slow, the case for which we expect to see the most dramatic price swings. Clearly, relative valuation is capturing something these fundamental valuation methods fail to include. Hackel and Livnat (1996, 9) and others argue that dividends may be unreliable for assessing firm value because of institutional constraints on firm managers to smooth dividends over time. So a third possibility is that the models and the market prices are fine and that the problem is simply one of overly smoothed dividends. The next section presents discussions of formal extensions of classic dividend valuation models that allow the use of earnings, or sales, or other nondividend accounting numbers to value companies.

Augmenting Dividend Discounting Models

Kamstra (2001) extends dividend discount models like the Gordon growth model to firms that do not pay out dividends and incorporates nondividend information like earnings or sales figures into fundamental valuation of firms that do pay out dividends. The basic premise of this work is to incorporate the proceeds from share liquidation into the cash flows that are used to value the firm, accounting for the reduction in future growth of cash flows from this liquidation of shares. Share liquidation refers to selling a fraction of the stock holdings in a portfolio of stock. This sale generates immediate cash flow but reduces potential cash flows into the future. For instance, if a shareholder sells 3 percent of his shares this year, he will reduce his dividend flow next period from his remaining shares by 3 percent as well as reduce the cash from further liquidations because his portfolio will be 3 percent smaller next period.

A reasonable question is, How might share liquidation help one value a firm? It is well known that dividends are typically set low enough that the dividend payments can be maintained through economic downturns, leading them to be lowered only rarely and to inaccurately reflect future prospects for the firm, as argued by Hackel and Livnat (1996) and others. Augmenting dividends with the proceeds of share liquidation—say, to produce a yield equal to 3 percent of the sales yield—should produce valuation rules that more accurately reflect future prospects. Accounting for the share liquidation produces valuation formulas that are still tied to fundamentals of cash flow paid to investors even if the liquidation rule is itself calibrated to firm sales, not firm dividends.

The Kamstra method extends dividend discount models like the Gordon growth model to firms that do not pay out dividends and incorporates nondividend information like earnings or sales figures into fundamental valuation of firms that do pay out dividends.

A wealth of other work has, of course, been done on valuing zero-dividend firms. Among these studies are approaches that extend formal dividend discounting to zero-dividend firms relying on techniques similar to those used in option-pricing (see Bakshi and Chen 1998; Schwartz and Moon 2000, 2001), approaches that replace dividends with earnings and payout ratios or sales and profit margins, and, of course, relative valuation methods.[18]

As the share liquidation rule of Kamstra (2001) uses past prices (to form the yield ratio), depending on how this rule is implemented it can have much in

16. The data range is shorter in Figure 6 than that displayed for relative valuation in Figure 1 because of the need to use greater lags of the data to form forecasts.

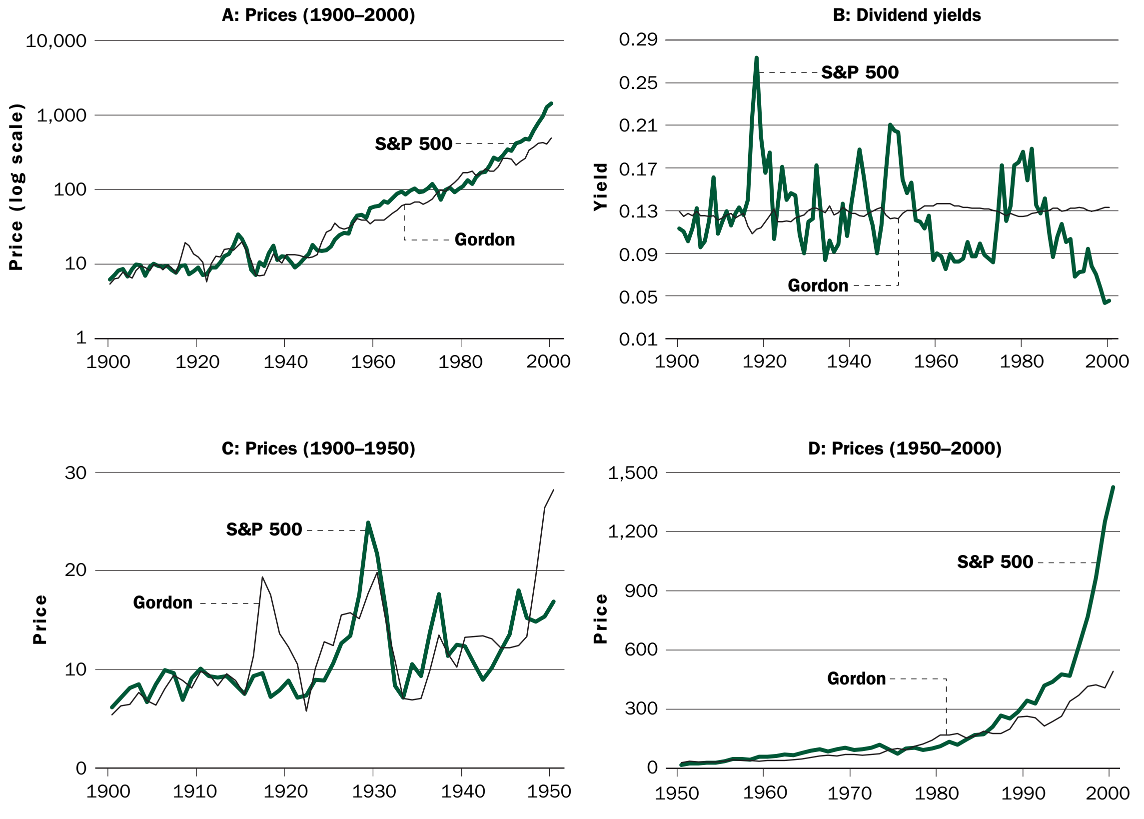
17. The high-fade-rate model was implemented by taking the average fade rate AR(1) parameter estimate of 0.26 and the standard deviation estimate of this parameter of 0.09 and subtracting two standard deviations from the parameter estimate, leaving a fade rate parameter of approximately 0.08. An unexpected 10 percent increase in growth would fade to less than 0.1 percent by year three for this parameter setting. The low-fade-rate model was implemented by taking the average fade rate AR(1) parameter of 0.26 and adding two standard deviations to it, producing a fade rate parameter of approximately 0.44. An unexpected 10 percent increase in growth would now take over seven years to fade to less than 0.1 percent.

Bracketing price estimates can also be formed for the other Gordon growth models, but these price estimates are fairly small shifts up and down from the forecasts presented.

18. See Damodaran (1994, 244–48) for an example using sales and Sharpe and Alexander (1990, 474–76) for an example using earnings.

FIGURE 7

The Gordon Growth Model with Augmented Dividends



common with relative valuation. For instance, if one were valuing private equity one would not have past earnings yields to provide an expected earnings yield. In this context, one would pick an expected yield ratio by looking at the earnings-to-price ratio of similar but publicly traded firms, an approach borrowed from relative valuation.

An advantage of a share liquidation rule for valuation over relative valuation is that the fade rate in cash flows and discount rates can be incorporated with share liquidation as outlined in Kamstra (2001) while the relative value model ignores fade rates. The relative value model, taken at face value, assumes that the sales yield (or whatever yield is being considered, say, the earnings yield) will remain constant forever while Kamstra provides a method that makes this yield trend to some long-run stable level.

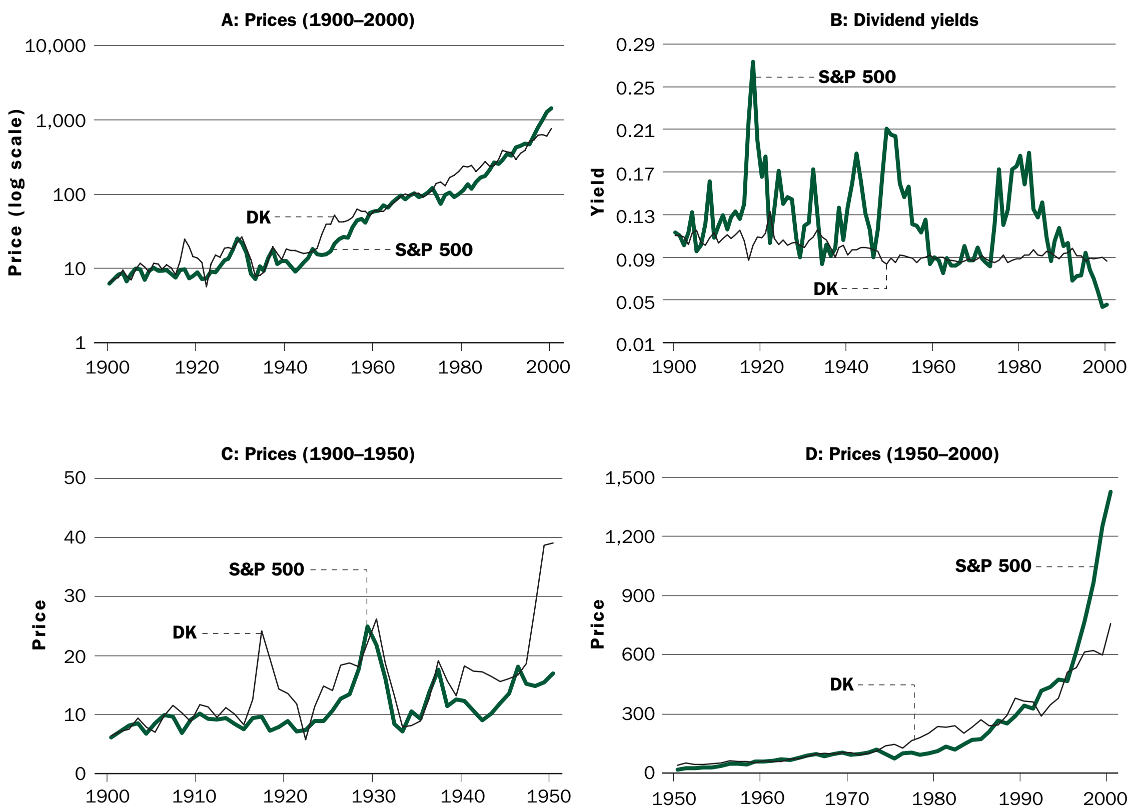
A disadvantage of the Kamstra method compared to the relative valuation method is that the long-run stable level of the yield ratio must be specified, and if this level is chosen incorrectly it can bias price forecasts. Also, the dependence (the fade rate) of the yield ratio and cash flow growth as well as the discount rate must be modeled, and typically the companies this method would be applied to would not have sufficient history to properly estimate fade rates based on own-company data. To implement the Kamstra method on such firms, a calibration to the S&P 500 index will be performed here, similar to that described above.

Compared to the techniques using option-pricing tools, the Kamstra method is simpler to apply though very similar in spirit. The approaches that replace dividends with earnings or sales have in common with relative valuation the disadvantage of not accounting for the fade rate of growth and discount rates and the advantage of simplicity over the Kamstra method.

Another valuation approach for zero-dividend firms is scenario analysis, the strategy of forecasting possible cash flows that a company might generate and computing the fair value of that company under the various scenarios. For instance, if there is a 50 percent chance that a company will be worth $5 per share and a 50 percent chance that it will be worth

FIGURE 8

The Donaldson-Kamstra Model with Augmented Dividends



$15 per share, then a price of $10 per share would be expected. This approach often combines elements of relative valuation and discounted cash flow analysis. Great skill and a great deal of detailed institutional knowledge of the firm and its industry are required to implement this valuation technique.[19]

I will restrict myself in this review to techniques I have already used, techniques that allow a narrow set of information for implementation and are therefore reasonably straightforward to apply.

Application to the S&P 500 index. In the case of the S&P 500 index with share liquidation set to equal accounting earnings, the total cash flow to the investor will equal the dividends paid plus earnings. The growth rate of this cash flow over the last 130 years equals 4.9 percent, and the annual yield ratio (see the appendix for the definition of this term) averages 8 percent. This information, together with the average annual discount rate (11 percent, as described above), allows us to produce Gordon prices, which are displayed in Figure 7.

One can also produce DK prices based on the discounted cash flow growth rates. Based on earnings plus dividends and an equity premium of 3 percent, the average S&P 500 discounted growth rate over the last 130 years has been 0.974.[20] Figure 8 presents price and cash flow (dividends plus earnings) yields for the DK model versus the actual market price and yield for the period 1900 to 2000.[21]

Both the simplest Gordon growth model (Figure 7) and the DK model perform remarkably better when conditioned on the extra information provided by earnings. With the added consideration of earnings, the Gordon model captures most of the price rise and decline of the 1920s and tracks prices up to 1990 very well. In addition, the DK model now captures

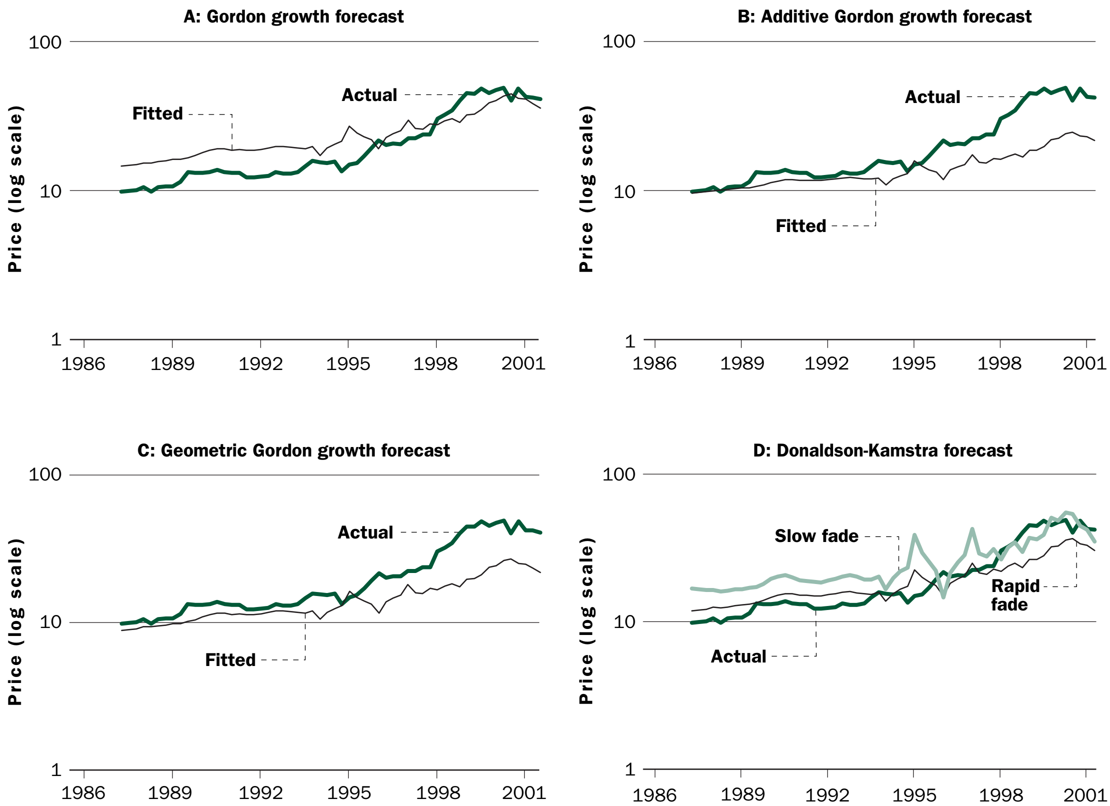
19. See Wilson (2000) and Copeland, Koller, and Murrin (2000) for extended discussions that outline implementation details.

20. The discounted cash flow growth rate equals one plus the cash flow growth rate divided by one plus the discount rate. This value should be, on average, close to but less than one.

21. Results are presented for the slow-fade-rate DK model, calibrated as described above.

FIGURE 9

Forecasts of BellSouth Share Prices with Dividends Augmented by Share Liquidation Based on Earnings



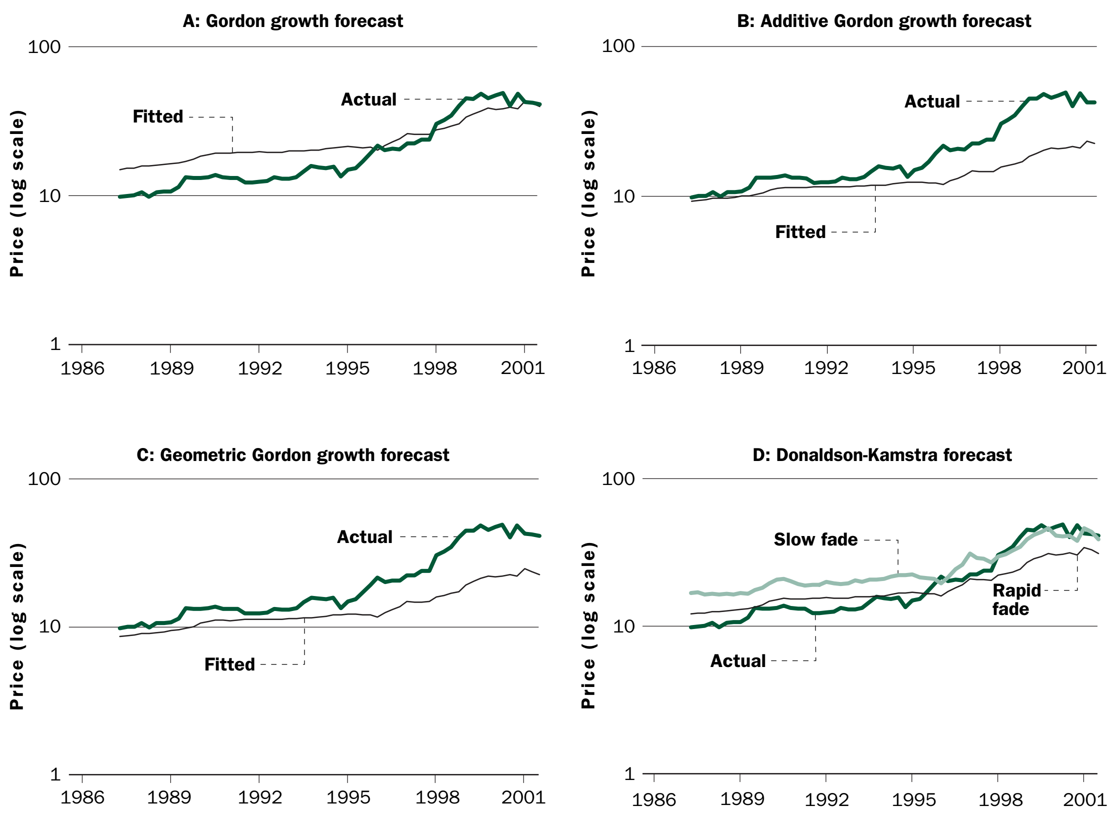
the timing of the turning point around the peak of the market in 1929 whereas both models peaked several years late when only dividends were used for pricing. Results from the additive and geometric Markov Gordon models are very similar to the basic Gordon model and are thus not presented here. The DK model forecasts prices and yields better than the Gordon growth model does, but the market yield ratio remains much more variable than can be explained by this model of fundamentals, and the market price at the end of the 1990s is approximately double what is forecast. Also worth noting is that some of the largest and most persistent deviations of market prices from forecast prices have occurred during periods of war, World War I and World War II in particular. This pattern highlights the fact that any algorithmic forecast based on a very restricted set of information can produce forecast prices that are less than reliable.

Application to BellSouth. It is also possible to apply these models to Bell South, augmenting its dividend payments with share liquidation based on either earnings, sales, or book value of equity. Figures 9, 10, and 11 show the logarithm of the price of BellSouth shares and of the forecast share price from the Gordon growth, additive and geometric Markov Gordon growth, and DK models.[22] Dividends are augmented with a stream of cash from liquidating shares equal to approximately 3 percent of the share price, calibrated to either earnings, sales, or book value of equity, and adjusting downward the growth of this cash stream to take account of this liquidation of shares.[23] Again, all the models borrow from the calibrations for the S&P 500 index, including setting the average discount rate to 11 percent and the equity premium to 3 percent and using the same timing conventions so that the forecasts are out-of-sample. The DK model results include forecasts from the slow- and rapid-fade-rate models, providing bracketing forecasts that one would expect to contain the actual market price.

The additive and geometric Gordon growth models never perform particularly well, regardless of the liquidation rule, but the classic Gordon growth

FIGURE 10

Forecasts of BellSouth Share Prices with Dividends Augmented by Share Liquidation Based on Book Value of Equity



model and the DK model perform reasonably well with a liquidation rule based on sales or book value of equity. The classic Gordon model picks up much of the price rise and some of the decline over the period considered. The price bracket formed by the rapid- and slow-fade-rate DK models augmenting dividends with liquidation based on sales or book value indicates that the market price of BellSouth was often within a reasonable range of values, although a case for prices being somewhat high in 1999 and 2000 can still be made. Valuation based on augmenting dividends with an earnings-calibrated liquidation rule tends to have more false movements and random volatility, but this is a subjective judgment. The better performance when using book value or sales mirrors the relative valuation pattern found when using book value or sales for BellSouth and suggests at least two things. First, sales are more informative than earnings, at least for BellSouth over the last twenty years or so. Second, it is more difficult to argue that the price bubble observed in BellSouth stock valuation over the last three years was irrational—much of the up and down movement can be explained by changes in cash flows associated with high growth in sales, book value, and earnings.[24]

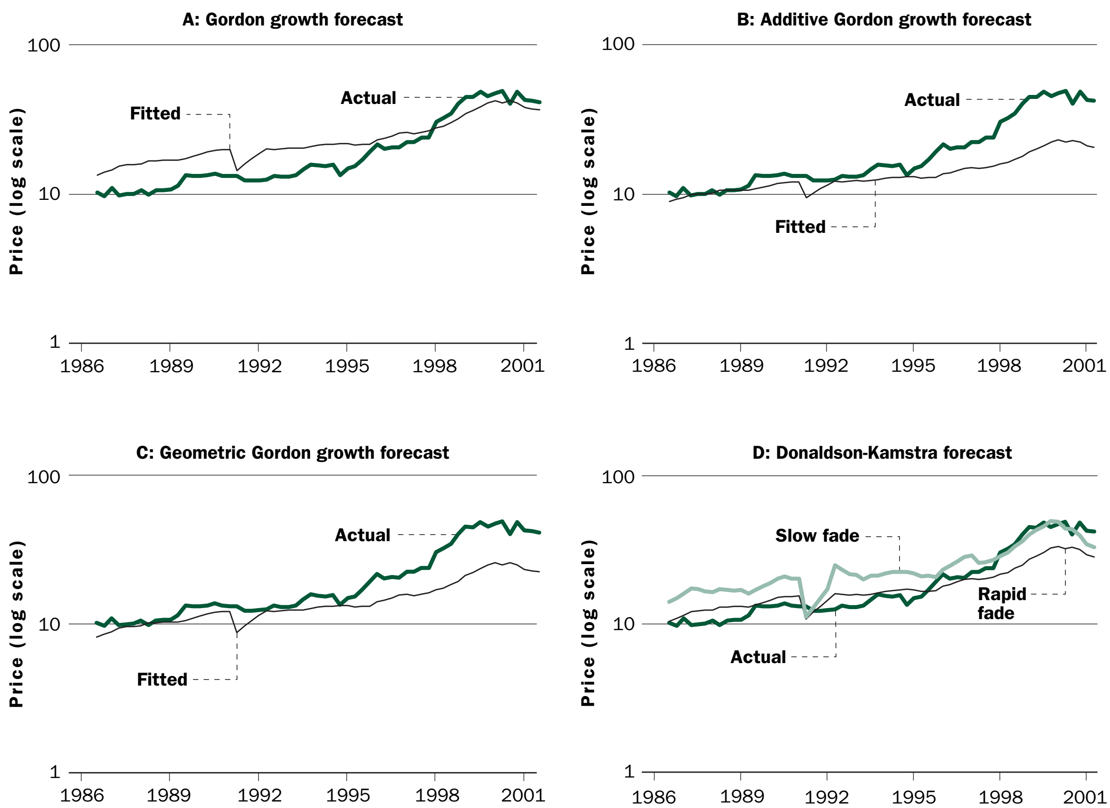
22. The data range is shorter here than those displayed in earlier figures because more lags of the data were needed to form forecasts.

23. The exact rule used when calibrating to sales was to liquidate a fraction of holdings equal to 3 percent multiplied by the most recently observed sales multiplied by the average price-to-sales ratio over the preceding year, not including the most recent quarter. The calibrations based on earnings and on book value of equity were performed similarly.

24. As the share liquidation scheme outlined here does make use of last year's sales, earnings, or book yield to calibrate liquidation, however, an argument can be made that a bubble was built into the "fundamental" price estimates generated. A share liquidation scheme based on the average yield over a longer period, as long as twenty years, does dampen the price rise in the late 1990s. Qualitatively, however, the evidence still supports the no-bubble view.

FIGURE 11

Forecasts of BellSouth Share Prices with Dividends Augmented by Share Liquidation Based on Sales



Application to high-growth firms. High-growth firms are particularly interesting for valuation exercises because such firms rarely pay out cash to shareholders, except perhaps to make share repurchases. The analysis will next consider Microsoft, Sun Microsystems, Starbucks, and Yahoo because all these firms are prominent members of the new economy, all have experienced very rapid growth, and all have had extreme share price fluctuations over the last several years. If the share liquidation scheme of Kamstra (2001) is used, these firms can be valued by traditional dividend-discounting models. Because all the Gordon growth models produce similar results, the discussion will focus on only the additive Gordon model and the DK model.

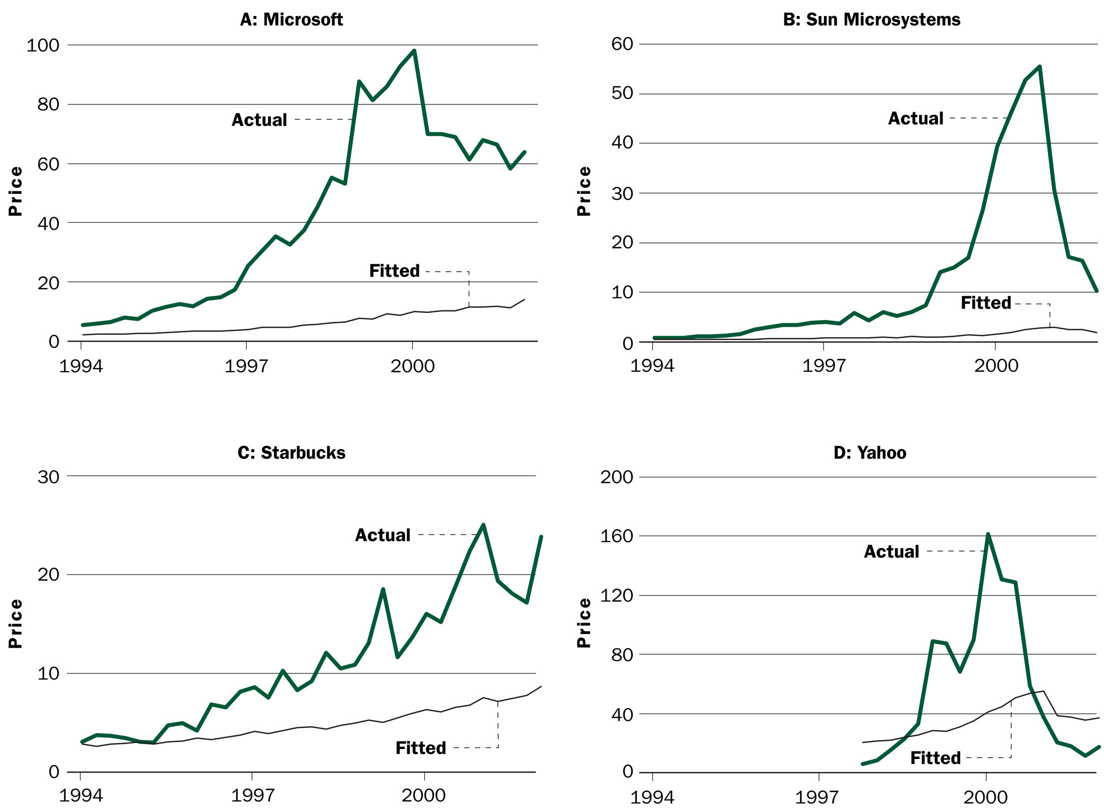
Figures 12 and 13 present forecasts from the additive Markov Gordon growth model and the DK model, respectively, based on a stream of cash from liquidating shares equal to approximately 3 percent of the share price, calibrated to sales. The calibrations used were identical to those used for BellSouth.[25] The DK model results include forecasts from the slow- and rapid-fade-rate models, providing bracketing forecasts that one would expect to contain the actual market price. In Figure 13 the prices are presented in logarithms to compress the scale for easier viewing.

The additive Gordon growth model (and indeed any Gordon model that ignores the fade rate) provides forecasts that are wildly at odds with the market prices for these four stocks. Even at the end of the sample, the last quarter of 2001, all but Yahoo still appear overvalued by the market. Given that the discount rate was calibrated to the S&P 500 index, even these prices are likely generous because these four stocks are arguably riskier than the average S&P 500 firm.[26] These plots of market prices versus fundamentals appear to strongly support the notion of a bubble in tech stock prices.

In contrast, the evidence from Figure 13 and the DK model prices—prices that take into account the fade rate of growth—does not support the notion of a bubble in the prices of these four stocks. By this method, Starbucks and Yahoo even appear to have

FIGURE 12

Additive Gordon Growth Forecasts of Share Prices of Microsoft, Sun Microsystems, Starbucks, and Yahoo Using Share Liquidation Based on Sales



been somewhat undervalued given the high growth rate of sales that each experienced over the last five years or so while Microsoft and Sun Microsystems display market prices that generally lie within the brackets formed by the slow- and rapid-fade-rate models. It should be noted that the bracketing forecasts generate a wide range of "reasonable" prices. Also, it should be noted that share value is estimated with models calibrated to the average S&P 500 firm, but an investor arguably faces more risk holding these four stocks than holding the average S&P 500 firm. Scenario analysis would factor in several different possible outcomes for all these stocks, including outright bankruptcy, that would lower the price estimates, possibly a great deal for Yahoo.

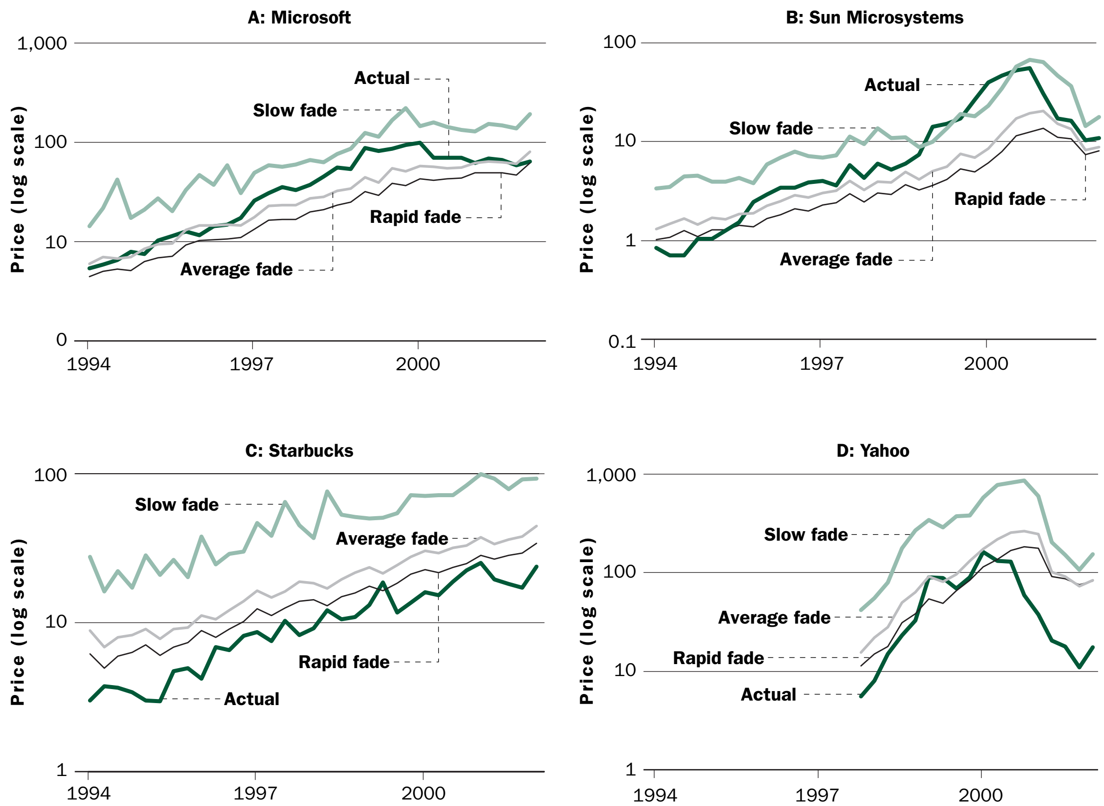
Conclusions

The pricing of stock market equity is one of the oldest problems in finance, but it is only in the last few decades that formal models have been developed to answer some of the most pressing questions. Many algorithms used to price equity are based on discounting cash flows accruing to the investor, though some methods base valuation on relative standing (that is, similar companies with similar balance sheets should be priced similarly, have similar price-to-sales ratios, similar price-to-earnings ratios, and so on) or a mix of discounting and relative valuation through scenario analysis. Valuation techniques based on the Gordon growth model, relative valuation, and the

25. The single exception is to the liquidation rule used in the DK and additive Markov Gordon growth models. Instead of using the average yield ratio from the past year, the average yield ratio is formed from the entire history of the stock. This rule is used because the high-growth stocks have much more volatile yield ratios than BellSouth has. Using only the past year produces similar results, with more exaggerated price movements forecast.
26. These four firms are all high-beta firms—that is, their stock returns are correlated with the overall market return but exhibit higher volatility than the overall market return.

FIGURE 13

Donaldson-Kamstra Bracketing Forecasts of Share Prices of Microsoft, Sun Microsystems, Starbucks, and Yahoo Using Share Liquidation Based on Sales



Note: Various parameterizations of the Donaldson-Kamstra model include a model calibrated to the average annual fade rate of the S&P 500 index over the last 100 years and models based on a rapid and a slow fade rate of growth in cash flows.

valuation method of Kamstra (2001) have been focused on here.

To demonstrate these methods in practice, they have been applied to pricing BellSouth shares, the S&P 500 index, and a few new-economy stocks. Pricing BellSouth using sales and sales growth is consistent with its dramatic rise and recent decline in price; this method is also appropriate for a small group of high-growth stocks, including Microsoft, Sun Microsystems, Starbucks, and Yahoo.

Fundamental models, however, have more trouble explaining the price movements of the overall market. Whether this failure to explain the overall market in the late 1990s is a shortcoming of these models or the kind of information used to price the index (earnings rather than, say, sales) or of an assumption of market rationality is not resolved here. Perhaps the most important point to take from this review is that algorithmic valuation techniques provide, at best, a rough starting point for firm valuation.

APPENDIX

Technical Details

Fundamental Valuation

The fundamental valuation equation is

$$(A1)\quad P_t = \varepsilon_t\left\{\frac{P_{t+1}+D_{t+1}}{1+r_t}\right\},$$

where P_t is the price of the stock at the beginning of time period t, D_{t+1} is the per share dividend paid on the stock, r_t is the rate at which payments are discounted, and ε_t denotes the expectation of the future price and dividends conditional on what is known at the end of period t.

Solving equation A1 forward (substituting out for the future prices with future dividends) yields the textbook result that the market price equals the expected discounted value of future dividends.

$$(A2)\quad P_t = \varepsilon_t\left\{\frac{D_{t+1}}{1+r_t}\right\}+\varepsilon_t\left\{\frac{D_{t+2}}{(1+r_t)(1+r_{t+1})}\right\}+$$
$$\varepsilon_t\left\{\frac{D_{t+3}}{(1+r_t)(1+r_{t+1})(1+r_{t+2})}\right\}+\ldots$$

where "…" means "and so on."

The Gordon Growth Model

Define the growth rate of dividends from the beginning of period t to the beginning of period $t + 1$ as $g_t \equiv (D_{t+1} - D_t)/D_t$, so that $D_{t+1} = D_t(1 + g_t)$, $D_{t+2} = D_t(1 + g_t)(1 + g_{t+1})$, and so on, and rewrite equation A2 as follows:

$$(A3)\quad P_t = D_t\varepsilon_t\left\{\frac{1+g_t}{1+r_t}\right\}+D_t\varepsilon_t\left\{\frac{(1+g_t)(1+g_{t+1})}{(1+r_t)(1+r_{t+1})}\right\}+$$
$$D_t\varepsilon_t\left\{\frac{(1+g_t)(1+g_{t+1})(1+g_{t+2})}{(1+r_t)(1+r_{t+1})(1+r_{t+2})}\right\}+\ldots$$

Assume constant discount rates $r_{t+i} = r$ and constant growth rates of dividends $g_{t+i} = g$ for all values of i and with $g < r$. Substituting r and g into equation A3 and applying results from infinite series yields the classic Gordon price defined as P_t^G:

$$(A4)\quad P_t^G = D_t\left[\frac{1+g}{r-g}\right] \text{ or } P_t^G = \frac{D_{t+1}}{r-g}.$$

The Additive and Geometric Markov Gordon Growth Models

The additive Markov Gordon growth model is

$$(A5)\quad P_t^{ADD} = D_t/r + [1/r + (1/r)^2](q^u - q^d)\Delta,$$

where q^u is the proportion of the time the dividend increases, q^d is the proportion of the time the dividend decreases, and $\Delta = \Sigma_{t=2}^{T}|D_t - D_{t-1}|/(T-1)$ is the average absolute value of the level change in the dividend payment.

The geometric Markov Gordon growth model is

$$(A6)\quad P_t^{GEO} = D_t\left[\frac{1+(q^u-q^d)\Delta^{\%}}{r-(q^u-q^d)\Delta^{\%}}\right],$$

where $\Delta^{\%} = \Sigma_{t=2}^{T}|D_t - D_{t-1}|/D_{t-1}|/(T-1)$ is the average absolute value of the percentage rate of change in the dividend payment.

The Donaldson-Kamstra Gordon Growth Model

Define the discounted dividend growth rate from the beginning of period t to the beginning of period $t + 1$ as $y_t \equiv (1 + g_t)/(1 + r_t)$ where again g_t equals $(D_{t+1} - D_t)/D_t$ (the dividend growth rate) and r_t is the discount rate. Rewrite equation A3 as follows:

$$(A7)\quad P_t = D_t[\varepsilon_t\{y_t\} + \varepsilon_t\{y_t y_{t+1}\} + \varepsilon_t\{y_t y_{t+1} y_{t+2}\} + \ldots].$$

The Donaldson and Kamstra (1996) method estimates the price by generating thousands of possible values of y_t, y_{t+1}, y_{t+2}, …, y_{t+I} (values of y out into the distant future, I periods from the present) and calculating

$$PV = D_t[y_t + y_t y_{t+1} + y_t y_{t+1} y_{t+2} + \ldots + y_t y_{t+1} y_{t+2} \cdots y_{t+I}]$$

for each, averaging these values of PV. Although this sum indexed by the parameter I should, technically, include all future values of y to infinity, if I is large enough there is only a very small truncation error. Donaldson and Kamstra (forthcoming) have found values of I = 400 to 500 for annual data to suffice. What distinguishes this method from other Gordon growth models is the way y_t is generated. Donaldson and Kamstra suggest time series models for y_t that have autoregressive patterns of dependence, a forecastable process.

The Augmented Dividend Case

Define A_t as the total cash an investor receives from her stock holdings in a particular company, including the payments the company makes to the investor (dividends paid by the company) and any proceeds the investor receives as a result of selling shares in the company (to other investors). Define V_t as the accounting variable (earnings, total asset value, sales, etc.) that will be used to calibrate investor share liquidations and notice that $A_t = D_t + V_t$, where again D_t is dividends. Define A's growth rate as $g_t^a \equiv (A_{t+1} - A_t)/A_t$.

Define $f_t = \alpha V_t / P_t$ where α is set to determine the yield. (For instance, if the firm pays no dividends, V_t is earnings, and one wants to extract from one's portfolio a yield equal to the earnings yield, one would set α equal to 1; if V_t was annual sales, one would set α to 7 percent to extract a yield of roughly 7 percent, as annual sales per share equals price per share for many firms, based on Compustat annual data for S&P 500 firms over the last twenty years.) Define the average yield ratio f_t as f, the average cash payment growth rate g_t^a as g^a, and the average discount rate r_t as r. Then Kamstra (2001) derives the Gordon price with augmented dividends to be

$$\text{(A8)} \quad P_t^{G,v} = A_t \left[\frac{1+g^a}{r-g^a+f(1+g^a)} \right].$$

For the zero-dividend case, it can be shown that r must equal g^a so that equation A8 reduces to $P_t^{G,v} = V_t/f$.[1] This formula is the relative value model. Knowing what yield (f) to expect, say, from knowing what yields similar firms generate and knowing what V is for the firm one is valuing reveals what the price of the firm should be. For example, if the firm is generating earnings of \$1 per share and similar firms have an earnings yield of 5 percent, then the firm should have a value of \$1/0.05 = \$20.

The Donaldson and Kamstra (1996) model was also extended in Kamstra (2001). Define $y_t^a = (1-f_t)(1+g_t^a)/(1+r_t)$ and rewrite equation A7 as

$$\text{(A9)} \quad P_t = A_t \mathcal{E}_t \{ y_t^\alpha + y_t^\alpha y_{t+1}^\alpha + y_t^\alpha y_{t+1}^\alpha \, y_{t+2}^\alpha + \ldots \}.$$

1. See, for instance, Ohlson (1991) for a discussion in the context of the growth of earnings when firms pay out less than 100 percent of earnings.

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