Don’t fight the Fed Model

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Don’t fight the Fed Model

Abstract

Over the past few decades, forward earnings yields (earnings forecast for next year scaled by aggregate market capitalization) approximately equal nominal 10-year risk-free rates in many stock markets. This regularity, known as the Fed model, is remarkable because it implies that stock valuations can be explained simply by just two parameters (forward earnings divided by nominal risk-free rates). In effect, two other parameters that should also impact stock valuations (anticipated growth and the equity premium) can be ignored because they cancel each other out. Despite its performance, the model has not been accepted by financial economists for a variety of reasons. I consider these different objections and show that the concerns are misplaced. In fact, contrasting markets/periods where the Fed model holds with those where it doesn’t hold has the potential to provide important insights.

Don’t fight the Fed Model

1. Introduction

The popular financial press refers often to the “Fed Model”, which appears to have first been mentioned in a July 1997 Federal Reserve Monetary Policy Report to Congress (see pp. 23-24 of http://www.federalreserve.gov/boarddocs/hh/1997/july/fullreport.htm). The model shows that forward earnings yields (forecasts for next year’s earnings divided by current valuations) for the US stock market gravitate toward 10-year government bond yields. Despite its remarkable descriptive ability, financial economists have raised a number of concerns about the model. In particular, Asness (2003) argues eloquently that we should all “fight” the Fed model. I claim that those concerns are misplaced and suggest instead that understanding the Fed model offers important insights regarding financial markets.

I should clarify at the outset that while the Fed report focuses on stock market mispricing, indicated by temporary deviations between the two yields (overweight equities when earnings yields exceed bond yields and underweight when below), my interest is in the documented average equivalence of the two yields. Despite the practical benefits of investigating potential market timing opportunities, I believe the underlying question of how earnings yields should vary with interest rate levels is an important one. To keep matters simple, I will consider only the “static” case by comparing earnings yields in two parallel worlds that are identical in every way except that one world has no inflation and the other has a fixed inflation rate and therefore higher nominal interest rates. Incorporating the “dynamic” case, where earnings yields change over time with changes in interest rates, confuses matters and those complexities are best discussed after developing insights from the static case.

Financial economists are uncomfortable with the Fed model for a variety of reasons. Many of the stated concerns arise from the commonly held belief (e.g., Ritter, 2002) that earnings yields must be “real” (unrelated to the level of expected inflation). In effect, P/E ratios should be relatively constant over time, not vary inversely with interest rates as they appear to in the recent past. Stated differently, investors must suffer from the inflation illusion described in Modigliani and Cohn (1979) if earnings yields comove with expected inflation.

To illustrate the inflation illusion claim (e.g., Campbell and Vuolteenaho, 2004), consider the Gordon (1962) dividend growth model that equates forward dividend yields to the excess of nominal risky discount rates (r) over nominal dividend growth in perpetuity (g). If dividend yields comove with expected inflation (because both comove with earnings yields), g must remain constant, since r comoves with expected inflation. If the Fed model holds, investors project nominal dividend growth rates that are invariant to expected inflation, but that doesn’t make sense!

which requires that aggregate stock market valuations are approximately equal to forward earnings divided by long-term risk-free rates. Even though the Fed model is based on earnings, not dividends, discussions of the Fed model consider valuation models based on dividend yields. I show that valuations based on forward earnings yields (e.g. Fairfield, 1994) offer different insights. I then use that understanding to consider different implications of the model.

Further probing of the dividend growth model reveals the pitfalls of using a payout ratio to link dividend yields to earnings yields. Specifically, while g is in general a function of expected inflation, so is the payout ratio that is necessary to get the desired dividend growth stream. In effect, the net effect of expected inflation on r, g, and the payout ratio is not easily determined.[1] Using theoretical relations specifically designed for earnings yields suggests that earnings yields are likely to vary with expected inflation because the growth measure that is

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[1] As shown in Section 3, the relation between expected inflation and earnings yields can be intuitively understood by projecting the value of g that would emerge under the case of full payout (g_{fp}).

relevant for earnings yields (referred to hereafter as *G*) is not likely to comove with expected inflation. As a result, observing evidence consistent with the Fed model does not imply that stock investors suffer from inflation illusion. Also, *G* is affected by the interaction of accounting conservatism and investment growth. Greater conservatism, due to accounting rules that cause book values to understate market values, biases observed earnings yields downward, and the extent of bias increases with investment growth. Finally, the Fed model holds when the effects of the two omitted variables—*G* and the equity risk premium—cancel each other out.

Since the Fed model is based on accounting earnings, I turn to the rules that determine accounting earnings and simulate numbers for different assets. The key insight is that accounting earnings include inflation holding gains, in addition to real profits, because the expenses used to calculate earnings are based on historical costs. This inclusion of inflationary gains causes earnings yields to vary with expected inflation. The one exception is land, for which historical costs are never expensed. Since land appreciation due to inflation is excluded from earnings, earnings yields for land represent real rates of return.

While the Fed model relates the level of expected inflation to stock prices (via the link between nominal interest rates and earnings yields), it is silent on the impact of *changes* in expected inflation on stock prices. In particular, it does not imply that stocks offer no hedge against inflation (e.g., Asness, 2003), similar to fixed rate bonds, even though earnings yields for stocks move with nominal rates, similar to bond yields. Since the Fed model equates stock prices to the ratio of forward earnings to nominal interest rates, the valuation impact of unexpected inflation is jointly determined by its effect on changes in expected earnings as well as changes in nominal interest rates. As the Fed model is agnostic about how expected earnings respond to unexpected inflation, it does not predict how stock prices respond to inflation shocks.

Extending the 1982-1997 US sample period examined in the original Fed report to other periods and stock markets with available earnings forecasts shows that the Fed model holds for the US since the 1960's and for many other stock markets since the mid 1980's, including Australia, Canada, France, Germany, and the UK.[2] This robust performance of the Fed model across so many markets in recent decades is remarkable given its parsimony. Stated differently, even though there is no *a priori* reason why the equity premium (which is positively related to earnings yields) should negate the growth term *G* (which is negatively related to earnings yields), the opposite effects of these two variables coincidentally cancel each other out. A practical benefit of this coincidence is that both effects can typically be ignored for aggregate valuations.

These two omitted factors do not always cancel out, however. The Fed model is not descriptive for Japan: earnings yields are lower (higher) than risk-free rates before (after) the mid 1990's. In essence, G's effect was initially greater than that of the equity premium, and the two effects reversed position subsequently. And investigation of US trailing, rather than forward, earnings yields for years before the 1960's suggests that forward earnings yields (if they had been available) would likely have been substantially higher than bond yields in those years.

Turning to some of the implications of the Fed model, the main conclusion is that stock market valuations are in general reasonably based on fundamentals—earnings forecasts and interest rates. P/E ratios higher (lower) than long-term averages are justified when bond yields are lower (higher) than average, and stock prices do not exhibit the extent of excess volatility implied by studies that calibrate current valuations with dividends observed subsequently (e.g., Shiller, 1981). Second, since *G*'s effect on earnings yields is in general likely to be low (below 5 percent), the equity premium for samples described by the Fed model must also be low.

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[2] I also examined Hong Kong, South Africa, and Taiwan, all of which had fewer forecasts available and gaps in the monthly bond yield series (results available upon request). Overall, the results are consistent with the Fed model, but there is more evidence of deviations, relative to the five non-US markets mentioned above.

Evidence inconsistent with the Fed model also provides interesting implications. I conjecture that *G* does not vary much over time for the US. If so, the equity risk premium was much higher in the US before the 1960's, when earnings yields substantially exceeded bond yields. This hypothesized large drop in the equity premium in the late 1950's, is consistent with the results in Asness (2003) and Campbell and Vuolteenaho (2004). The evidence in Japan, where earnings yields climbed despite a decline in interest rates, is probably driven by a decline in *G* caused by the interaction between accounting conservatism and growth, rather than a rise in the equity risk premium. Japanese firms tend to follow very conservative accounting (because of the conformity requirements between accounting and tax earnings) and earnings yields were biased downward substantially in the earlier period because of higher prevailing growth rates.

The next section augments the evidence documented in the Fed report, by considering more years for the US and adding six other markets. Section 3 discusses the implications of that evidence and the link between earnings yields and expected inflation, and Section 4 concludes.

2. Evidence underlying the Fed model.

To construct the time-series for aggregate earnings yields (forward earnings scaled by market value), I scanned the IBES summary files for countries with sufficient firms with available data to construct an aggregate that was reasonably representative of the overall market. I obtained data for the US beginning in January, 1976, and for six other markets (Australia, Canada, France, Germany, Japan, and UK), beginning in January 1987. The summary files provide consensus (mean) earnings per share forecasts, based on all analysts with active forecasts for that stock, and share prices as of the middle (the third Friday) of each month. I require non-missing data for price per share, number of shares outstanding, and earnings per share (eps) forecasts for the next full fiscal year.[3] I include months with missing number of shares outstanding on IBES if that data is available on the CRSP monthly files (for US firms only).

The aggregation process is straightforward. Each month, I multiply both the price per share and the forecast eps by the number of shares to get the market capitalization and forecast earnings for each firm and then add across all firms with available data that month to calculate aggregate market capitalization and aggregate forecast earnings. For a country-month to be included, I require a minimum of 100 firms with available data. The median number of firms across months in different markets ranged between 321 for Australia and 2804 for the US. For non-US firms with data in US dollars, I convert earnings and prices using the foreign exchange rate as of the IBES pricing day.

I then calculate the ratio of forecast aggregate earnings to market capitalization to get the forward earnings yield for that country-month. While the number of firms used to calculate these aggregates varies across time, the ratio is relatively insensitive to the inclusion or exclusion of the smaller firms that are likely to drop in and out of the sample from month to month. For the long-term risk-free rate, I use the 10-year Government bond yields from Global Financial Data. To align the two yields, I use risk-free rates as of the 20th of each month.[4]

Figure 1 contains the plots for the bond yields and the forward earnings yields for the aggregate stock portfolios for the US. The markers on the bottom axis refer to the beginning of each of the years noted; i.e., the data above the 1979 marker corresponds to January, 1979. The main finding is that the two series appear to be approximately equal for years before and after the period examined in the original Fed report. There is some evidence, however, of earnings yields

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[3] If, for example, the month is June 1990, then for a calendar year firm (which would have reported its 1989 earnings some time earlier in 1990), the forecast I use will be for the year 1991.

[4] For France and Germany, I use the Benchmark 10-year yields as the Government bond series was incomplete. For earlier years for some markets, if the daily data is missing, I substituted the end of the month yields. For the US, prior to April, 1953, I use the yields for Treasury bonds with maturity greater than 10 years.

exceeding bond yields in the late 1970’s and after 2001, consistent with the equity premium being unusually high and/or the growth term (G) being unusually low for those years. And there is evidence consistent with the opposite situation during the late 1990’s.

To be sure, those deviations are also consistent with the stock market being temporarily underpriced (overpriced) when earnings yields exceed (are less than) bond yields. Readers evaluating potential mispricing should scale the deviations between the two series by the level of the bond yield to gauge the extent to which stock prices deviate from those predicted by the Fed model. Even though the deviations around 2000 are smaller than those during the late 1970’s, they represent larger valuation deviations from the Fed model, due to the lower interest rates.

To supplement these results, I also derived forward earnings yields over the 1960’s for a sample of 174 firms described in Cragg and Malkiel (1982). Their data allowed a calculation of one earnings yield per year, not monthly yields as in Figure 1. Those results are plotted in Panel A of Figure 2. While the sample of firms is relatively small, it consists primarily of large firms and these earnings yields should be quite representative of the prevailing aggregate earnings yields. Once again, the results suggest a remarkable consistency with the Fed model.

Note that analysts’ forecasts for next year (e_1) are biased upward, and the 10-year risk-free rate likely understates the rate that applies to all future cash flows. While the extent of bias in forecasted aggregate earnings has not been documented, at the firm level the median level of optimism is about one percent of price (Table VI in Claus and Thomas, 2001, for forecasts made between 1985 and 1997).[5] And to the extent that 30-year rates are a more representative estimate of long-term rates than 10-year rates, those rates have exceeded 10-year rates by about 30 basis

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[5] Since the extent of optimism in earnings forecasts declines as the forecasts approach the earnings announcements, and since a majority of US firms have calendar year-ends, forward earnings yields calculated just after annual earnings are announced early in the following year (e.g., in March) will contain more optimism bias than earnings yields calculated just prior to annual earnings announcements (e.g., in January).

points in the US. In effect, adjusting for these two biases suggests that the equivalence between forward earnings yields based on optimistic analyst forecasts and 10-year bond yields implies that unbiased estimates of long-term bond yields exceed unbiased estimates of earnings yields by about 1.3 percent. I will return to this bias in Section 3.3, when discussing the equity premium.

To illustrate the importance of *forward* earnings yields for the Fed model, I also report in Figure 1 the annual series for trailing earnings yields and dividend yields for all firms with available data on Compustat. Trailing earnings represent the “bottom line” earnings (including extraordinary items and discontinued operations). The markers for the two series for 1978, for example, which are reported just to the left of the 1979 marker on the horizontal axis, are based on earnings and dividends for firm-years ending in December, 1978, as well as all fiscal year-ends between June, 1978 and May, 1979, and the prices are as of the end of 1978.[6]

The Fed model does not hold for trailing earnings yields or dividend yields, as the levels of those two series in Figure 1 are clearly below long-term risk-free rates.[7] In general, forward earnings exceed trailing earnings because the transitory components of trailing earnings, which are not expected to recur in forward earnings, tend to be negative on average (especially evident during recessions) and because forward earnings for next year include normal expected growth over the two-year period since the trailing earnings of last year. And dividend yields are lower still, because they represent only a fraction of trailing earnings.

My final analysis of US earnings and bond yields considers *trailing* earnings yields for the S&P 500 since 1925, taken from http://aida.econ.yale.edu/~shiller/data.htm, and plots them in Figure 2, Panel B, against long-term risk-free rates. (These data have been discussed elsewhere in great detail, and my objective here is to establish patterns that can be compared in

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[6] Even though Compustat covers more firms than IBES, the two sets of yields are comparable (confirmed by comparing the dividend yield series for the Compustat and IBES samples).

[7] The Fed model also does not hold when short-term rates are substituted for long-term rates.

section 3 with the Fed model to develop additional insights.) Even though the results in Figure 1 suggest that trailing earnings yields offer a biased and noisy estimate of the forward earnings yields required to investigate the Fed model, the trailing yields reported here can be adjusted upward by the difference between forward and trailing earnings yields reported in Figure 1 (since 1976) to get a rough sense of forward earnings yields before the 1960's.

The results indicate that trailing earnings yields are substantially higher than risk-free rates before the 1960's, and then lie below risk-free rates after that. Adjusting these trailing earnings yields upward suggests that the gap between earnings yields and risk free rates would be even higher before the 1960's for forward earnings, whereas the gap after the 1960's would shrink. In essence, the Fed model, which seems to hold for the US after 1960, does not hold at all before that point. The earlier period, which encompasses the Depression of the 1930's and World War II and its aftereffects during the 1950's, is associated with relatively high risk premia and/or relatively low expectations of long-term growth (*G*). Subsequently, risk premia fell and/or *G* rose and the two effects tend to approximately cancel each other for the next four plus decades.

Turning to the results for other countries, reported in Panels A through F of Figure 3, bond yields are approximately equal to forward earnings yields for Australia, Canada, France, Germany, and UK (in Panels A, B, C, D, and F, respectively). Less weight should be placed on apparently large deviations between the two yields noted for some countries during the earlier part of the sample period, as there are considerably fewer firms with available data in these cases. As with the US after 1960, the risk premium effect in these five countries comoves with the growth effect (*G*) such that they almost exactly offset each other. The evidence for Japan, reported in Panel E, is clearly inconsistent with the Fed model. A discussion of possible reasons for those departures is deferred until Section 3.

For the five countries where the earnings and bond yields generally track each other, there are similarities across countries in the timing and extent to which the two yields deviate temporarily from each other. For example, earnings yields are higher than 10-year rates for all countries after 2002. However, other temporary deviations are not as universal. For example, the apparent overpricing noticed during the Internet bubble of the late 1990's for the US is observed in Canada, France, and Germany, but is not evident for Australia and the UK.[8]

3. Discussion and implications

I use two methods to show that earnings yields are not real, and should comove with expected inflation. First, I probe the earnings yields relation that is adapted from the constant dividend growth model to reveal flaws in the intuitive predictions made in the prior literature and then confirm that understanding by investigating formal relations for earnings yields that are derived from the general Williams (1938) dividend discount model, described in equation (1) below. Second, I develop examples of accounting rules for specific assets and find that earnings yields move with expected inflation for most assets, except land.

$$p_0 = \frac{d_1}{(1+r)} + \frac{d_2}{(1+r)^2} + \frac{d_3}{(1+r)^3} + \dots \qquad (1)$$

where

p_0 = current price, at the end of year 0,

d_t = dividends expected to be paid to current shares at the end of future year t,

r = expected nominal rate of return for the equity market.

3.1 General formulas for earnings yields

Financial economists often link earnings yields to expected inflation by adapting the dividend yield relation implied by the Gordon (1962) dividend growth model, described in

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[8] Evidence on membership in the Technology sector is consistent with these differences: countries with more firms in that sector are more likely to have lower earnings yields than bond yields during the late 1990's.

equation (2), by assuming that the constantly growing dividend stream is a constant fraction of an earnings stream that also grows at the same rate, *g*, in perpetuity.

$$p_0 = \frac{d_1}{r-g} = \frac{py * e_1}{r-g} \tag{2}$$

where
g = expected nominal dividend growth rate, in perpetuity.
e_t= earnings expected to be earned by current shares at the end of future year t,
py = expected payout ratio ($=d_t/e_t$).

Rearranging the terms in the dividend and earnings valuation models in equation (2) provides the following relations for forward dividend and earnings yields.

$$\frac{d_1}{p_0} = \left(r-g\right) = r_f + r_p - g \tag{3}$$

$$\frac{e_1}{p_0} = \left(r-g\right) * \frac{1}{py} = \left(r_f + r_p - g\right) * \frac{1}{py} \tag{4}$$

where
r_f = long-term nominal risk-free rate, = long-term real risk-free rate (rr_f) + expected inflation (i),
r_p = long-term risk premium,

The intuitive argument for why earnings yields are real (e.g., Ritter and Warr, 2002) is that a) dividend yields must be real since the effect of expected inflation cancels out on the right-hand side of equation (3) as both r_f and g increase with inflation, and b) earnings yields must mimic dividend yields, since they are linked by a constant *py*. The first requirement is satisfied when the assets generate real cash flows (p_0 does not vary with expected inflation) and forward dividends (d_1) are selected such that they increase with expected inflation ($d_1=d_0*[1+i]$). The second requirement is not easily satisfied, however, because *py*, which is determined by the accounting rules underlying e_1, is not a constant and typically varies with expected inflation (see discussion in Section 3.2). This joint variation of r, g, and py with i makes it difficult to predict how e_1/p_0 should vary with i.

The same rationale, relating to the covariation of py with i, explains why observing that earnings yields covary with i does not imply that investors project the same g for different levels of expected inflation. That is, evidence consistent with the Fed model does not imply that investors suffer from inflation illusion; it is reasonable for both r_f and g to covary with i and yet have earnings yields covary with i because py also varies with i.

Another way to see why earnings yields likely vary with i is to consider a full payout dividend policy, which forces the payout ratio (py) to be constant (=1), and then estimate how g varies with i, for that special case. Consider, for example, a depreciable machine that generates real cash flows. Since accounting depreciation is based on historical costs, earnings based on that depreciation is "overstated" in the sense that it includes inflation gains. Paying out all those earnings as dividends maintains an investment base that is constant in nominal dollars, but declining in real dollars, with the extent of real decline increasing with expected inflation. As a result, the nominal growth in dividends that can reasonably be expected from such a dividend policy, labeled g_{fp}, is close to zero and unlikely to vary with i. Given that both g and py don't vary with i for the special case of full payout, earnings yields covary with i because r_f the remaining term on the right hand side of equation (4) covaries with i.

This discussion illustrates the potential pitfalls of using the dividend growth model and an assumed payout ratio to infer the properties of earnings yields. Understanding the determinants of earnings yields requires an understanding of how accounting earnings are actually calculated. Moreover, earnings yields should not be affected by dividend yields or payout policies, since dividend policy should ideally be irrelevant. Finally the relevant growth rate should be anchored in economic growth prospects, unlike the hypothetical rate at which dividends can grow in perpetuity (*g*), which is determined largely by the dividend policy chosen (since it must equal the excess of *r* over the dividend yield).[9]

Fortunately, there are earnings yields models available that offer some of these desirable attributes. Two recent models are described in Fairfield (1996) and Ohlson and Juettner-Nauroth (2004), and both are derived from the general dividend discount model noted in equation (1). For purposes of this discussion, it is more convenient to adapt the trailing P/E relation derived in Fairfield (1996) to provide the following formal relation for forward P/E ratios (which are simply the inverse of forward earnings yields).

$$\frac{p_0}{e_1} = \frac{1}{r}\left[1 + \frac{\Delta ri_2}{e_1(1+r)} + \frac{\Delta ri_3}{e_1(1+r)^2} + \ldots\right] = \frac{1}{r}\left[1+G\right] \qquad (5)$$

where

ri_t= residual income in year t, = $e_t - r^*bv_{t-1}$

bv_t = book value of equity in year t,

Δri_t = first difference in residual income = $ri_t - ri_{t-1}$

G = the present value of growth in residual income, scaled by e_1.

The forward P/E ratio is equal to the inverse of the long-term expected return on stocks (*r*) multiplied by a growth term (1+*G*). That growth term measures the growth in residual income or “accounting rents” in each future year, which represent earnings less a charge for the cost of equity capital, discounted back at the expected rate of return on equity (*r*). While it appears conceptually similar to the adaptation of the Gordon dividend growth model in equation (4), note how the discount rate affects the growth term in square brackets by discounting each future year’s growth in rents at the prevailing rate, *r*. Although nominal earnings and nominal residual

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[9] The same economic growth prospects can be used to generate a range of values of *g*, simply by changing dividend payout.

income grow at higher rates when expected inflation is higher, discounting those higher nominal amounts by a higher nominal expected rate of return reduces the comovement between expected inflation and *G*. In sum, we expect a smaller covariation between *G* and *i* than that between the nominal rate *r* and *i*, and this difference should cause forward earnings yields to vary positively with *i*; i.e., there is no reason to believe that the two effects will cancel out fully and earnings yields will be real.

3.2 Spreadsheet examples for specific asset classes

Turning from a general discussion based on earnings yields formulas to the specific accounting rules that determine earnings for different assets offers a more concrete description of the extent to which earnings yields are affected by expected inflation. These examples, presented as spreadsheet simulations, are not intended to be comprehensive, but are offered as illustrations that provide an intuitive sense of why earnings yields covary with inflation for most assets. The results of the simulations for two levels of expected inflation, 0 and 2 percent, are provided in Table A-2 through Table A-7 of the Appendix, in terms of a) the physical units of assets acquired and disposed each year, b) the corresponding accounting and market values of the assets, c) the accounting earnings, residual income and dividends paid, and d) a reconciliation of dividend and earnings yields, based on equations (3) and (5), respectively. The right column in each row of the various tables describes how the numbers in that row were calculated. The discussion below offers an overview of the simulations.

I consider four broad classes of assets—financial assets, inventory, depreciable machinery, and land—that span the different attributes that are relevant to this discussion. Financial assets are assumed to have fixed nominal cash flows (e.g., a fixed rate bond), whereas the remaining three assets have cash flows that are fixed in real terms; i.e., the nominal cash flows increase exactly to offset expected inflation. Each unit of the financial asset pays $10 each year in perpetuity, each inventory unit has a real cost of $1 per unit inventory costs and increases in value at the expected rate of return when held in the firm, each machine unit generates a real annual cash flow of $10 for four years, and each land unit generates real annual rents of $10 in perpetuity.

To keep matters simple, I assume that all assets generate risk-free cash flows (risk premium, r_p is zero) that are expected to generate zero economic rents (net present value, or NPV, is zero). This allows a clearer delineation of the conditions needed for real earnings yields. The real risk-free rate is assumed to be 3 percent, which results in nominal rates of 3 and 5.06 percent for the two inflation scenarios of 0 and 2 percent, respectively.

I consider two types of accounting rules for the asset with real cash flows—unbiased and conservative, where accounting values of assets are expected to equal their market values under unbiased accounting but lie below market value under conservative accounting.[10] Only unbiased accounting is considered for the financial asset. Inventory held for one year results in unbiased accounting (since market values are recognized upon sale of appreciated inventory at the end of the year), whereas inventory held for two years results in conservative accounting (market value of unsold one-year-old inventory is not yet recognized). I depreciate the machine in two ways, economic depreciation and sum-of-the-years'-digits; where the former method results in unbiased accounting (since the depreciation equals the decline in market value) and the latter produces conservative accounting (since it is an accelerated depreciation method). Accounting for land does not recognize any appreciation (unless the land is sold) and results in conservative

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[10] Unbiased accounting is an ex ante concept and allows for ex post accounting values to deviate from market values.

accounting because accounting values do not recognize inflationary gains in nominal values. Under zero inflation, however, the accounting for land is unbiased.

Given the assumption of zero NPV, unbiased accounting results in residual income that is always zero (accounting rents equal economic rents). This is true for assets with cash flows denominated in nominal and real terms. Substituting ri_t=0 in equation (6) causes all the residual income change terms (Δri_t) to drop to zero, which then causes G to equal zero. In effect, unbiased accounting results in earnings yields that covary with expected inflation, since they equal the nominal risk-free rate, r.

Under conservative accounting, however, residual income is no longer zero even for zero NPV assets (accounting rents do not equal economic rents). As long as nominal investment growth is positive, earnings under conservative accounting will be less than that under unbiased accounting, which results in forward earnings yields being lower than nominal risk-free rates. For the special case of zero growth in nominal investment, the two sets of earnings numbers will be equal and forward earnings yields will equal nominal risk-free rates.

To show the impact of investment growth I consider two cases of dividend payout: 50 percent and 100 percent (or full payout of accounting earnings); the former results in positive growth whereas the latter results in zero growth. Note that the growth due to issuance of new shares is not relevant here, and I focus only on growth accruing to the shares currently outstanding, which is generated by reinvested earnings in these examples. The numbers under full payout also allow an examination of whether changes in expected inflation alter values for g_{fp}, the corresponding dividend growth that can be sustained in perpetuity. Recall that the discussion in Section 3.1 suggests that while nominal values of g are in general expected to vary with inflation, g_{fp} is not likely to vary with expected inflation.

A summary of the impact of expected inflation on earnings yields, dividend yields, and dividend growth in perpetuity is provided in Table A-1, along with the corresponding levels of discount rates. Under the description in the financial economics literature, earnings yields and dividend yields should be real, and dividend growth in perpetuity should covary with expected inflations. Under the description provided in sections 3.1 and 3.2, earnings yields should covary with expected inflation and dividend growth in perpetuity for the important case of full payout should not vary with expected inflation. Land is the only asset that satisfies the description in the financial economics literature: earnings yields and dividend yields remain essentially unchanged across the two inflation scenarios and g_{fp} varies with expected inflation (even for the case of full payout).[11] In all other cases, earnings yields increase as expected inflation rises, and the dividend growth rate under full payout does not. A brief description of each case follows.

The results for financial assets (Case A in Table A-2 and first two rows of Table A-1) are straightforward. The description of earnings and dividend yields from the prior financial economics literature is unlikely to apply here since those predictions are based on assets with real, not nominal, cash flows. Not surprisingly, earnings yields covary with expected inflation. Even though dividend growth in perpetuity varies with expected inflation for other cases of dividend payout, it is zero for the important case of full payout.

The results for inventory held for one year (Case B in Table A-3 and the third and fourth rows of Table A-1) resemble those for financial assets even though the cash flows are now denominated in real terms. Earnings yields are nominal because the costs used to calculate accounting earnings are historical costs. As a result, accounting earnings include both real profits as well as inflationary holding gains. Dividend growth under full payout is not a function of

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[11] This small difference in yields when expected inflation rises is anticipated in the literature, because $d_1=d_0*[1+i]$ (see for example, equation (1) in Ritter and Warr, 2002).

expected inflation (it is zero in both inflation scenarios) because paying out all accounting earnings as dividends reduces the real asset base available to generate future dividends.

Another way to see why the intuition in the financial economics literature garnered from equation (4) does not apply is to consider how payout varies if dividends are required to be real (d_1=d_0*[1+i]). That is, the dividend payout for the 2 percent inflation/50 percent payout scenario is adjusted so that the real value of the dividends paid equals the real value of the dividend paid under the 0 percent inflation/50 percent scenario. It can be shown that the payout ratio that satisfies this criterion is just above 30 percent. Even though the inflation effects of nominal discount rates and dividend growth in perpetuity cancel each other out in equation (4), because they both vary with expected inflation, earnings yields are not real and increase with expected inflation because the relevant payout rates decrease with expected inflation.

Case C (described in Table A-4 and summarized in the fifth and sixth rows of Table A-1) considers the case of a depreciating machine, under economic depreciation. There are two differences in this simulation, relative to Cases A and B, due to the number of periods required to achieve a steady state growth. First, I increase the asset base by one unit per year over the first four years until the asset base includes assets that vary in age between 0 and 3 years. Second, I wait for a few years after year 4 for the 50 percent payout/2 percent inflation scenario before growth settles to a steady state (when the asset base reaches a steady state average age). Despite the increased complexity, the results remain unchanged: earnings yields vary with expected inflation and dividend growth rates under full payout remain constant. As with inventory in Case B, earnings from machines include both real and inflationary profits because accounting depreciation is based on historical costs, not replacement costs.

Case D (described in Table A-5 and summarized in the sixth and seventh rows of Table A-1) represents the first case where earnings yields are real, dividend yields are real for full payout, and dividend growth for full payout varies with inflation. The key feature of land accounting is that the increase in land value due to inflationary gains is not included in earnings, until the land is sold. Of the total nominal required rate of return, the portion compensating investors for inflation is excluded from accounting earnings and the remaining portion, which represents compensation for the real return, is collected as rent and included in accounting earnings. (Note that switching to "mark to market" accounting for land would include inflationary gains in accounting earnings and cause earnings yields to vary once again with expected inflation.) To the extent that land represents a small portion of the total assets owned by firms, the impact of land accounting on earnings yields is likely to be minimal.

Cases E and F consider conservative accounting for inventories and machines, and the results are reported in Tables A-6 and A-7 and summarized in the last four rows of Table A-1, respectively. Unlike land, which produces conservative numbers only under positive expected inflation, book values always lie below market values for these two cases. As suggested earlier, the interaction of conservatism and positive growth (indicated by a dividend payout less than 100 percent) causes earnings yields to rise above those under unbiased accounting. Importantly, however, there is no indication that conservative accounting changes the findings observed under unbiased accounting; i.e., earnings yields continue to covary with expected inflation.

Overall, the analysis of specific assets confirms the results of the general analysis of earnings yields formulas in Section 3.1. I find no reason to believe that aggregate earnings yields should be real and no support for the suggestion that the Fed model implies that investors suffer from inflation illusion. This analysis also suggests that links among dividend yields, dividend growth rates, and nominal interest rates should be forged with considerable care because of confounding due to payout ratios. Consider, for example, time-series variation in dividend payout for the US sample in Figure 1: it hovered around 50 percent until the early 1990's, at which point it fell steadily to about 35 percent by the late 1990's and recovered to about 40 percent by early 2005. Some of the time-series variation in dividend yields observed in Figure 1 must be due to this variation in dividend payout policies, and must cause time-series variation in g that is unrelated to fundamental growth.

<u>*3.3 Implications of the Fed model for the equity premium*</u>

While considerable attention has been paid in the literature to the high comovement between earnings and bond yields implied by the Fed model, there is less focus on the fact that the model requires that the two yields equal each other. I consider next the implications of this feature of the Fed model for the equity premium.

Even though the earnings yield relation in equation (5) is more comprehensive, the full payout version of equation (4), presented below, is more convenient for discussion purposes.

$$\frac{e_1}{p_0} = (r_f + r_p - g_{fp}) \tag{6}$$

And under the Fed model, where the earnings yield equals the risk-free rate, equation (6) implies that the risk premium for equity should equal g_{fp}, the growth rate in perpetuity that can be sustained by a hypothetical market following a full payout dividend policy.

$$\frac{e_1}{p_0} = r_f \Rightarrow r_p = g_{fp} \tag{7}$$

This equivalence between g_{fp} and r_p offers insights about the level of and variation over time in the equity premium. As described in section 3.1, g_{fp} relates to the growth in nominal earnings that a constant (nominal) investment base can provide in perpetuity. Holding aside cases where the combination of accounting conservatism and growth in earnings is likely to create higher values of g_{fp} in general I claim that this growth must be a very low number. While it may be possible for high growth firms to be associated with high growth rates, even under full payout, I find it hard to see how all firms in aggregate can generate values of g_{fp} under full payout that are much higher than 2 or 3 percent. If so, for periods that are described reasonably the Fed model, the equity premium is likely in line with the lower estimates that have been proposed recently in the literature (e.g. Claus and Thomas, 2001, and Fama and French, 2002).

As mentioned in Section 2, analysts' earnings forecasts are biased upward and the 10-year rate is likely to understate the true long-term risk-free rate, leaving a net bias effect of about 130 basis points. Incorporating this bias drops the equity premium even further.

Turning to time-variation in the equity premium, the equivalence between r_p and g_{fp} required by the Fed model suggests that both g_{fp} and r_p are relatively constant through time as long as the Fed model holds. If the risk premium varied much over time, it must then be the case that g_{fp} would also vary in the same way. I believe this scenario is less likely as I do not see why the earnings growth for a full payout economy would vary exactly with the equity premium. (A discussion of the pre-1960 period is deferred until Section 3.4)

3.4 Implications of the Fed model for excess volatility

Attempts to relate market valuations with dividends, both contemporaneous and paid in the future, have typically met with little success. A number of prior papers have concluded that this weak relation between stock prices and fundamentals (level of dividends and expected returns) is evidence in support of the view that stock prices are too volatile, in the sense that they deviate often from fundamentals. Figure 1 from Grossman and Shiller (1981) is included as Figure 4 to illustrate the potential magnitude of excess volatility in stock prices.

The comovement between earnings and bond yields noted in Figure 1suggests that there is far less excess volatility than that indicated by analyses such as those reported in Figure 4. Moving from the market level to the firm level, there is now substantial evidence (e.g. Liu and Thomas, 2000) that a substantial fraction of the variation in stock prices (returns) can be explained by levels of (changes in) forecast earnings and long-term interest rates.

3.5 Why are deviations from the Fed model observed in some markets and periods?

The two pieces of evidence documented that are clearly inconsistent with the Fed model are the results for the US before 1960 (Figure 2, Panel B) and the results for Japan (Figure 3, Panel E). I do not interpret this contradictory evidence as suggesting that the Fed Model is patently false. Rather I believe it suggests that the conditions necessary for the Fed model to hold existed during the post-1960 period for the US and for most other countries in recent years, but those conditions do not hold for these two subsamples where earnings yields deviate substantially from bond yields. Listed below is a partial list of potential reasons for why those conditions may not hold.

First, these subsamples may be associated with characteristics that cause the equity risk premium to deviate substantially from g_{fp}, the growth in full payout earnings that can be sustained in perpetuity. The Depression and the World War that dominated the pre-1960 US data may have caused an environment where the equity risk premium was unusually high and long-term growth expectations were unusually low. Since the lower limit for full payout growth is unlikely to be a large negative value (more likely to be zero or a small negative value), those results suggest that the equity premium for the US stock market between 1925 and 1960 was quite high, relative to what it has been in the post-1960 period. The evidence for Japan before the mid 1990's indicates the opposite position: where risk-free rates substantially exceeded earnings yields. This explanation would suggest that long-term growth expectations were unusually high and/or the risk premium was unusually low. Again, since the equity premium is unlikely to be negative, these conditions are more consistent with unusually high growth expectations. As suggested in Section 3.3, very high values of g_{fp} are generally unlikely, except for cases with very conservative accounting. Japan appears to be an ideal candidate for this last explanation, since accounting in Japan has been known to be conservative because of the conformity requirement with tax accounting. The subsequent decline in earnings yields, after the mid 1990's, is consistent with the accounting remaining conservative in Japan, but the upward bias of that conservatism on earnings yields is reduced due to a decline in investment growth.

Second, the relation between earnings yields and bond yields may be affected by accounting rules, investor-level taxation and ownership practices that are unique to these two subsamples. This explanation applies more to Japan than the pre-1960 period in the US. Reported earnings would need to be understated (overstated) in periods when earnings yields were lower (higher) than bond yields. Similarly, to the extent that cross-holdings are common in Japan, the incentives for corporate owners to have investees under or overstate reported earnings may have changed over time. Also, since the earnings and bond yields reported here are before investor-level taxation, changes in investor taxation for stocks or bonds could alter the relation between the two before-tax yields observed.

Third, stock markets may be grossly inefficient for long periods. Specifically, it is possible that stock prices in the US were too low during the pre 1960 period and they were too high in Japan before the mid 1990's when bond yields exceeded earnings yields, and subsequently they are too low in Japan when the opposite situation holds.

4. Conclusion

The Fed model offers a fascinating window into how stock prices are set at the aggregate level. There is disagreement about whether the model describes how prices are set, and even more disagreement about whether it should be descriptive of how prices are set. Those who subscribe to the model value its simplicity, and those expressing concerns believe it is too simplistic. The evidence presented here and elsewhere suggests that the Fed model is indeed a parsimonious description of how prices are set in the US since the 1960's, and it also appears to be descriptive of how prices have been set over the last few decades for many other markets.

One reason why the Fed model has not gained wider acceptance among financial economists is the common belief that earnings yields should be real and should not move with nominal interest rates. Evidence consistent with the Fed model has been interpreted as suggesting that investors suffer from inflation illusion and project the same future nominal growth during high and low periods of expected inflation. I show here that both reasons to reject the Fed model are without basis. The next step is to gain a better understanding of what the Fed model can tell us about other fundamental issues such as the equity premium and excess volatility in stock prices. I hope this paper makes some early strides in that direction.

Appendix

Impact of expected inflation (i) on forward earnings yields (e_1/p_0) and dividend growth (g) for different assets and payout policies

Recent papers on the Fed model (e.g., Ritter and Warr, 2002) suggest that e_1/p_0 should not vary with i and that investors must suffer from inflation illusion (e.g., Modigliani and Cohn, 1977) if e_1/p_0 varies with i. Inflation illusion refers to projections of nominal dividend growth rate in perpetuity (g) that do not vary with i. The examples below consider the accounting for different assets to investigate how i impacts e_1/p_0 and g for those assets, and how that impact varies with dividend payout policy. The main findings are: a) e_1/p_0 varies with i, b) g varies with i for general dividend payout policies, but it does not for the important case of full payout, which is the case that is relevant for efforts to intuitively link dividend yields to earnings yields. These findings are the opposite of the predictions in the literature. Land, however, is the one exception for which those predictions hold; i.e., for land e_1/p_0 does not vary with i and g under full payout (g_{fp}) varies with i. The conclusion is that in general it is reasonable for e_1/p_0 to vary with i and that observing such a relation does not imply that investors suffer from inflation illusion; i.e., does not imply that they project g that does not vary with i.

Given that accounting tends to be conservative—*ex ante*, accounting values for assets (liabilities) are lower (higher) than their market values—these examples also consider the impact of conservative accounting on earnings yields. The main finding is that e_1/p_0 is biased downward under conservative accounting, with the extent of bias increasing with nominal growth in investment.

The six asset cases I consider are: A) Fixed rate Bonds; B) Inventory, held for one period; C) Machinery, depreciated over a four-year life using economic depreciation (book value equals market value); D) Land; E) Inventory, held for two years; and F) Machinery, depreciated over a four-year life using sum-of-years' digit method (an accelerated method, labeled SOYD). The cash flows for case A are denominated in nominal dollars; for all others they are denominated in real dollars. Cases A, B, and C correspond to unbiased accounting, where book values are expected to equal market values, cases E and F correspond to conservative accounting, and case D represents unbiased (conservative) accounting under the 0 (2) percent inflation scenario.

For each asset case, I consider two levels of expected inflation, 0 percent and 2 percent, and two dividend payout policies, 50 percent and 100 percent of accounting earnings. Cash flows occur at the end of each period, and the firms owning these assets are 100 percent equity financed.

I assume all assets generate riskless cash flows corresponding to a real rate of return of 3 percent, which is also the real risk-free rate; i.e., all assets are zero net present value. As a result, the nominal rates of return generated by these assets correspond to the nominal risk-free rates of 3 percent and 5.06 percent under the 0 and 2 percent inflation scenarios, respectively. There are no taxes.

The valuation relations for dividend and earnings yields are obtained from equations (3) and (5), respectively.

$$\frac{d_1}{p_0} = (r - g) \qquad (3)$$

$$\frac{p_0}{e_1} = \frac{1}{r}\left[1 + \frac{\Delta ri_2}{e_1(1+r)} + \frac{\Delta ri_3}{e_1(1+r)^2} + \ldots\right] = \frac{1}{r}\left[1 + G\right] \qquad (5)$$

where

p_0 = current price, at the end of year 0	e_t = earnings expected to be earned by current shares at the end of future year t
d_t = dividends expected to be paid to current shares at the end of future year t	ri_t= residual income in year t, = $e_t - r*bv_{t-1}$
r = expected nominal rate of return, (= nominal risk-free rate, r_f)	bv_t = book value of equity in year t,
g = expected nominal dividend growth rate, in perpetuity	Δri_t = first difference in residual income = $ri_t - ri_{t-1}$
	G = the present value of growth in residual income, scaled by e_1.

Since the assets are assumed to be riskless, the expected nominal rate of return r equals the nominal risk free rate r_f,. Also, for the case of unbiased accounting the assumption of zero NPV assets causes residual income to be zero, which in turn makes all changes in residual income and G to be zero. In effect, both the risk premium effect as well as the growth effect that is relevant for earnings yields cancel out, since they are both equal to zero, and the Fed model is expected to hold.

Table A-1 below summarizes the key results (simulated values for e_1/p_0, e_1/p_0, and g) for each of the 4 combinations (2 inflation scenarios times 2 dividend payout policies).

Case	Asset	Nature of accounting	Nature of cash flow	Expected Inflation	Nominal values of						
					Discount rate ($r=r_f$)	Earnings yield (e_1/p_0)		Dividend yield (d_1/p_0)		Terminal div. Growth (g)	
						100% pay.	50% pay.	100% pay.	50% pay.	100% pay.	50% pay.
A	Financial	Unbiased	Nominal	0%	3.00%	3.00%	3.00%	3.00%	1.50%	0.00%	1.50%
A	Financial	Unbiased	Nominal	2%	5.06%	5.06%	5.06%	5.06%	2.53%	0.00%	2.53%
B	1-yr Inv.	Unbiased	Real	0%	3.00%	3.00%	3.00%	3.00%	1.50%	0.00%	1.50%
B	1-yr Inv.	Unbiased	Real	2%	5.06%	5.06%	5.06%	5.06%	2.53%	0.00%	2.53%
C	Machine- Econ. Deprec.	Unbiased	Real	0%	3.00%	3.00%	3.00%	3.00%	1.50%	0.00%	1.50%
C	Machine- Econ. Deprec.	Unbiased	Real	2%	5.06%	5.06%	5.06%	5.06%	2.53%	0.00%	2.53%
D	Land	Unbiased	Real	0%	3.00%	3.00%	3.00%	3.00%	1.50%	0.00%	1.50%
D	Land	Conservative	Real	2%	5.06%	3.06%	3.06%	3.06%	1.53%	2.00%	3.53%
E	2-yr Inv.	Conservative	Real	0%	3.00%	3.00%	2.98%	3.00%	1.49%	0.00%	1.51%
E	2-yr Inv.	Conservative	Real	2%	5.06%	5.06%	5.00%	5.06%	2.50%	0.00%	2.56%
F	Machine-SOYD	Conservative	Real	0%	3.00%	3.00%	2.65%	3.00%	1.32%	0.00%	1.68%
F	Machine-SOYD	Conservative	Real	2%	5.06%	5.06%	4.43%	5.06%	2.21%	0.00%	2.85%

Highlighted cells indicate scenarios where the earnings yield (e_1/p_0) does not covary with expected inflation.
Description of the assumptions underlying the simulation is provided in the prior page, and details of the different cases are provided in Tables A-2 to A-7 below.

Table A-2: Case A: Asset is fixed-rate bonds, each unit with nominal coupon = $10 per year in perpetuity.

Panel A: Inflation=0%, $r=r_f=3\%$

	100% payout				50% payout				Description
year	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	
units of asset owned	1	1	1	1	1	1.015	1.0302	1.046	= prior year's # +(revenue - dividend)/asset value
book value of Asset	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	units owned * asset value
market value of Asset	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	units owned * asset value
book value of equity	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	= prior year's # +net income - dividend
market value of equity	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	= prior year's # * (1+r) - dividend
revenue		10.00	10.00	10.00		10.00	10.15	10.30	prior year's asset units*revenue/asset
net income		10.00	10.00	10.00		10.00	10.15	10.30	equals revenue (no costs)
dividend		10.00	10.00	10.00		5.00	5.08	5.15	equals income*payout ratio
growth in dividends		0.00%	0.00%			1.50%	1.50%		
Gordon formula price	333.33	333.33			333.33	338.33			=next year's dividend/(r-dividend growth after next year)
residual income (ae)		0.00	0.00	0.00		0.00	0.00	0.00	= net income - r*last year's book value of equity
forward P/E	33.33	33.33	33.33		33.33	33.33	33.33		= market value of equity/next year's net income

Panel B: Inflation=2%, $r=r_f=5.06\%$

	100% payout				50% payout				
year	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	
units of asset owned	1	1	1	1	1	1.025	1.051	1.078	= prior year's # +(revenue - dividend)/asset value
book value of Asset	197.63	197.63	197.63	197.63	197.63	202.63	207.75	213.01	units owned * asset value
market value of Asset	197.63	197.63	197.63	197.63	197.63	202.63	207.75	213.01	units owned * asset value
book value of equity	197.63	197.63	197.63	197.63	197.63	202.63	207.75	213.01	= prior year's # +net income - dividend
market value of equity	197.63	197.63	197.63	197.63	197.63	202.63	207.75	213.01	= prior year's # * (1+r) - dividend
revenue		10.00	10.00	10.00		10	10.25	10.51	prior year's asset units*revenue/asset
net income		10.00	10.00	10.00		10	10.25	10.51	equals revenue (no costs)
dividend		10.00	10.00	10.00		5.00	5.13	5.26	equals income*payout ratio
growth in dividends		0.00	0.00	0.00		2.53%	2.53%		
Gordon formula price	197.63	197.63			197.63	202.63			=next year's dividend/(r-dividend growth after next year)
residual income (ae)		0.00	0.00	0.00		0.00	0.00	0.00	= net income - r*last year's book value of equity
forward P/E	19.76	19.76	19.76		19.76	19.76	19.76		= market value of equity/next year's net income

Table A-3: Case B: Asset is inventory held for 1-year, with real cash flows.

The costs and selling prices for inventory in Panel A are \$1 and \$1.03 respectively. In panel B, they increase each year at 2 percent, with expected inflation.

Panel A: Inflation=0%, r=rf=3%

	100% payout				50% payout				Description
year	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	
# of units of inventory	100	100.00	100.00	100.00	100.00	101.50	103.02	104.57	=last year's # + units purchased - units sold
book value of Asset	100.00	100.00	100.00	100.00	100.00	101.50	103.02	104.57	=last year's # + inventory purchased (\$) - COGS
market value of Asset	100.00	100.00	100.00	100.00	100.00	101.50	103.02	104.57	= units of inventory * this year's inventory cost/unit
book value of equity	100.00	100.00	100.00	100.00	100.00	101.50	103.02	104.57	= last year's # + net income - dividend
market value of equity	100.00	100.00	100.00	100.00	100.00	101.50	103.02	104.57	= last year's # * (1+r) - dividend
units sold	0.00	100.00	100.00	100.00	0.00	100.00	101.50	103.02	= last year's # of units in inventory
Revenue		103.00	103.00	103.00		103.00	104.55	106.11	= last year's # of inventory units * this year's selling price/unit
COGS		100.00	100.00	100.00		100.00	101.50	103.02	= last year's inventory units * last year's cost/unit
net income		3.00	3.00	3.00		3.00	3.05	3.09	= revenue - COGS
Inventory purchased (\$)	100.00	100.00	100.00	100.00	100.00	101.50	103.02	104.57	= revenue - dividend
Inventory purchased (units)	100.00	100.00	100.00	100.00	100.00	101.50	103.02	104.57	= cost of inventory purchased/this year's unit cost
residual income (ae)		0.00	0.00	0.00		0.00	0.00	0.00	= net income - r*(last year's book value of equity)
forward P/E	33.33	33.33	33.33		33.33	33.33	33.33		= market value of equity/next year's net income
dividend paid		3.00	3.00	3.00		1.50	1.52	1.55	= net income * payout ratio
future growth in dividends		0.00%	0.00%			1.50%	1.50%		
Gordon Formula price	100.00	100.00			100.00	101.50			= next year's dividend/(r - growth in dividends after next year)

Panel B: Inflation=2%, $r=r_f=5.06\%$

	100% payout				50% payout				
year	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	
# of units of inventory	100	98.04	96.12	94.23	100	100.52	101.04	101.57	=last year's # + units purchased - units sold
book value of Asset	100.00	100.00	100.00	100.00	100.00	102.53	105.12	107.78	=last year's # + inventory purchased (\$) - COGS
market value of Asset	100.00	100.00	100.00	100.00	100.00	102.53	105.12	107.78	= units of inventory * this year's inventory cost/unit
book value of equity	100.00	100.00	100.00	100.00	100.00	102.53	105.12	107.78	= last year's # + net income - dividend
market value of equity	100.00	100.00	100.00	100.00	100.00	102.53	105.12	107.78	= last year's # * (1+r) - dividend
units sold	0.00	100.00	98.04	96.12	0.00	100.00	100.52	101.04	= last year's # of units in inventory
Revenue		105.06	105.06	105.06		105.06	107.72	110.44	= last year's # of inventory units * this year's selling price/unit
COGS		100.00	100.00	100.00		100.00	102.53	105.12	= last year's inventory units * last year's cost/unit
net income		5.06	5.06	5.06		5.06	5.19	5.32	= revenue - COGS
Inventory purchased (\$)	100.00	100.00	100.00	100.00		102.53	105.12	107.78	= revenue - dividend
Inventory purchased (units)	100.00	98.04	96.12	94.23	0.00	100.52	101.04	101.57	= cost of inventory purchased/this year's unit cost
residual income (ae)		0.00	0.00	0.00		0.00	0.00	0.00	= net income - r*(last year's book value of equity)
forward P/E	19.76	19.76	19.76		19.76	19.76	19.76		= market value of equity/next year's net income
dividend paid		5.06	5.06	5.06		2.53	2.59	2.66	= net income * payout ratio
future growth in dividends		0.00%	0.00%			2.53%	2.53%		
Gordon Formula price	100.00	100.00			100.00	102.53			= next year's dividend/(r - growth in dividends after next year)

Table A-4: Case C: Asset is machinery, depreciated over a four-year life using economic depreciation (book value equals market value).

Panel A: Inflation=0%, $r=r_f=3\%$

The asset value at each date is given by the schedule below (=PV of remaining cash flows discounted @ 3%)

year	**0**	**1**	**2**	**3**	**4**	average asset
nominal cash flows		10.00	10.00	10.00	10.00	
Market Value of Asset	$37.17	$28.29	$19.13	$9.71	$0.00	$23.58

These are also the book values of the asset, if the firm follows economic depreciation

economic depreciation		$8.88	$9.15	$9.43	$9.71	$9.29

	100% payout				50% payout					Description
year	**0**	**1**	**4**	**5**	**0**	**1**	**4**	**5**	**6**	
# of assets held	1	2	4	4	1	2	4.04	4.09	4.15	=prior year's asset held + assets purchased - assets retired
assets purchased	1	1	1	1	1	1	1.04	1.05	1.06	(revenue - dividend)/asset value
assets retired	0	0	1	1	0	0	1	1	1	=assets purchased 4 years earlier
book value of Asset	37.17	65.46	94.3	94.3	37.17	65.46	95.72	97.15	98.61	=sum over tranches of (units owned*depreciated asset value)
market value of Asset	37.17	65.46	94.3	94.3	37.17	65.46	95.72	97.15	98.61	=sum over tranches of (units owned*depreciated asset value)
book value of equity	37.17	65.46	94.3	94.3	37.17	65.46	95.72	97.15	98.61	= prior year's # +net income – dividend
market value of equity	37.17	65.46	94.3	94.3	37.17	65.46	95.72	97.15	98.61	= prior year's # * (1+r) – dividend
Revenue		10	40	40		10	40	40.38	40.86	units owned * revenue/unit
depreciation expense		8.88	37.17	37.17		8.88	37.17	37.51	37.94	=sum over tranches of (units owned*depreciation)
net income		1.12	2.83	2.83		1.12	2.83	2.87	2.91	revenue less depreciation
residual income (ae)		0	0	0		0	0	0	0	= net income - r*last year's book value of equity
forward P/E	33.33	33.33	33.33		33.33	33.33	33.33	33.33		= market value of equity/next year's net income
dividend paid		-27.17	2.83	2.83		-27.17	1.41	1.44	1.46	income*payout ratio
growth in dividends			0.00%	0.00%			1.50%	1.50%	1.50%	
Gordon Formula price			94.3				95.72	97.15		= next year's dividend/(r-dividend growth after next year)

Panel B: Inflation=2%, $r=r_f=5.06\%$

The asset value at each date is given by the schedule below (=PV of remaining cash flows discounted @ 5.06%)

year	**0**	**1**	**2**	**3**	**4**	**5**
real cash flows		10.00	10.00	10.00	10.00	10.00
nominal cash flows		10.20	10.40	10.61	10.82	11.04
in year t+1	10.20	10.40	10.61	10.82	11.04	11.26
in year t+2	10.40	10.61	10.82	11.04	11.26	11.49
in year t+3	10.61	10.82	11.04	11.26	11.49	11.72
in year t+4	10.82	11.04	11.26	11.49	11.72	11.95
Market Values & Book Values under economic depreciation are given by						
Mkt. Val. at purchase	$37.17	$37.91	$38.67	$39.45	$40.24	$41.04
Mkt. Val. 1 year later	$28.85	$29.43	$30.02	$30.62	$31.23	$31.85
Mkt. Val. 2 years later	$19.91	$20.31	$20.71	$21.13	$21.55	$21.98
Mkt. Val.3 years later	$10.30	$10.51	$10.72	$10.93	$11.15	$11.38
Mkt. Val 4 years later	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

	100% payout				50% payout					Description
year	**0**	**1**	**4**	**5**	**0**	**1**	**12**	**13**	**14**	
# of assets held	1.00	2.00	3.95	3.89	1.00	2.00	4.18	4.20	4.22	=prior year's asset held + assets purchased - assets retired
assets purchased	1.00	1.00	0.95	0.94	1.00	1.00	1.05	1.06	1.06	(revenue - dividend)/asset value
assets retired	0.00	0	1.00	1.00	0.00	0	1.03	1.04	1.04	=assets purchased 4 years earlier
book value of Asset	37.17	66.77	100.07	100.07	37.17	66.77	125.31	128.48	131.73	=sum over tranches of (units owned*depreciated asset value)
market value of Asset	37.17	66.77	100.07	100.07	37.17	66.77	125.31	128.48	131.73	sum over tranches of (units owned*depreciated asset value)
book value of equity	37.17	66.77	100.07	100.07	37.17	66.77	125.31	128.48	131.73	= prior year's # +net income – dividend
market value of equity	37.17	66.77	100.07	100.07	37.17	66.77	125.31	128.48	131.73	= prior year's # * (1+r) – dividend
Revenue		10.20	43.30	43.61		10.20	52.75	54.08	55.45	units owned * revenue/unit
depreciation expense		8.32	38.23	38.55		8.32	46.57	47.74	48.94	=sum over tranches of (units owned*depreciation)
net income		1.88	5.06	5.06		1.88	6.18	6.34	6.50	revenue less depreciation
residual income (ae)		0.00	0.00	0.00		0.00	0.00	0.00	0.00	= net income - r*last year's book value of equity
forward P/E	19.76	19.76	19.76		19.76	19.76	19.76	19.76		= market value of equity/next year's net income
dividend paid		-27.71	5.06	5.06		-27.71	3.09	3.17	3.25	income*payout ratio
growth in dividends			0.00%	0.00%			2.53%	2.53%		
Gordon Formula price			100.07				125.31			= next year's dividend/(r-dividend growth after next year)

Table A-5: Case D: Asset is land, with real cash flows in perpetuity = $10 per unit, and nominal cash flows increasing with expected inflation.

Panel A: Inflation=0%, $r=r_f=3\%$

	100% payout				50% payout				Description
year	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	
# of units of land held	1	1.00	1.00	1.00	1	1.02	1.03	1.05	=last year's # + land purchased/market value of land per unit
book value of Asset	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	=last year's # + land purchased
market value of Asset	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	=#of units held * market value of land/unit
book value of equity	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	= last year's # + net income – dividend
market value of equity	333.33	333.33	333.33	333.33	333.33	338.33	343.41	348.56	= last year's # * (1+r) – dividend
Revenue		10.00	10.00	10.00		10.00	10.15	10.30	= last year's # of land units * rent/unit
net income		10.00	10.00	10.00		10.00	10.15	10.30	= revenue
Land purchased		0.00	0.00	0.00		5.00	5.08	5.15	= revenue – dividend
residual income (ae)		0.00	0.00	0.00		0.00	0.00	0.00	= net income - r*(last year's book value of equity)
forward P/E	33.33	33.33	33.33		33.33	33.33	33.33		= market value of equity/next year's net income
dividend paid		10.00	10.00	10.00		5.00	5.08	5.15	= net income * payout ratio
future growth in dividends		0.00%	0.00%			1.50%	1.50%		
Gordon Formula price	333.33	333.33			333.33	338.33			= next year's dividend/(r - growth in dividends after next year)

Panel B: Inflation=2%, $r=r_f=5.06\%$

	100% payout				50% payout				Description
year	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	
# of units of land held	1	1	1	1	1	1.02	1.03	1.05	=last year's # + land purchased/market value of land per unit
book value of Asset	333.33	333.33	333.33	333.33	333.33	338.43	343.71	349.18	=last year's # + land purchased
market value of Asset	333.33	340.00	346.80	353.74	333.33	345.10	357.28	369.89	=#of units held * market value of land/unit
book value of equity	333.33	333.33	333.33	333.33	333.33	338.43	343.71	349.18	= last year's # + net income – dividend
market value of equity	333.33	340.00	346.80	353.74	333.33	345.10	357.28	369.89	= last year's # * (1+r) – dividend
Revenue		10.20	10.40	10.61		10.20	10.56	10.93	= last year's # of land units * this year's rent/unit
net income		10.20	10.40	10.61		10.20	10.56	10.93	= revenue
Land purchased		0.00	0.00	0.00		5.10	5.28	5.47	= revenue – dividend
residual income (ae)		-6.67	-6.46	-6.25		-6.67	-6.56	-6.46	= net income - r*(last year's book value of equity)
forward P/E	32.68	32.68	32.68		32.68	32.68	32.68		= market value of equity/next year's net income
dividend paid		10.20	10.40	10.61		5.10	5.28	5.47	= net income * payout ratio
future growth in dividends		2.00%	2.00%			3.53%	3.53%		
Gordon Formula price	333.33	340.00			333.33	345.10			= next year's dividend/(r - growth in dividends after next year)

Table A-6: Case E: Asset is inventory, held for two years.
The costs and selling prices (2 years later) for inventory in Panel A are $1 and $1.0609 respectively. In panel B, they increase each year at 2 percent, with expected inflation. To achieve steady state immediately, I impose an investment growth of 1.511 and 2.561 percent in year 1, in panels A and B, respectively.

Panel A: Inflation=0%, r=rf=3%

	100% payout				50% payout					Description
year	**0**	**1**	**2**	**3**	**0**	**1**	**3**	**4**	**5**	
# of units of inventory	100	200.00	200.00	200.00	100	201.51	204.56	207.65	210.78	last year's # + units purchased - units sold
book value of Asset	100.00	200.00	200.00	200.00	100.00	201.51	204.56	207.65	210.78	last year's # + inventory purchased ($) - COGS
market value of Asset	100.00	203.00	203.00	203.00	100.00	204.51	207.60	210.74	213.92	= sum over tranches of (# * this year's value/unit)
book value of equity	100.00	200.00	200.00	200.00	100.00	201.51	204.56	207.65	210.78	= last year's # + net income - dividend
market value of equity	100.00	203.00	203.00	203.00	100.00	204.51	207.60	210.74	213.92	= last year's # * (1+r) - dividend
units sold	0.00	0.00	100.00	100.00	0.00	0.00	100.00	101.51	103.05	= units of inventory purchased 2 years ago
Revenue		0.00	106.09	106.09		0.00	106.09	107.69	109.32	= units sold* this year's selling price/unit
COGS		0.00	100.00	100.00		0.00	100.00	101.51	103.05	= units sold * cost/unit from 2 years ago
net income		0.00	6.09	6.09		0.00	6.09	6.18	6.28	= revenue - COGS
Inventory purchased ($)	100.00	100.00	100.00	100.00	100.00	101.51	103.05	104.60	106.18	= revenue - dividend
Inventory purchased (units)	100.00	100.00	100.00	100.00	100.00	101.51	103.05	104.60	106.18	= cost of inventory purchased/this year's unit cost
residual income (ae)		-3.00	0.09	0.09		-3.00	0.04	0.05	0.05	= net income - r*(last year's book value of equity)
forward P/E	-	33.33	33.33		-	33.58	33.58	33.58	33.58	= market value of equity/next year's net income
dividend paid		-100.00	6.09	6.09		-101.51	3.04	3.09	3.14	= net income * payout ratio
future growth in dividends		-	0.00%			-	1.51%	1.51%	1.51%	
Gordon Formula price	-	203.00			-	204.51	207.60	210.74		= next year's div./(r–div. growth after next year)

Panel B: Inflation=2%, r=rf=5.06%

	100% payout				50% payout					Description
year	**0**	**1**	**2**	**3**	**0**	**1**	**3**	**4**	**5**	
# of units of inventory	100	198.04	194.16	190.35	100	200.55	201.65	202.76	203.88	last year's # + units purchased - units sold
book value of Asset	100.00	200.00	200.00	200.00	100.00	202.56	207.75	213.07	218.53	last year's # + inventory purchased ($) - COGS
market value of Asset	100.00	205.06	205.06	205.06	100.00	207.62	212.94	218.39	223.99	= sum over tranches of (# * this year's value/unit)
book value of equity	100.00	200.00	200.00	200.00	100.00	202.56	207.75	213.07	218.53	= last year's # + net income - dividend
market value of equity	100.00	205.06	205.06	205.06	100.00	207.62	212.94	218.39	223.99	= last year's # * (1+r) - dividend
units sold	0.00	0.00	100.00	98.04	0.00	0.00	100.00	100.55	101.10	= units of inventory purchased 2 years ago
Revenue		0.00	110.38	110.38		0.00	110.38	113.20	116.10	= units sold* this year's selling price/unit
COGS		0.00	100.00	100.00		0.00	100.00	102.56	105.19	= units sold * cost/unit from 2 years ago
net income		0.00	10.38	10.38		0.00	10.38	10.64	10.91	= revenue - COGS
Inventory purchased ($)	100.00	100.00	100.00	100.00	100.00	102.56	105.19	107.88	110.65	= revenue - dividend
Inventory purchased (units)	100.00	98.04	96.12	94.23	100.00	100.55	101.10	101.66	102.22	= cost of inventory purchased/this year's unit cost
residual income (ae)		-5.06	0.26	0.26		-5.06	0.13	0.13	0.13	= net income - r*(last year's book value of equity)
forward P/E	-	19.76	19.76		-	20.01	20.01	20.01	20.01	= market value of equity/next year's net income
dividend paid		-100.00	10.38	10.38		-102.56	5.19	5.32	5.46	= net income * payout ratio (after year 1)
future growth in dividends		-	0.00%			-	2.56%	2.56%	2.56%	
Gordon Formula price	-	205.06			-	207.62	212.94	218.39		= next year's div./(r–div. growth after next year)

Table A-7: Case F: Asset machinery, depreciated over a four-year life using sum-of-years' digit method (an accelerated method, labeled SOYD).

Panel A: Inflation=0%, $r=r_f=3\%$

The asset value at each date is given by the schedule below (=PV of remaining cash flows discounted @ 3%)

year	**0**	**1**	**2**	**3**	**4**	average asset
nominal cash flows		10.00	10.00	10.00	10.00	
Market Value of Asset	$37.17	$28.29	$19.13	$9.71	$0.00	$23.58
SOYD depreciation schedule		40%	30%	20%	10%	mean
SOYD depreciation		$14.87	$11.15	$7.43	$3.72	$9.29
book value of asset	$37.17	$22.30	$11.15	$3.72	$0.00	$18.59

	100% payout				50% payout					Description
year	**0**	**1**	**4**	**5**	**0**	**1**	**17**	**18**	**19**	
# of assets held	1	2	4	4	1	2	5	5.08	5.17	prior year's asset held + assets purchased - retired
assets purchased	1	1.00	1.00	1.00	1.00	1.00	1.28	1.30	1.32	= (revenue - dividend)/asset value
assets retired	0	0	1	1	0.00	0.00	1.20	1.22	1.24	assets purchased 4 years earlier
book value of Asset	37.17	59.47	74.34	74.34	37.17	59.47	94.03	95.60	97.20	sum over tranches of (units *depreciated book value)
market value of Asset	37.17	65.46	94.30	94.30	37.17	65.46	118.75	120.74	122.76	sum over tranches of (units *depreciated market value)
book value of equity	37.17	59.47	74.34	74.34	37.17	59.47	94.03	95.60	97.20	= prior year's # +net income - dividend
market value of equity	37.17	65.46	94.30	94.30	37.17	65.46	118.75	120.74	122.76	= prior year's # * (1+r) - dividend
Revenue		10.00	40.00	40.00		10.00	49.15	49.97	50.81	= units owned * revenue/unit
depreciaton expense		14.87	37.17	37.17		14.87	46.05	46.82	47.61	sum over tranches of (units owned*depreciation)
net income		-4.87	2.83	2.83		-4.87	3.10	3.15	3.20	= revenue less depreciation
residual income (ae)		-5.98	0.60	0.60		-5.98	0.32	0.33	0.33	= net income - r*last year's book value of equity
forward P/E	-7.64	-10.87	33.33		-7.64	-10.87	37.72	37.72		= market value of equity/next year's net income
dividend paid		-27.17	2.83	2.83		-27.17	1.55	1.57	1.60	= income*payout ratio
growth in dividends			0.00%	0.00%			1.68%	1.68%		
Gordon Formula price			94.30				119.25			= next year's dividend/(r-dividend growth after next year)

Panel B: Inflation=2%, $r=r_f=5.06\%$

See Panel B of Table A-4 for the asset value at each date (=PV of remaining cash flows discounted @ 5.06%)

year	**0**	**1**	**2**	**3**	**4**
SOYD depreciation		40%	30%	20%	10%
book value of asset	100%	60%	30%	10%	0%

	0	**1**	**2**	**3**	**15**	**16**
Book Values under SOYD are given by:						
Book Value at purchase	$37.17	$37.91	$38.67	$39.45	$50.03	$51.03
Book Value 1 year later	$22.30	$22.75	$23.20	$23.67	$30.02	$30.62
Book Value 2 year later	$11.15	$11.37	$11.60	$11.83	$15.01	$15.31
Book Value 3 year later	$3.72	$3.79	$3.87	$3.94	$5.00	$5.10
Book Value 4 year later	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

	100% payout				50% payout					Description
year	**0**	**14**	**15**	**16**	**0**	**1**	**14**	**15**	**16**	
# of assets held	1.00	3.27	3.20	3.14	1.00	2.00	4.36	4.39	4.43	prior year's asset held + assets purchased - retired
assets purchased	1.00	0.79	0.78	0.76	1.00	1.00	1.10	1.11	1.12	= (revenue - dividend)/asset value
assets retired	0.00	0.86	0.84	0.82	0.00	0.00	1.07	1.08	1.09	assets purchased 4 years earlier
book value of Asset	37.17	77.74	77.74	77.74	37.17	60.22	105.98	109.00	112.10	sum over tranches of (units *depreciated book value)
market value of Asset	37.17	100.63	100.63	100.63	37.17	66.77	136.11	139.98	143.97	sum over tranches of (units *depreciated market value)
book value of equity	37.17	77.74	77.74	77.74	37.17	60.22	105.98	109.00	112.10	= prior year's # +net income - dividend
market value of equity	37.17	100.63	100.63	100.63	37.17	66.77	136.11	139.98	143.97	= prior year's # * (1+r) - dividend
Revenue		43.96	43.96	43.96		10.20	57.03	58.66	60.32	= units owned * revenue/unit
depreciaton expense		38.87	38.87	38.87		14.87	51.17	52.63	54.12	sum over tranches of (units owned*depreciation)
net income		5.09	5.09	5.09		-4.67	5.86	6.03	6.20	= revenue less depreciation
residual income (ae)		1.16	1.16	1.16		-6.55	0.65	0.67	0.69	= net income - r*last year's book value of equity
forward P/E	-7.96	19.76	19.76		-7.96	-12.12	22.57	22.57		= market value of equity/next year's net income
dividend paid		5.09	5.09	5.09		-27.71	2.93	3.02	3.10	= income*payout ratio
growth in dividends		-0.01%	0.00%				2.86%	2.85%		
Gordon Formula price		100.62					136.52			= next year's dividend/(r-dividend growth after next year)

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Figure 1

Earnings yields (forward and trailing), dividend yields, and 10-year risk-free rates for US (1/1976 to 3/2005)

Forward earnings yields are from IBES, trailing earnings and dividend yields are from Compustat, and 10-year risk-free rates are taken from Global Financial Data

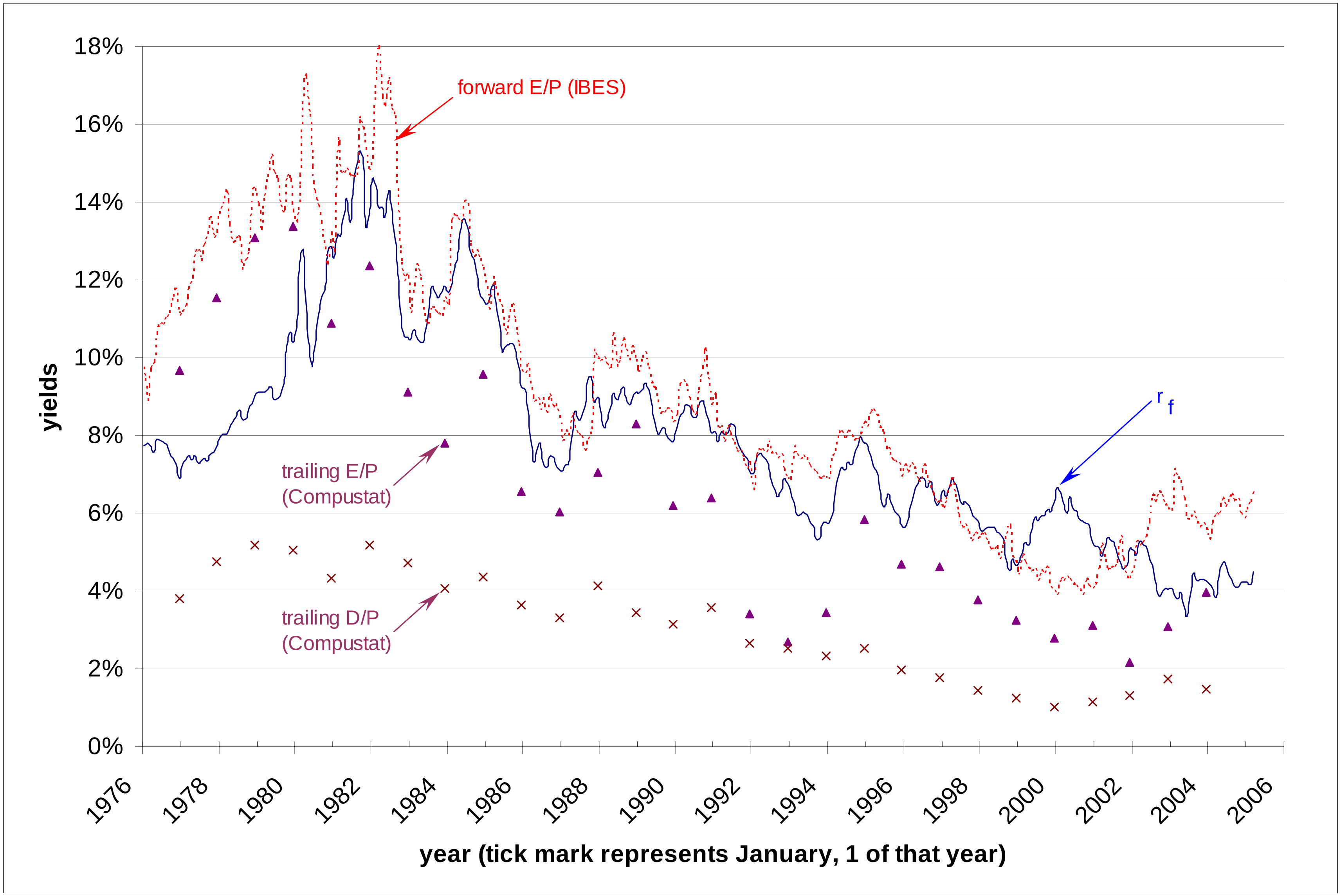
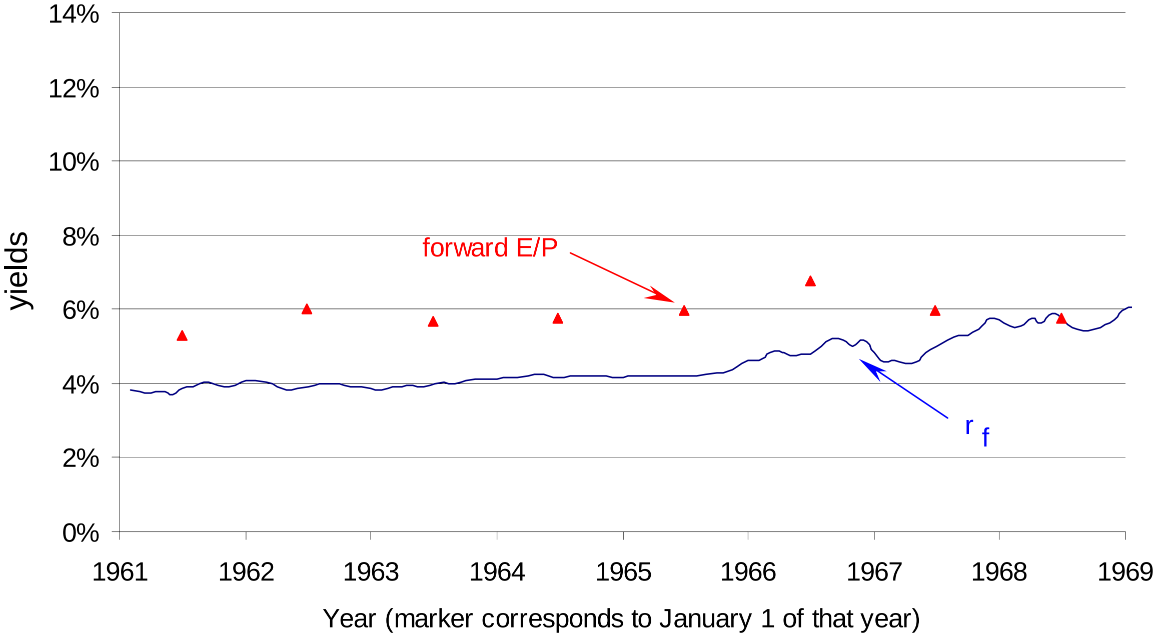


Figure 2

Earnings yields and 10-year risk-free rates (r_f) for the US

Risk-free rates from Global Financial Data (= tcm10p through 3/31/1953, and = tcm10y after that)

Panel A: 1961 to 1968: 174 firms with forward earnings yields covered in Cragg and Malkiel (1982)



Panel B: Trailing earnings yields for the S&P 500, from 1925 (from http://aida.econ.yale.edu/~shiller/data.htm)

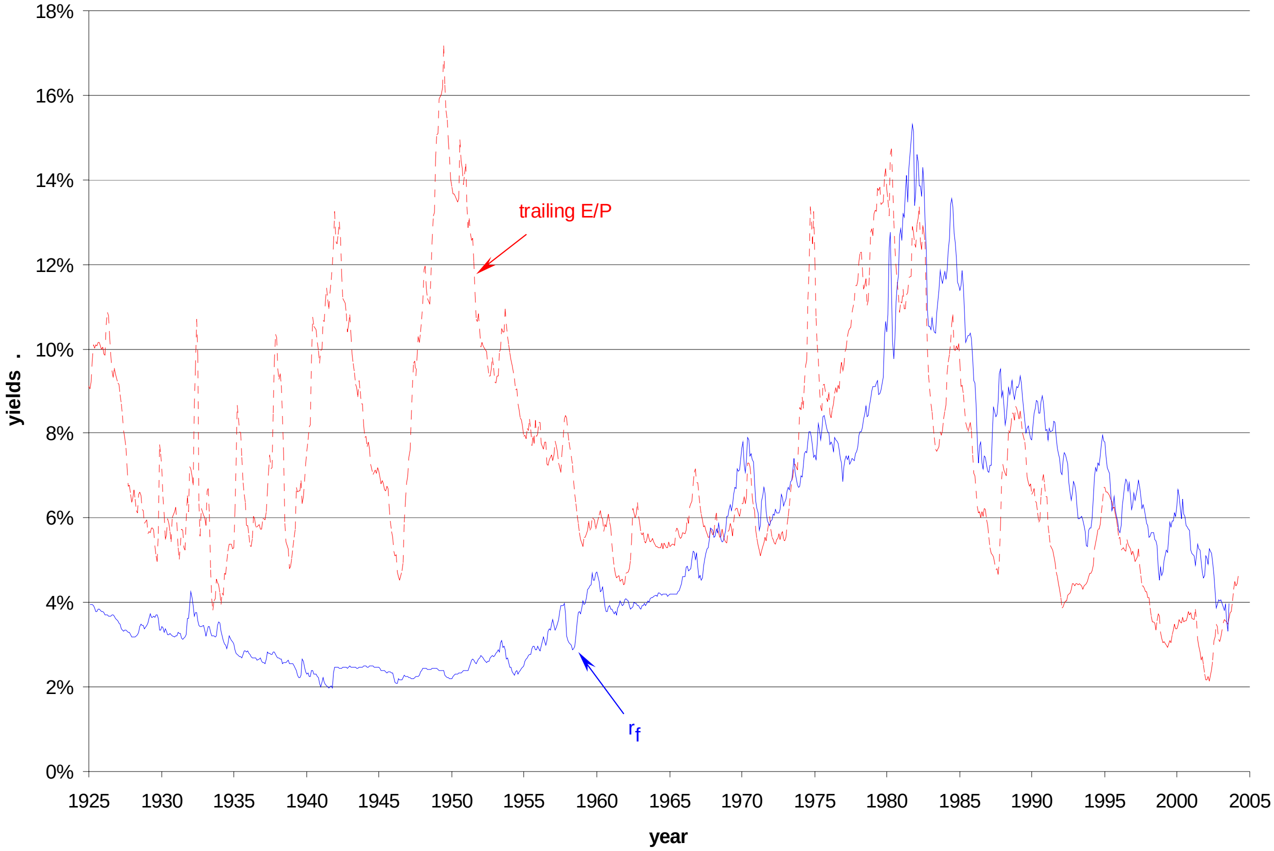
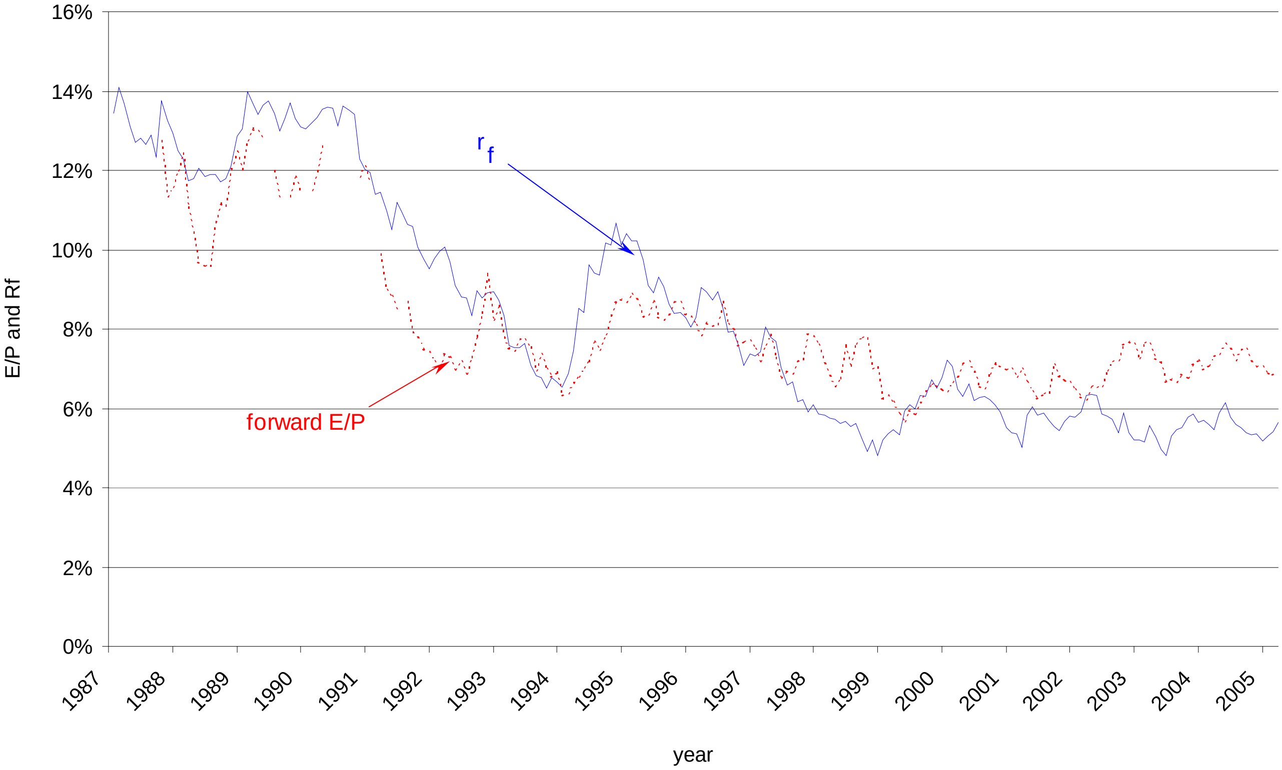
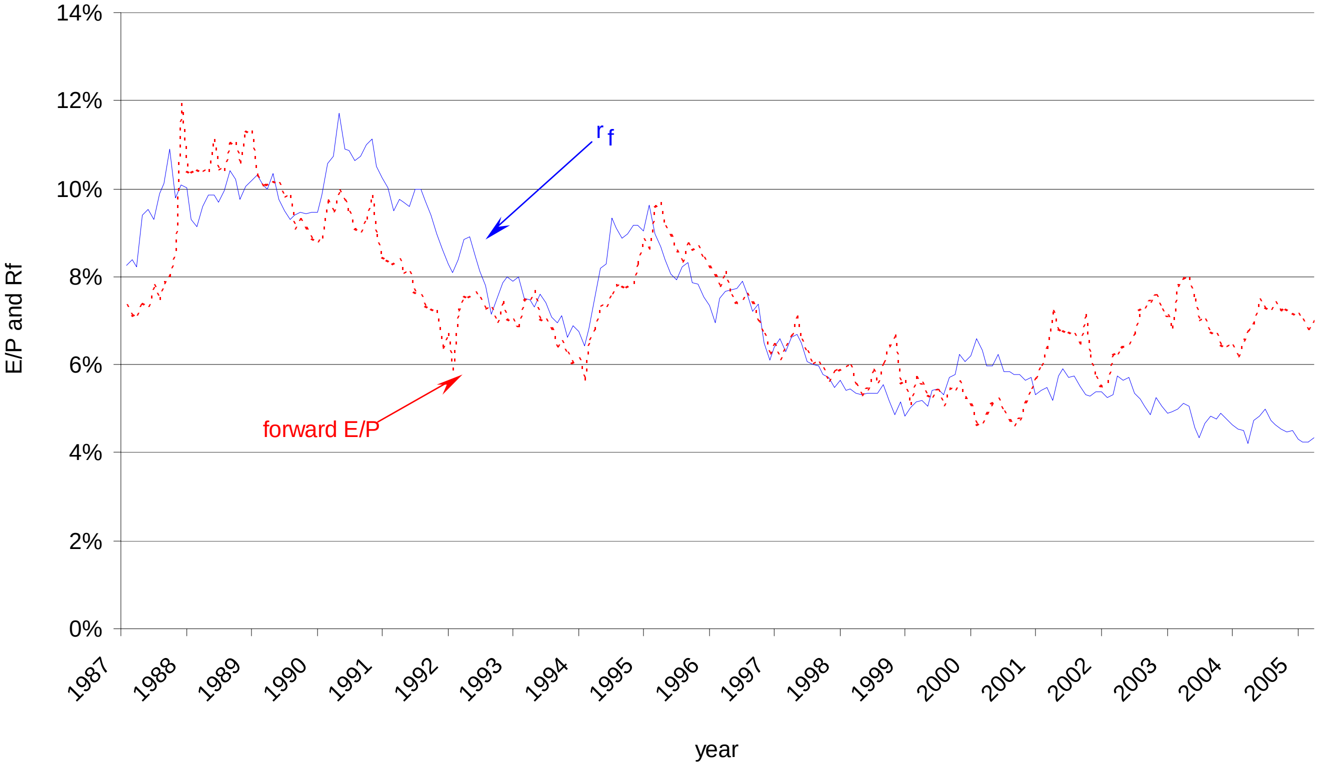


Figure 3
Forward earnings yields (from IBES) and 10-year risk-free rates (1/1987 to 3/2005)

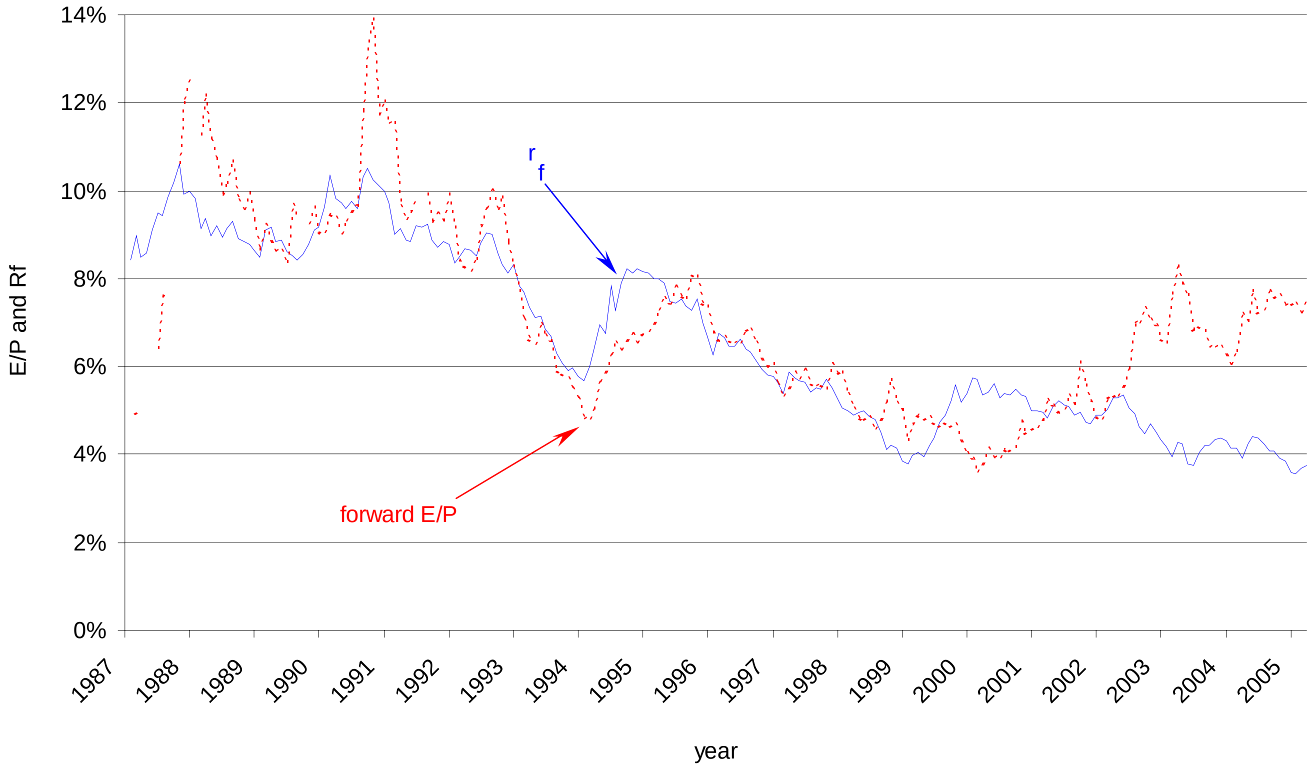
Panel A: Australia



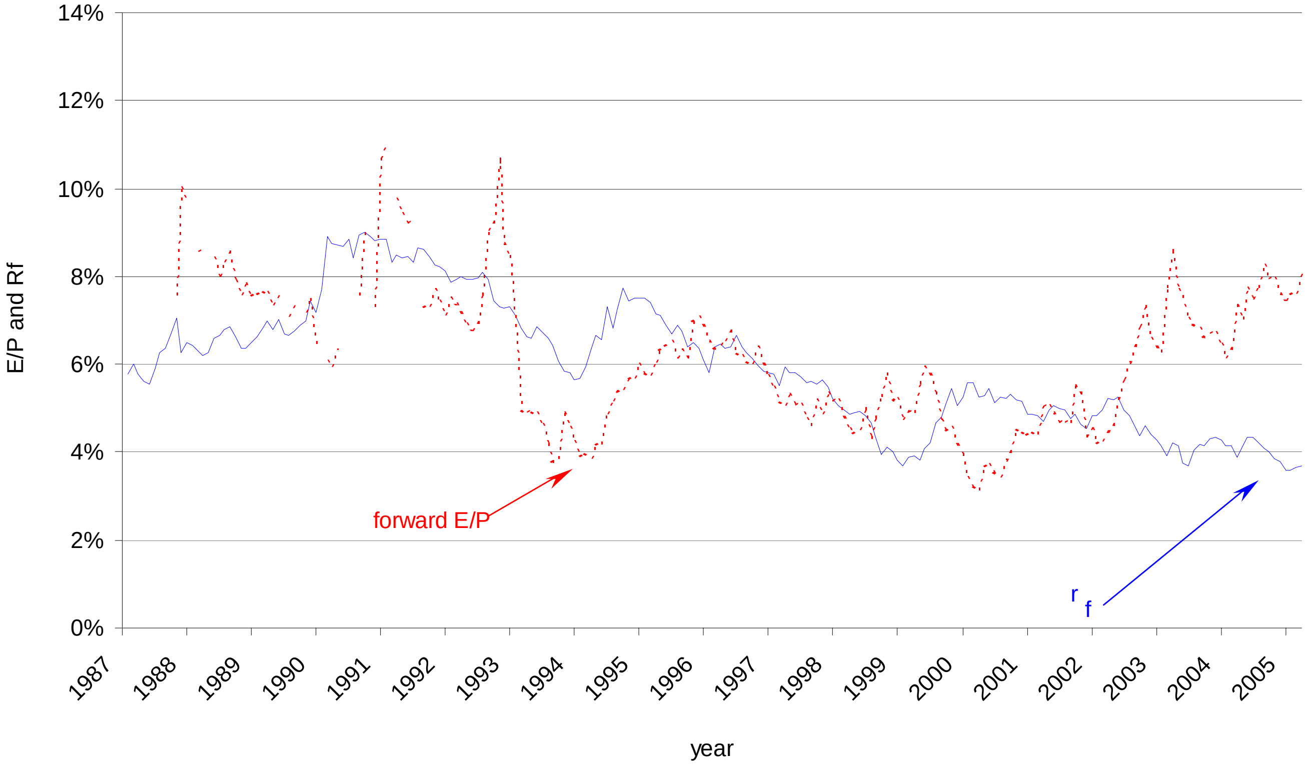
Panel B: Canada



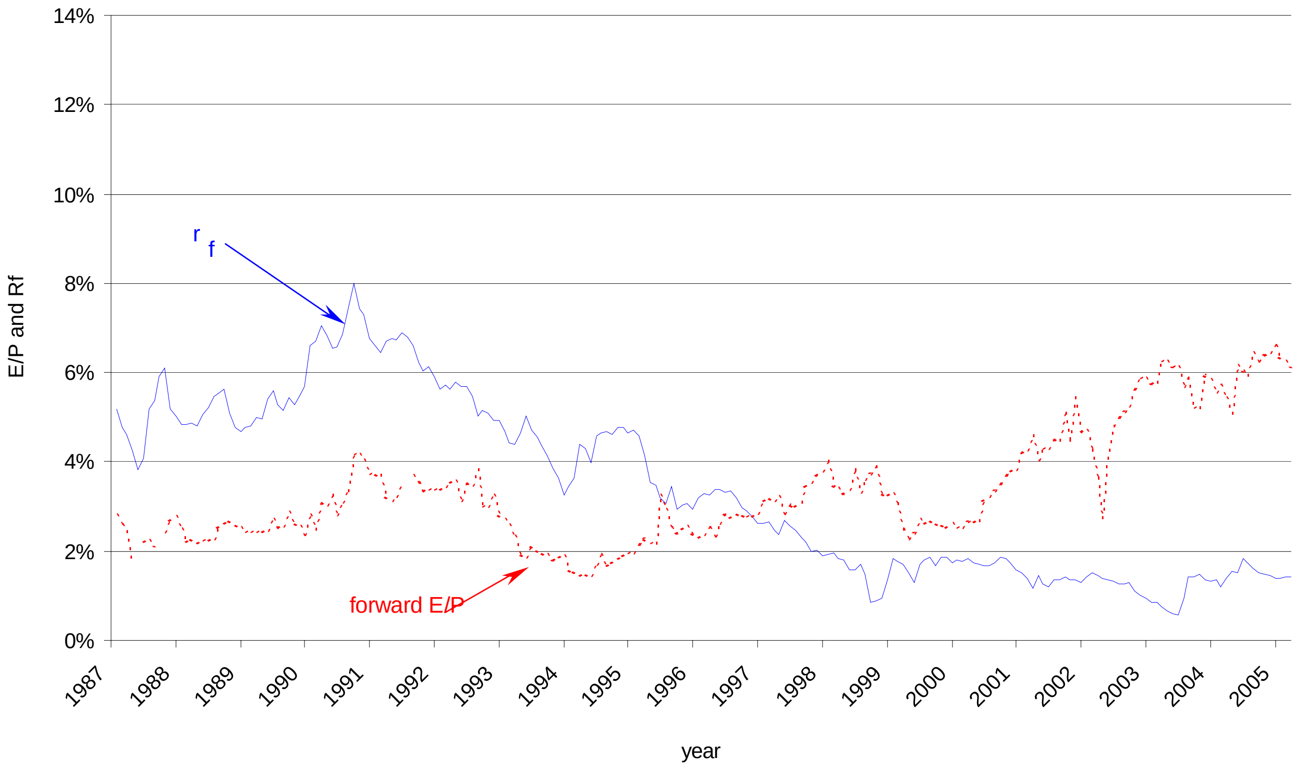
Panel C: France



Panel D: Germany



Panel E: Japan



Panel F: UK

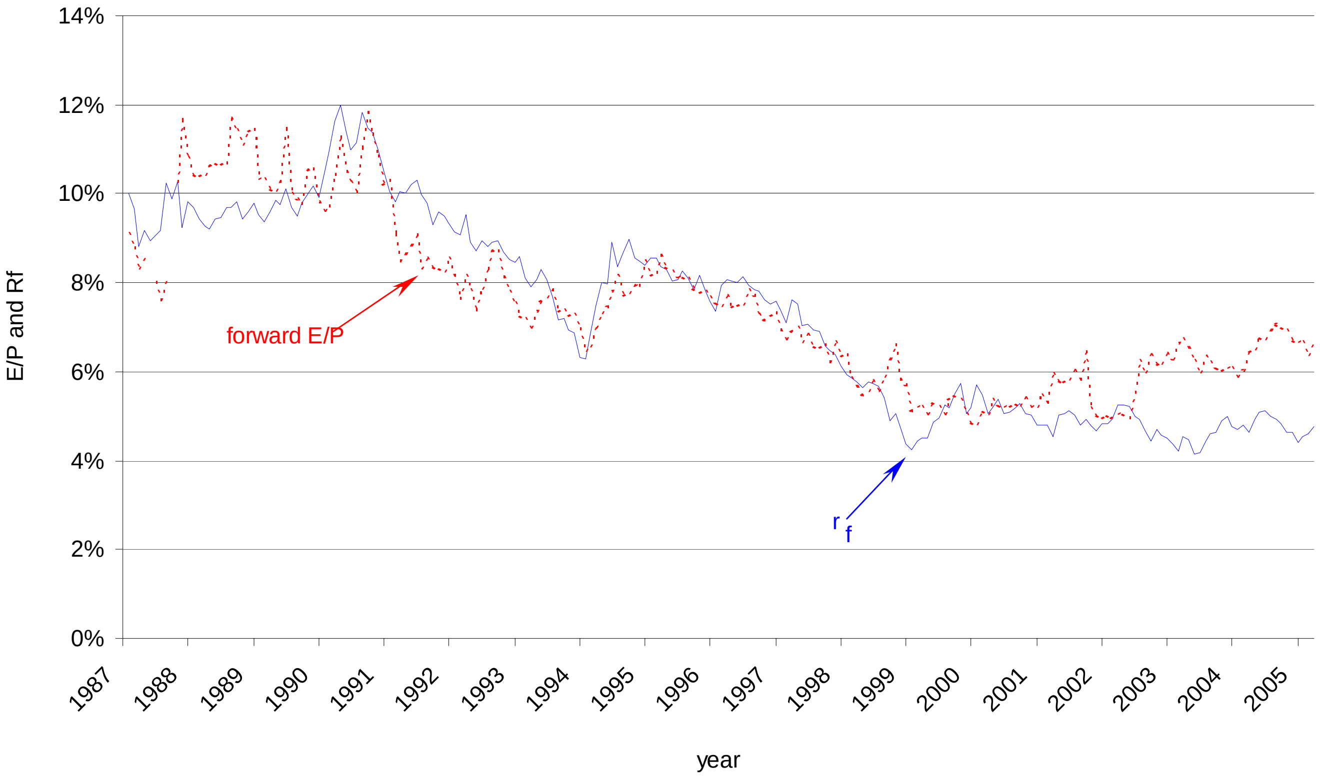


Figure 4

Evidence of excess volatility provided in Grossman and Shiller (1981)

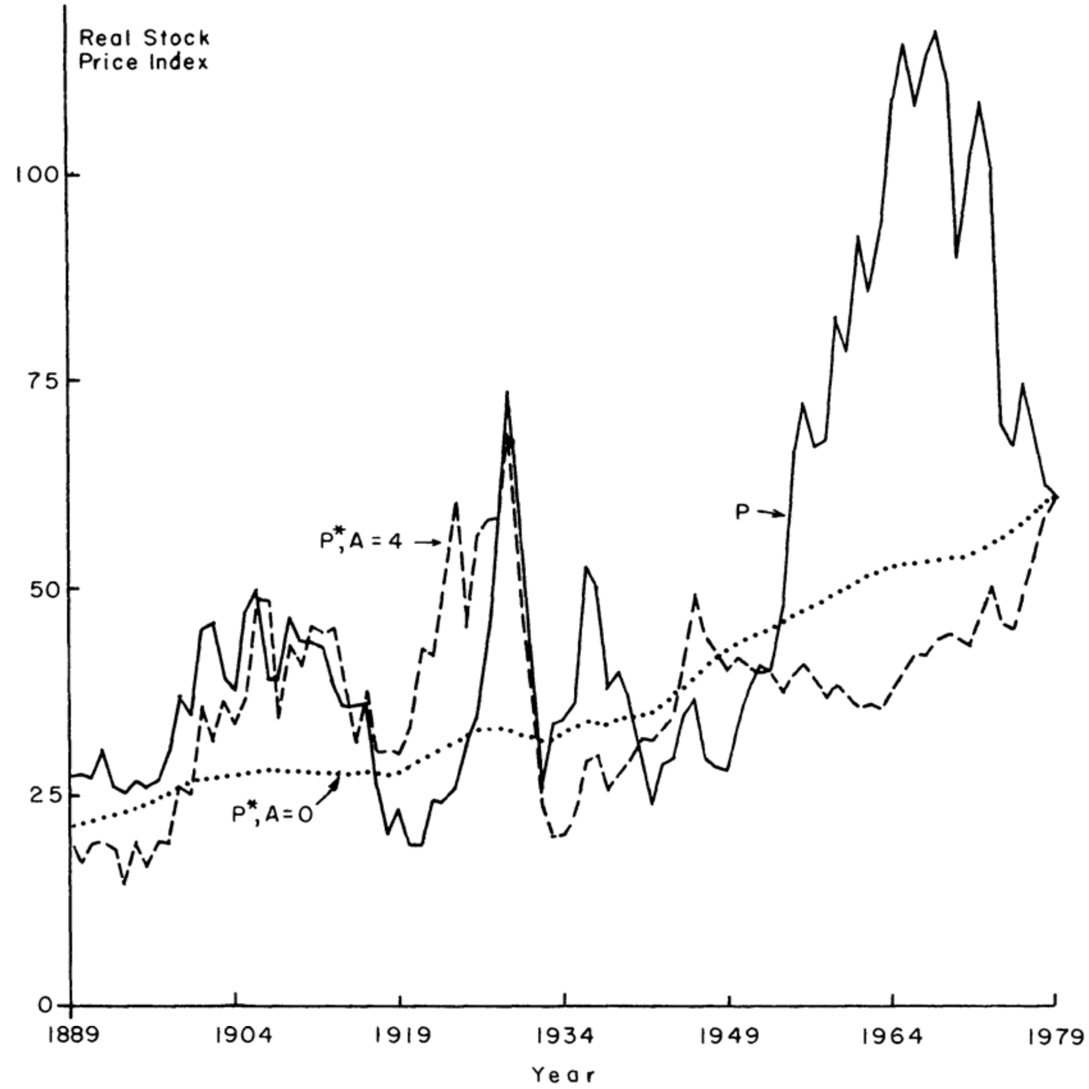


FIGURE 1. ACTUAL AND PERFECT FORESIGHT STOCK PRICES, 1889– 1979

Note: The solid line P_t is the real Standard and Poor Composite Stock Price Average. The other lines are: P_t^* (as defined by expression (6) and (7), the present value of actual subsequent real dividends using the actual stock price in 1979 as a terminal value. With $A=0$ (dotted line) the discount rates are constant, while with $A=4$ (dashed line) they vary with consumption.