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Stock Prices and Fundamentals

1. *Introduction*

While stock returns in the United States this past century have exceeded Treasury returns by an average of about 6% annually, in the last few years they have done so by more than 12% annually. Commentators have suggested a variety of explanations for the dramatic stock-market run-up that accompanied these high returns. The baby boom is entering peak savings years, productivity has escalated worldwide due to technological improvements and political change, and stock-market participation rates are on the rise. The growth of mutual funds has lowered transaction costs and made diversification feasible. Public awareness of the benefits of stock-market investing is high. On the other hand, irrational exuberance could be fueling the price rise, with inexperienced investors expecting double-digit returns to continue indefinitely or at least long enough to reap a substantial gain.

Whether the price rise is due primarily to fundamentals or whether it is the result of a bubble is important to policymakers concerned with avoiding the real disruption a sharp stock-market decline could precipitate. It is also important to the academic debate over the determinants of stock valuations. Because this paper is about the relations between stock prices and fundamentals, we emphasize three broad categories of explanations for the recent price rise: changes in corporate earnings growth, changes in consumer preferences, and changes in stock-market participation patterns. The goal in qualifying the importance of fundamental effects is to better understand whether a combination of fundamentals and statistical fluctuation can plausibly explain the observed magnitudes, or whether a bubble is the likely cause of the price rise.

The paper has benefited from the comments of John Campbell, Annette Vissing-Jørgensen, and participants of the 1999 NBER Macroeconomics Annual Conference. We thank the National Science Foundation for financial support.

Although the paper touches on a variety of issues, its main contribution is to look more closely at how participation patterns have changed, and at how they are expected to affect required returns in a stochastic equilibrium model. We interpret participation broadly to include both the fraction of the population that holds any stocks, and the degree of diversification of a typical stockholder. To review the evidence, we use data from the Survey of Consumer Finances (SCF) to document changes in stockholding patterns and reported attitudes toward risk from 1989 to 1995. Consistent with previous studies (e.g., Poterba, 1993; Vissing-Jørgensen, 1997), we see an increasing rate of stock-market participation over time. Participation rates among the wealthy, who own the majority of stock, however, have increased only slightly. Foreign participation changes may also influence required returns. Using data from the U.S. Treasury, we find that net purchases of stocks by foreigners have been relatively high in recent years, but small in comparison with total trading volume. Finally, flow-of-funds data show that diversification has increased markedly, with large outflows of individual stocks from household portfolios moving into mutual funds and other institutional accounts.

To quantify the potential impact of these changes, we calibrate an overlapping-generations model that allows for considerable heterogeneity in the cross section of nonmarketable income risk, preferences, diversification, and participation. This extends the analyses of Basak and Cuoco (1998), Saito (1995), and Vissing-Jorgensen (1997), all of whom consider the effect of participation when traded securities span income realizations. We use this framework to experiment with changes in stock-market participation rates, changes in background risk, changes in preferences, and changes in the expected dividend process reflecting changes in diversification. We find that for realistic changes in raw participation rates, expected stock returns change very little. Within the range of risk-aversion parameters normally considered, preference changes also have little effect on expected return differentials. Changing the rate of time preference has a significant effect on the level of all returns, but not on the differential between stock and bond returns. One factor that appears to have a significant effect on required returns is the degree of assumed diversification. This suggests that one fundamental reason for the stock price run-up may be the rapid growth of mutual funds and the accompanying large increase in diversification.

The remainder of the paper is organized as follows. In Section 2 we review the statistical evidence on whether the current stock price level is anomalous. In Section 3, we discuss some possible explanations for the stock price increase in the context of a simple discounted-cash-flow model, and present some evidence from the SCF and other sources on changes in stock-market participation patterns. The influence of participation rates, extent of diversification, background income risk, and preferences on stock prices is examined in Section 4 in an overlapping-generations model. By considering a variety of scenarios reflecting simultaneous changes in several of these factors, we show that changes in fundamentals can account for perhaps half of the observed increase in price–dividend ratios in the model. Section 5 concludes.

2. *Empirical Facts*

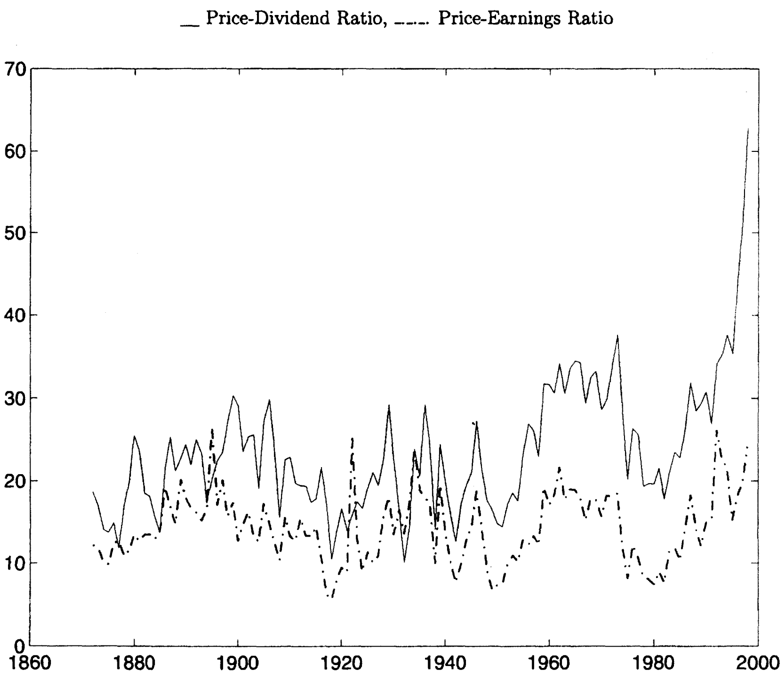
Historically stocks have returned a substantial premium over bonds. Over the period 1871 to 1998, the average annual (log) real return on a broad-based index of U.S. stocks was 7.3%, compared to an average (log) real return on bonds of about 3%.[1] The return on stocks over the last few years has exceeded this historical average. For example, since 1991, the average real return on stocks was 17% per year. This has led many observers to question whether expected returns looking forward are lower than they have been in the past.

A related issue is the composition of recent returns, which have been mostly the result of capital gains rather than increased dividend payments. To illustrate this, Figure 1 plots the ratios of prices to dividends and prices to earnings for aggregate U.S. stocks. (For the years since 1926 this is based on the S&P 500 index.) Notice that the price–dividend ratio for this index has increased to an unprecedented level since about 1995. The increase in this ratio is significant because in a discounted-cash-flow model of stock valuation, it indicates a reduction in the expected rate of return or an increase in the dividend growth rate (see Section 3). Because dividends are discretionary and only one of the ways in which corporations distribute cash to shareholders, it may be more informative to look at price–earnings ratios. Figure 1 also shows the ratio of prices to earnings. This ratio is also at a relatively high level, but the change has not been as dramatic as for dividends.

A notable aspect of the rise in the price–dividend ratio is that there is substantial evidence that a large value of the price–dividend ratio predicts lower stock returns in the future. For example, Table 1 reports the results of regressing annual (log) stock returns on a constant and the log of the price–dividend ratio lagged one year for the period 1887 to 1998. Notice that the coefficient on the dividend–price ratio is negative. This is consistent with a large body of evidence (e.g., Campbell and Shiller, 1988; Hodrick, 1992; Lamont, 1998). At the current high level of the

1. Source: Robert Shiller's data, available at http://www.econ.yale.edu/shiller/chapt26.html.

Figure 1 PRICE–DIVIDEND RATIO AND PRICE–EARNINGS RATIO, 1871–1998



price–dividend ratio, this regression predicts a substantial decline in the stock market over the next year. In fact, since 1995 this regression has consistently predicted a decline in the stock market.

On the other hand, due to the substantial variability in stock returns, it is possible that the recent returns are within the bounds of normal statis-

Table 1 REGRESSION OF ONE-YEAR STOCK RETURNS ON LAGGED P/D OVER THE PERIOD 1871 TO 1998

Coefficient	*Estimate*	*Standard Error*[a]
α	0.28	0.02
β	−0.07	0.05

$\log R^s_{t+1} = \alpha + \beta \log(P_t/D_t) + \epsilon_t$.

[a]Corrected for conditional heteroskedasticity and autocorrelation using the procedure of Newey and West (1987) and two years of lags.

tical fluctuations, without any change in the underlying driving processes. For example, the standard deviation of the annual premium of stock returns over bond returns over the period 1871 to 1998 was 18%. Therefore, it is not improbable that one would observe several years of premiums in excess of 20% per year, even with no change in the underlying statistical process. Since there is not a statistically definitive answer to the question of whether returns have been abnormally high, we focus below on whether recent changes in various aspects of the economy are large enough to suggest a fundamental change in expected returns.

3. *Possible Explanations*

In this section, we discuss some of the potential explanations that have been offered for the stock price run-up, and begin to evaluate their likely quantitative importance in the context of a simple discounted-cash-flow model. We also present some evidence on changes in market participation patterns that may be influencing required returns.

3.1. GORDON GROWTH MODEL

The *Gordon growth model* is perhaps the simplest fundamentals-based approach to predicting stock prices.[2] In this model, stock prices are based on the discounted present value of future expected dividend payments. It is assumed that dividends grow, on average, at a constant rate, g, and investors discount dividends at a constant rate, r. Dividends, earnings, and growth are connected by two equations: $\text{DIV} = (1 - p)E$ and $g = p(\text{ROE})$, where DIV is dividends, E is earnings, p is the proportion of earnings reinvested, and ROE is the marginal physical product of capital. If the marginal physical product of capital is constant, and if the fraction of reinvested earnings is constant, then, all else equal, dividend growth is constant. Then the price–dividend ratio equals $1/(r - g)$.

The model highlights two of the fundamental reasons that the price–dividend ratio can change. The first is due to changes in dividend growth, reflected in the choice of g. The second is due to changes in preferences that affect the subjective rate of time preference or the premium demanded for risk, reflected in the choice of r.

Expectations of g may be higher than in the past for several reasons. A major determinant of dividend growth is the availability of profitable investment projects. The potential for sustained economic growth in excess of historical precedent has been attributed to the opening and

2. This valuation model, a staple of market analysts, is described, for instance, in Brealey and Myers (1996).

integration of world markets, continuing technological advances, and an increasingly educated labor force. In fact, U.S. per capita GDP growth has been slightly higher than average in recent years, averaging 2.3% from 1995 to 1998, compared with 2.0% from 1947 to 1998.

Other considerations suggest that r may be lower than in the past. One possibility is that aggregate preferences have changed. Either a decrease in risk aversion or an increase in patience could contribute to the run-up in stock prices. Risk aversion could vary across generations due to their varying experiences and circumstances. For example, baby boomers do not share their parents' first-hand experience with the Great Depression. Some have argued that the economy is more stable, reducing the exposure to background risk, and possibly reducing the risk to dividends. Davis and Willen (1998) show, for example, that the income risk for households with various educational attainments has changed over time. Reduced transaction costs in financial markets make diversification easier, which, as discussed below, can reduce effective aversion to the risk of holding stocks as people hold more diversified portfolios.

It should be noted that these types of changes affect the risk-free rate as well as the expected return on stocks. Since the risk-free rate has been relatively stable over the period of the recent stock price run-up, in much of what follows we focus on factors that affect the equity premium, rather than the absolute level of rates.[3]

The Survey of Consumer Finances (SCF) is one of the few data sources that provides some direct survey evidence on peoples' attitude towards financial risk and how it has changed over time. Respondents to the SCF answer detailed questions, both quantitative and qualitative, about their financial situation. The survey is conducted by the Federal Reserve Board every three years, with different households in each survey year. Here we focus on the question:

Which of the statements on this page comes closest to the amount of financial risk that you (and your husband/wife) are willing to take when you save or make investments? If more than one box checked, code smallest category #.

1. *take substantial financial risks expected to earn substantial returns*
2. *take above average financial risks expecting to earn above average returns*
3. *take average financial risks expecting to earn average returns*
4. *not willing to take any financial risks*

3. See Blanchard (1993) for an analysis of historical trends in the equity premium and risk-free rate.

Table 2 AVERAGE RESPONSE BY AGE AND SURVEY YEAR TO QUESTIONS ABOUT RISK AVERSION FROM THE SCF.

	Response[a]		
Year	*Age < 35*	*35–65*	*>65*
1989	3.14 (0.88)	3.32 (0.77)	3.63 (0.61)
1992	3.19 (0.84)	3.26 (0.81)	3.64 (0.60)
1995	3.07 (0.87)	3.18 (0.82)	3.58 (0.68)

[a]Implied population standard deviations in parentheses.

Table 2 reports the average response by age and survey year. The implied population standard deviation across responses is reported in parentheses. Since the population represented by the survey totals approximately 90 million households, the standard errors of the estimates of the means are quite small. Consistent with the idea that risk tolerance has increased, the average reported aversion to risk has decreased slightly for each age category over time. Older households own significantly more stock than younger households, and reported risk aversion increases with age in each survey year. When a similar tabulation (not reported here) is done conditional on households that own at least $500 in stocks, the same patterns emerge with respect to age and time. The average reported level of risk tolerance, however, is higher when we condition on stockholders. For instance, in 1995 the average risk attitude for stockholders over age 65 was 3.17, as compared to 3.58 for all households over 65. This suggests that those who already own stocks are more risk-tolerant as a group than nonparticipants. Hence, the entry of new stockholders may slightly decrease the average level of risk tolerance. One would expect this to mitigate the effect of wider participation in reducing the equity premium.

There are objective reasons why the underlying subjective rate of time preference also may be changing. Increases in life expectancy beyond retirement would likely increase the incentive to save and thereby reduce required returns. Mortality, for example, has declined at an average annual rate of 3.3% over the period 1900 to 1988 (Social Security Administration). Past improvements in health and life expectancy might understate expected improvements in these factors that are premised on continued medical progress.[4] As with the other explanations considered for the stock price run-up, however, it is hard to point to events that would

4. In fact, there is a lively debate in the demographic literature on these questions, with some authors claiming that a life expectancy at birth of 100 years will be realized early in the next century.

trigger a large change in aggregate preferences over the course of only a few years.

Calibrating the Gordon growth model gives a rough sense of how far earnings growth rates or stock returns would have to deviate from their historical averages to justify current price levels. This approach has the advantage that it allows one to avoid taking a definitive stand on the magnitude of technology or preference parameter changes. In the tabulations presented here, we focus on earnings-adjusted price–dividend ratios rather than actual price–dividend ratios because earnings are likely to be a more stable proxy for long-run payments to shareholders. Consistent with the average ratio of dividends to earnings over the period 1947 to 1997, we assume an average reinvestment rate of 50%. Hence, the adjusted price–dividend ratio is defined as twice the price–earnings ratio.[5]

Over the past century, real earnings growth has averaged about 1.4% annually, with a standard deviation of about 25%. Table 3 shows the required growth rate in the future to match current and historical adjusted price–dividend ratios, for various levels of required returns. For r ranging from 5% to 15%, column 2 reports the growth rate g that is consistent with the adjusted price–dividend ratio of 28 for the period 1872 to 1998. Column 3 reports the growth rate necessary to match the adjusted price–dividend ratio of 48 in January 1998 (the ratio in January 1999 is even higher at 58). For instance, to realize a real stock return of 7% (consistent with a 6% equity premium and a 1% real risk-free rate) and to match the average historical adjusted price–dividend ratio of 28 requires growth of 3.4%. To match the 1998 adjusted price–dividend ratio of 48, assuming a real risk-free rate of 3% and an equity premium of 6%, requires perpetual growth of 6.9%. This is a large number by historical standards, suggesting that, at least in this simple model, a plausible increase in the expected long-run growth rate is unlikely to be the sole explanation for the increase in stock prices.

The growth rate and required return enter symmetrically in these calculations. Therefore, another interpretation of the results in Table 3 is that if growth rates are expected to be similar to historical averages, the expected real return on the stock market is now less than 5%. Again assuming a risk-free return of 3%, this implies an equity premium below 2%. This large a change in expected returns also seems unlikely to have taken place over the period of only a few years.

One shortcoming of this model is the restriction that the expected

5. While stock prices depend on the long-run behavior of dividends, properly measured, in the short run dividends can vary due to temporary changes in payout policy (for instance, in response to changes in the tax law). Therefore, it is common to focus on the price–earnings ratio, adjusted for reinvestment rates, to approximate long-run price–dividend ratios.

Table 3 GROWTH RATES IMPLIED BY THE GORDON GROWTH MODEL

r^s	*Long-Run g to Match Historical* P/E	*Long-Run g to Match 1998* P/E	*Ten-Year g to Match 1998* P/E *with 2% Tail*
0.05	0.014	0.029	0.064
0.07	0.034	0.049	0.134
0.09	0.054	0.069	0.189
0.11	0.074	0.089	0.236
0.13	0.094	0.109	0.280
0.15	0.114	0.129	0.320

growth rate is constant. This assumption, however, can be relaxed quite easily. A minor variation on the model is to assume a higher growth rate for some number of years, followed by a return to a lower long-run growth rate. Column 4 of Table 3 reports, for each value of r in column 1, the growth rate over 10 years necessary to explain the adjusted price–dividend ratio in January 1998. The calculation assumes that the growth rate returns to the long-run average of 2% from year 10 onward. In this case achieving a 9% average rate of return requires a growth rate of 18.9% for ten years!

Although these calculations are admittedly primitive, more detailed analyses along similar lines produce qualitatively similar conclusions. For instance, Lee and Swaminathan (1999) estimate the value of individual stocks in the Dow Jones Industrial Average, projecting cash flows using accounting data and analysts' forecasts, and discounting using the CAPM. They conclude that the index is about 1.6 times the fundamental value predicted by their analysis.

Despite the apparently large changes in parameters necessary to explain current price levels, these results do not preclude a fundamentals-based explanation. It is possible that there have been a simultaneous increase in expected growth rates and a reduction in required returns. For instance, if the long-run growth rate is realistically expected to be about 2.4% and if expected returns fall to about 6.6%, current prices are in line with fundamentals. Our focus in the rest of the paper is on whether such a change in expected returns can be attributed to measurable changes in the economy, in the context of an equilibrium model. One factor of particular interest is the change in stock-market participation patterns, which is the topic of the next subsection.

3.2 STOCK-MARKET PARTICIPATION PATTERNS

It is well documented that a large fraction of the U.S. population holds little or no stocks (Bertaut and Haliassos, 1995; Blume and Zeldes, 1993) and that participation varies systematically with factors such as wealth and age (Gentry and Hubbard, 1998; King and Leape, 1987). As noted in several recent studies (e.g., Basak and Cuoco, 1998; Constantinides, Donaldson, and Mehra, 1998; Saito, 1995; Polkovnichencko, 1998; Vissing-Jørgensen, 1997), an increase in the stock-market participation rate has, in theory, the potential to decrease the required risk premium on stocks because it spreads market risk over a broader population.[6] Not only has the number of participants been rising, but the nature of participation has changed. A typical stockholder today has a more diversified portfolio than in the past, presumably due to the lower cost of diversification. Thus, the effective risk of the typical portfolio may have declined. In this subsection, we review some of the evidence on these changes.

The best source of data on market participation rates in the United States is perhaps the SCF, which reports detailed information about household wealth composition every three years. Using these data, Poterba (1998) reports that in 1995 there were approximately 69.3 million shareholders in the United States, compared to 61.4 million in 1992 and 52.3 million in 1989. There is also evidence that people are entering the market at a younger age. Poterba and Samwick (1997) show that baby boomers are participating more heavily in the market than previous generations at a similar age. Baby boomers are entering peak savings years and directing some of their savings into stocks. More generally, the aging of the population should result in a greater demand for stocks, since older people hold proportionally more of their wealth in the market than do younger people (see, e.g., Heaton and Lucas, 1998). Finally, foreign participation in the U.S. markets has increased, further spreading the risk across a broader population.

Market participants are also holding more diversified portfolios, which reduces their exposure to risk from their stockholdings. This is potentially important, since holders of diversified portfolios may demand a lower average return. Historical evidence on this phenomenon of improving diversification is summarized in Allen and Gale (1994). Friend and Blume (1975) found that a large proportion of investors had only one or two stocks in their portfolios and very few had more than ten. At the time, this lack of diversification in individual stockholdings could not be justified by the claim that these investors achieved diversification through unreported mutual-fund holdings. In fact, King and Leape (1984) found that

6. Bakshi and Chen (1994) note that to the extent that demographic changes have an effect on the demand for stocks, they will have a predictable effect on asset prices. Bodie, Merton, and Samuelson (1992) provide a theoretical justification for the demand for stocks to vary with age.

only 1% of investors' wealth was in mutual funds at around that time. In contrast, Poterba (1998) reports a sharp increase in the proportion of stock held in mutual funds over time and a reduction in directly held stocks. For instance, while the total number of individuals holding stock increased from 61.4 million to 69.3 million from 1992 to 1995, the number of individuals holding stock directly fell from 29.2 million to 27.4 million over the same period. In the calibrations presented below, we will look at whether this diversification effect is significant by comparing stock prices with different underlying assumptions about dividend volatility, where high assumed dividend volatility proxies for less diversification.

Although these statistics point to an increase in participation and a reduction in risk exposure, it is questionable how significant these effects are quantitatively. The change from 52 million to 69 million participants is a 33% increase, but when the numbers are wealth-weighted, the increase is much smaller. Now as in the past, the vast majority of stocks are held by wealthy individuals. For instance, Poterba (1998) finds that in the 1995 SCF, 82% of stock was held by households with a stock portfolio exceeding $100,000, and 54% of stock was held by households with annual income over $100,000. This suggests that stockholdings remain extremely concentrated. Figures 2 and 3 present a more complete picture of how the distribution of stockholdings vs. wealth and income has changed over the period 1989 to 1995 (see also Table 4). Using data from the SCF, we plot the share of stocks held against the share of income or wealth. Stockholding looks more democratic when measured relative to income than relative to wealth, since as noted in Vissing-Jørgensen (1997), lower-labor-income households own a larger share of the market than in the past. When the metric is wealth, however, there has been very little change—holdings were and are extremely concentrated.

Table 4 PROPORTION OF POPULATION THAT HOLDS STOCK BY WEALTH COHORT

Percentile Range (%)	*Range ($)*	*Proportion (%)*	*Range ($)*	*Proportion (%)*
<25	<801	2.3	<1101	4.7
26–50	801–40,051	13.0	1102–40,500	17.8
51–75	40,052–121,500	21.6	40,501–126,251	28.7
76–90	121,501–279,001	36.7	126,252–309,501	47.8
91–95	279,001–456,000	55.4	309,502–574,000	62.8
96–99	456,001–1,767,730	65.8	574,001–1,814,330	78.3
>99	>1,767,730	84.3	>1,814,331	82.0

Figure 2 PERCENTAGE OF STOCK HELD BY INCOME PERCENTILE

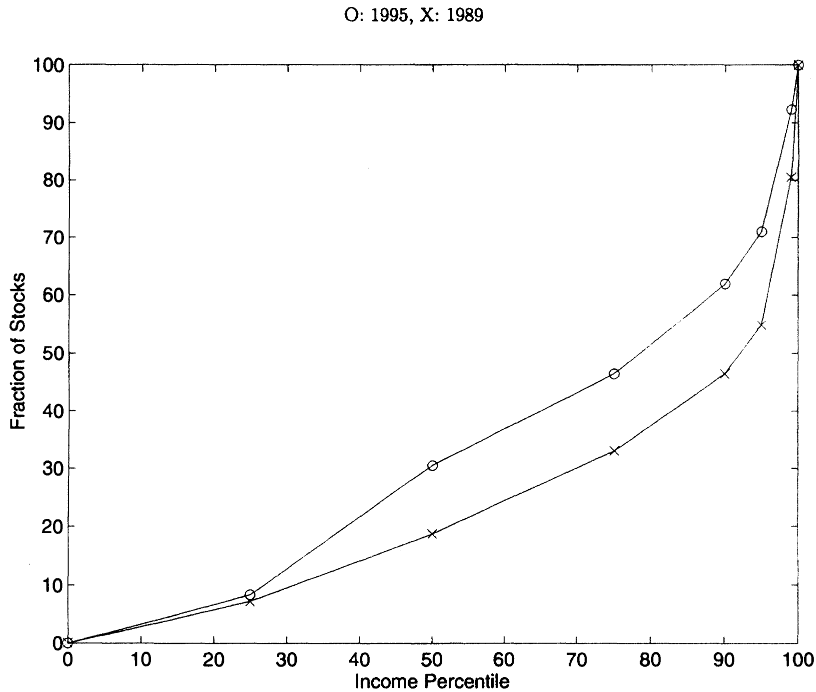


Figure 3 PERCENTAGE OF STOCK HELD BY WEALTH PERCENTILE

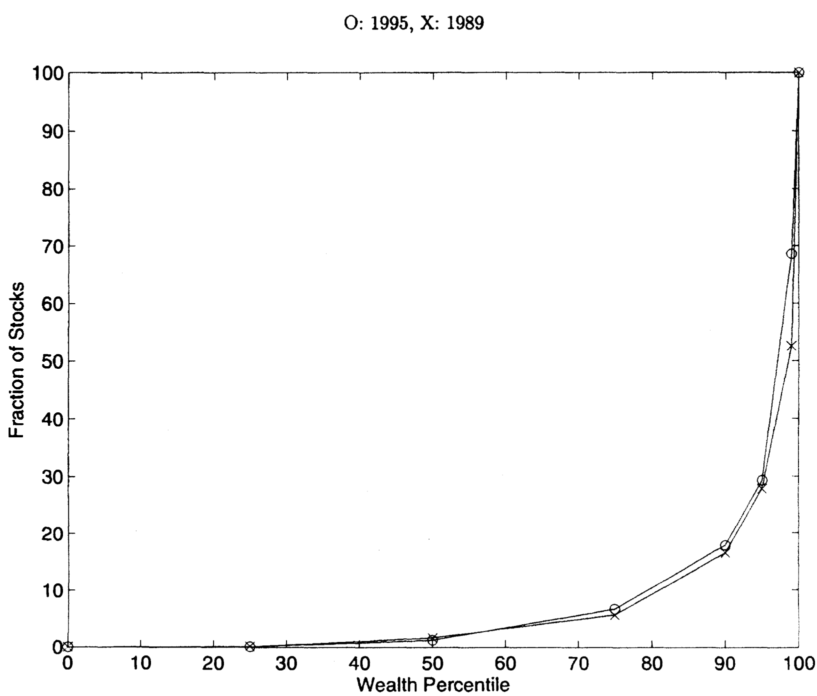


Table 5 NET PURCHASES OF STOCKS BY INDIVIDUALS

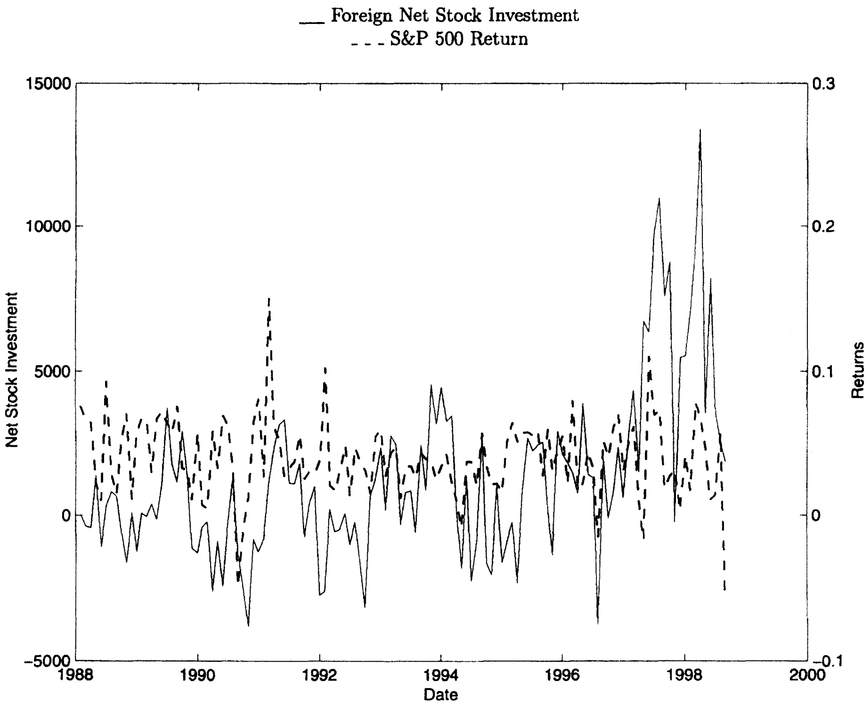
	Purchases (billions of dollars)		
Year	*Net*	*Through Mutual Funds*	*Outside Mutual Funds*
1995	−116.1	91.3	−207.4
1996	−101.9	218.4	−320.3
1997	−179.0	190.2	−369.2

Ideally, one would like to measure the net investment in the stock market in recent years on behalf of households. If net inflows were large, one could perhaps conclude that the demand for stocks had significantly increased. The fact that aggregate savings rates are low is indirect evidence that these net inflows cannot be large. Still, there could be substitution out of money and bonds into stocks, increasing the net flow into stocks. According to the flow-of-funds accounts, U.S. Treasury securities are the only category of fixed-income investment that had a large net outflow from the household sector in recent years. Calculating flows into stocks directly is tricky because there have been large changes in the institutional structure of the investment industry. Table 5, using data from the Investment Company Institute, shows net purchases of stocks, purchases made through mutual funds, and purchases made outside mutual funds, by households, from 1995 to 1997. While purchases made through mutual funds increased significantly over the period, net purchases of equities by households were actually negative in each year. This is because households were net sellers of equities to institutions.

Changes in foreign participation in the U.S. market may also affect expected returns. Assuming that foreign participants are similar to U.S. stockholders in their attitude towards risk and their ex ante risk exposure, an increase in foreign participation should lower expected returns by increasing opportunities for diversification. Net foreign purchases of stock have spiked sharply in recent years (see Figure 4), and these inflows, over the period January 1988 to February 1999, have a correlation of 0.13 with monthly returns on the S&P 500. The average monthly net inflow between January 1996 and February 1999 is $3.8 billion, compared to only $349 million from the period January 1988 to December 1995. Although the inflows have increased significantly, they still represent a small fraction of total market transactions, which totaled approximately $479 billion per month in 1997 on the New York Stock Exchange alone.[7]

7. Data on foreign purchases and sales of U.S. stocks are from the U.S. Department of the Treasury's table "TIC Capital Movements, U.S. Transactions with Foreigners in Long Term Securities." S&P 500 monthly returns data are from Robert Shiller. Total trading volume is from the *NYSE 1997 Fact Book*.

Figure 4 FOREIGN NET INVESTMENT AND RETURNS



4. *An Overlapping-Generations Model*

In this section, we ask whether changing stock-market participation patterns and increased diversification can have a quantitatively important effect on stock prices in an equilibrium model. We calibrate an overlapping-generations (OLG) model in which agents face both aggregate and idiosyncratic income risk, and a variable subset of agents has limited access to financial markets.

The effects of limited participation in financial markets has been considered by a number of authors, including Basak and Cuoco (1998), Saito (1995), and Vissing-Jørgensen (1997). In these papers, aggregate consumption is completely traded in financial markets in the form of dividends. Only a limited number of agents can trade claims on this dividend flow directly. The other agents participate in financial markets only by trading claims to risk-free bonds. The result is incomplete sharing of aggregate risk, with stockholders often taking leveraged positions to accommodate the demand for bonds by nonparticipants. Because of this, a larger risk premium is necessary to induce those in the stock market to hold all of the aggregate risk. It is difficult to justify the magnitude of the observed equity premium in these models, however, unless one assumes very high risk aversion or very low participation rates.

One way to increase the effects of limited participation is to include other sources of uninsurable income risk. For instance, income from wages and/or privately held businesses constitutes the majority of income for most households (Heaton and Lucas, 1998). These income flows are difficult to contract upon, and a large component of this income risk is specific to each individual of household. We refer to the sum of labor income and privately held business income as *nonmarketed income.* Potential differences in the properties of this income for participants versus nonparticipants are likely to influence the effects of limited participation on asset returns. This is consistent with the empirical observation that the consumption of stockholders is more volatile than that of nonstockholders (Mankiw and Zeldes, 1991). Polkovnichenko (1998) demonstrates how differential income risk and risk aversion can affect asset prices in a model with infinite-lived heterogeneous agents. He shows that a small fixed transaction cost that endogenously limits stock-market participation can interact with idiosyncratic risk to result in a bigger equity premium than in a representative agent model, although matching the observed premium is still elusive.

The model presented here allows us to examine the effect of participation and diversification while considering a greater degree of cross-sectional heterogeneity than in the previous literature, due to the simplifying assumption of two-period lives. Unlike the papers discussed above, which focus on whether limited participation can explain the historical equity premium, we focus on the question of to what extent observed *changes* in participation rates can explain the recent run-up in stock prices. We also emphasize the effect of changes in the degree of portfolio diversification.

4.1 STRUCTURE OF THE MODEL

At each time period, t, a generation of J "young" agents are born and live for two periods.[8] Let $C(j,t)$ be the consumption of agent j when young,

8. Storesletten, Telmer, and Yaron (1998) consider an OLG model in which the agents face nontradable idiosyncratic risk and live for a large number of periods. We limit ourselves to a smaller number of periods to make numerical solution of the model easier.

and $C^o(j,t+1)$ be the consumption of agent j when old ($j = 1,2, \ldots, J$). The utility specification for agent j distinguishes between risk aversion and the elasticity of intertemporal substitution. We use the parametric form proposed by Epstein and Zin (1989) and Weil (1990):

$$U(j,t) \equiv \log C(j,t) + \frac{\beta_j}{1-\alpha_j} \log E[C^o(j,t+1)^{1-\alpha_j} \mid \mathcal{F}(t)], \tag{1}$$

where $\beta_j > 0$ and $\alpha_j > 0$. Here $\mathcal{F}(t)$ is the information available at time t and is assumed to be common across agents. As discussed by Epstein and Zin (1989), the parameter α_j is the coefficient of relative risk aversion. The elasticity of intertemporal substitution equals one. In the experiments considered below, changes in participation affect the equilibrium volatility of individual consumption in the second period. In general, this affects both the level of interest rates and the equity premium. By distinguishing between risk aversion and the elasticity of intertemporal substitution, the effect of the income process on the equity premium is to some extent separated from its effect on the risk-free rate.

Each agent $j(j = 1,2, \ldots, J)$ is endowed with random nonmarketed income $Y(j,t)$ at time t and random nonmarketed income $Y^o(j,t+1)$ when old at time $t+1$. The details of the individual income processes are described below. The agents trade in financial markets in an attempt to smooth consumption over time. There are two securities that can be traded: a stock and a risk-free bond. At time t the stock represents a claim to future dividends $\{D(t+\tau) : \tau = 1,2, \ldots\}$. The total supply of stock is normalized to one. The bond is assumed to be in zero net supply.

Each agent is exposed to nonmarketed income risk that has both an aggregate component and an idiosyncratic component. Aggregate nonmarketed income at time t is denoted by $Y^a(t)$, where

$$Y^a(t) = \sum_{j=1}^{J} Y(j,t) + \sum_{j=1}^{J} Y^o(j,t). \tag{2}$$

In equilibrium, this endowment plus dividends equals aggregate consumption at time t. The properties of individual nonmarketed income $Y(j,t)$ and $Y^o(j,t)$ will be potentially important in assessing the effects of changing participation and background income risk on equilibrium returns.

At time t each young agent maximizes utility (1) subject to a constraint that depends on the agent's access to financial markets. Let $P^s(t)$ be the price of the stock at time t, and $P^b(t)$ be the price of a bond that pays one unit of consumption at time $t + 1$ for sure. If agent j has access to both financial markets, then the agent's flow wealth constraints are

$$C(j,t) = Y(j,t) - S(j,t)P^S(t) - B(j,t)P^b(t), \tag{3a}$$
$$C^o(j,t+1) = Y^o(j,t+1) + S(j,t)[P^s(t+1) + D(t+1)] + B(j,t), \tag{3b}$$

where $S(j,t)$ gives the stockholdings of agent j, and $B(j,t)$ gives the bondholdings of agent j. A subset of the agents is assumed to have only limited access to financial markets and can trade only in bonds. In this case the constraints (3) are replaced by

$$C(j,t) = Y(j,t) - B(j,t)P^b(t), \tag{4a}$$
$$C^o(j,t+1) = Y^o(j,t+1) + B(j,t). \tag{4b}$$

An equilibrium is given by processes for stock and bond prices $\{P^s(t) : t = 0,1, \ldots\}$ and $\{P^b(t) : t = 0,1, \ldots\}$ such that

$$\sum_{j=1}^{J} S^*(j,t) = 1, \tag{5a}$$

$$\sum_{j=1}^{J} B^*(j,t) = 0, \tag{5b}$$

where $\{S^*(j,t),B^*(j,t)\}$ maximizes (1) subject to (3) if the agent can trade in both markets, or subject to (4) if the agent can trade only in the bond market.

We assume that nonmarketed income $\{Y^a(t) : t = 0,1, \ldots\}$ and dividend income grow over time in such a way that the growth rate of aggregate income is a stationary process. Consistent with this, we assume that at time t we have $Y(j,t) = y(j,t)Y^a(t)$ and $D(t) = d(t)Y^a(t)$, where $y(j,t)$ denotes the share of individual j's income in aggregate income, and $d(t)$ the dividend relative to aggregate nonmarketed income. Similarly we assume that $Y^o(j,t) = y^o(j,t)Y^a(t)$. This implies that one can look for an equilibrium in which the stock price also scales with aggregate income, so that $P^s(t) = p^s(t)Y^a(t)$. Finally, we assume that the face value of a bond purchased at time t is given by $Y^a(t)$, so that $B(j,t) = b(j,t)Y^a(t)$, where $b(j,t)$ gives the quantity of these "rescaled" bonds purchased by agent j.

4.2 CALIBRATION

In this subsection, we calibrate the model in order to revisit quantitatively some of the questions discussed in Section 3. How much do assumed changes in participation rates affect the predicted equity premium and expected returns (and hence prices)? How does the degree of portfolio diversification affect required returns? Can small changes in preference parameters, reflecting changes in patience or risk aversion, result in large changes in required returns? How important is heterogeneity in income risk? To answer these questions, the model is solved numerically using standard techniques. Although we assume considerable heterogeneity in the cross section, the fact that agents only live for two periods makes the problem numerically tractable.[9]

We begin by describing the parameterization of the income processes and preferences. Parameters are chosen to reflect limited stock-market participation, and to try to match gross features of the data with respect to stock returns, the risk-free rate, and the driving processes for nonmarketed income and dividends.

As in most exercises of this type, the equity-premium puzzle remains a serious problem. For income and dividend processes and participation rates based on historical data, the model predicts an unrealistically small equity premium. We have increased the assumed volatility of aggregate income to increase the predicted premium, but want to emphasize that this may not be a neutral adjustment with respect to the other quantities of interest.[10]

4.2.1 Income and Preferences Let $\gamma(t) \equiv \log[Y^a(t)/Y^a(t-1)]$ be the growth rate of aggregate nonmarketed income at time t. Then the aggregate state of the economy is given by $z(t) \equiv [\gamma(t)\ d(t)]'$, which is assumed to be generated by a Markov chain. To calibrate a process for $z(t)$ we assume that a period corresponds to 25 years. The first period roughly corresponds to the working years between age 40 and retirement, and the second period is the time in retirement. Over the period 1889 to 1985, the average annual (log) growth rate in real aggregate consumption was 1.7% with a standard deviation of 3.5%. So that the model will produce a nonnegligible equity premium, we assume that the standard deviation of the aggregate growth rate in the model is 1.5 times the historical standard deviation of aggregate

9. The Matlab code is available upon request.

10. Recently Campbell and Cochrane (1998) suggested that time-varying habit provides a higher estimate of the equity premium in a model based on aggregate consumption. However, Cochrane (1997) claims that this preference specification cannot account for the recent run-up in stock prices.

consumption. For the same reason, we assume that annual income growth is independently and identically distributed over time, although in fact it is slightly negatively autocorrelated. This implies a 25-year average (log) growth rate of 42.5% with a standard deviation of 17.5%. This distribution is discretized by assuming that γ takes on the values 0.16 and 0.69 with equal conditional probability.

The capital share in total income averages approximately 30%. Consistent with the aggregate statistics reported in Heaton and Lucas (1998), we assume that only half of this capital income is actually tradable. The nontradable portion, generated by private business holdings, is accounted for in nonmarketed income. Since dividends in the model are scaled relative to nonmarketed income, this means that we require $d(t)$ to average 18%. In most of the calculations $d(t)$ is fixed at 18%. In other experiments described below, we assume a more volatile dividend process to proxy for a lack of diversification.[11]

The relative nonmarketed income of young agent j and of old agent k at time t are given by

$$y(j,t) = \epsilon(j,t)[1 - \eta(t)], \tag{6}$$
$$y^o(k,t) = \epsilon^o(k,t)\eta(t), \tag{7}$$

where

$$\sum_{j=1}^{J} \epsilon(j,t) = 1 \quad \text{and} \quad \sum_{k=1}^{J} \epsilon^o(k,t) = 1. \tag{8}$$

Under this normalization, $\eta(t)$ gives the share of old individuals' nonmarketed income in total nonmarketed income. The analysis is sensitive to this parameter because the amount of nonmarketed income influences agents' attitude towards the risk of investment income. For the basic analyis we assume that $\eta = 0.2$ for all t, reflecting the observation that noninvestment wealth is relatively small for retirees. In the sensitivity analysis, this parameter is varied to a maximum of 0.3.

The process for $\epsilon(j,t)$ and $\epsilon^o(k,t)$ captures idiosyncratic income risk across agents. We know from earlier work (e.g., Constantinides and Duffie, 1996) that asset returns are potentially sensitive to the persistence of idiosyncratic income shocks and to the correlation and conditional covariance of idiosyncratic and aggregate shocks. We assume a process for individual income risk based in part on the estimations re-

11. In constructing the total dividend series, we always normalize the level of dividends so that they average 15% of GDP.

ported in Deaton (1992) and adjusted for the assumed 25-year period length. Deaton reports a standard deviation of shocks for an MA(1) specification of individual income growth of 15%, and an MA coefficient of −0.4. Based on this, the idiosyncratic income shocks for both the young and the old are assumed to have a standard deviation of 45% over each 25-year period. The shock when young is assumed to be completely persistent, so that

$$\epsilon^{o}(j,t+1) = \epsilon(j,t)\omega(j,t+1), \tag{9}$$

where $\omega(j,t+1)$ is the further 45%-standard-deviation shock to relative nonmarketed income that agent j faces when old. In experiments below, we also consider the situation in which the idiosyncratic shocks of a subset of the population are correlated with dividends. This captures the possibility that certain classes of agents, such as business owners or executives who own large shares of stock in their own corporation, face risks that are more correlated with the market than a typical individual. Because preferences are homothetic, when agents are assumed to be homogeneous only the ω-shock affects prices and portfolio choice. When the wealth and income of participants and nonparticipants differ, however, the income distribution of the young can affect predicted returns.

For most of the analysis, preferences are parametrized with $\beta_j = 0.95^{25}$ and $\alpha_j = 5$ for all j. These parameters are also varied in the sensitivity analysis.

4.2.2 Varying Participation Rates Table 6 shows what happens when the assumed participation rate in the stock market is varied between 30% and 100% of the population, assuming the preference specification and processes for individual and aggregate income described above. As one would expect, increased participation lowers the equity premium. Notice, however, that the effect is small in the region of participation rates that correspond to the data. For example, when participation increases from 50% to 80% of the population, the equity premium and the absolute level of equity returns are reduced by less than a tenth of a percent. Changing participation also has a small effect on the level of the risk-free rate, with an increase in participation increasing the average rate of return. This can be attributed to a precautionary effect that decreases when risk is spread more evenly over the population. Although small, this effect is in keeping with the observation that the risk-free rate has risen in recent years.

Consistent with the literature on the equity-premium puzzle, aggre-

Table 6 AVERAGE ANNUAL RETURNS AS A FUNCTION OF PARTICIPATION

Percentage of Stockholders	Returns (%)		
	$E(r^b)$	$E(r^s)$	$E(r^s - r^b)$
100	4.42	5.47	1.05
90	4.40	5.48	1.08
80	4.38	5.49	1.11
70	4.37	5.50	1.13
60	4.35	5.51	1.16
50	4.33	5.52	1.19
40	4.32	5.53	1.21
30	4.32	5.55	1.23

gate income and dividend risk alone are not sufficient to generate a sizable equity premium. This is true even under the assumption of extremely limited participation, inflated aggregate risk, and nonmarketed income risk. Still, the premium predicted here is higher than in Mehra and Prescott (1985) by about 1%. Experiments not reported here indicate that this difference is due primarily to the assumption that aggregate risk is higher than that observed in the data, rather than to limited participation or exposure to idiosyncratic income risk.

In the experiments that follow, we examine other stochastic steady states based on different degrees of diversification, risk aversion, etc. Although looking across steady states does not allow one to watch returns gradually changing over time as parameters gradually change, it does provide an upper bound on the size of these effects. Thus, one can give a temporal interpretation to some of the experiments. For instance, we will compare the stylized historical past, with low diversification and low participation rates, to the stylized present, with greater diversification, more complete participation, and greater patience.

4.2.3 Increasing Diversification As a proxy for the increased diversification of a typical market participant over time, we vary the assumed volatility of the dividend process. It is an empirical fact that the variability of returns falls dramatically as diversification increases. Based on CRSP monthly data from 1962 to 1997, Table 7 shows the effect of diversification on a typical portfolio's annual standard deviation. In monthly data, we find an average individual stock standard deviation of 16% and an average pairwise covariance of 0.01. The portfolio standard devia-

Table 7 THE EFFECT OF DIVERSIFICATION ON PORTFOLIO VOLATILITY

No. of Stocks	*Standard Deviation (%)*	
	Monthly	*Annual*
1	16.0	55.4
2	11.7	40.4
3	9.8	33.9
4	8.7	30.2
5	8.0	27.7
10	6.3	21.9
20	5.3	18.3
100	4.3	14.9
500	4.1	14.1

tions reported in the table assume equal value weights on each stock. Monthly returns are annualized under the assumption that they are independent. These calculations show that holding a one-stock portfolio results in an annual standard deviation of 55%, while increasing holdings to five stocks decreases the standard deviation to 28%, and holding 500 stocks brings it down to 14%.

The above statistics on portfolio returns do not translate directly into parameter values, since the inputs into the model are income and dividend processes, whereas returns are endogenous. One assumption about dividends that produces returns consistent with those observed in CRSP data is that $d(t)$ is variable over time, taking on the values 0.11 and 0.25 with equal probability. This level of variation essentially brackets the variation in dividends' share in total income, based on the S&P 500 dividend flow and U.S. gross domestic product since 1947. We call this the case of *high dividend volatility.* It implies variation that is approximately consistent with a three-stock portfolio under the parametrizations we focus on.

Second, we consider a situation referred to as *correlated high dividend volatility.* Here the aggregate dividend is assumed to be correlated with nonmarketed income, taking on the value 0.11 in the low-nonmarketed-income state and 0.25 in the high-nonmarketed-income state. These first two cases bracket two views of the relation between dividend growth and income growth. The first is that there is very little correlation between income growth and dividend growth on an annual basis. The second is that over longer time periods, such as the 25-year periods considered here, there is a positive correlation between dividends and income.[12]

Finally, we represent the increased volatility in a poorly diversified portfolio by assuming a skewed distribution of dividends. The dividend share, δ, is fixed at 0.1865 for 95% of the time, but falls to 0.06 for 5% of the time, independent of the aggregate state. This *skewed dividend* case represents bankruptcy of a poorly diversified portfolio. It is further assumed that zero is an absorbing state for the value of a bankrupt portfolio after this small dividend is paid. To maintain stationarity, bankrupt shares are replaced by new shares in the new generation. These new shares are held in the portfolios of the young, but cannot be sold until the following period. The reason to consider a more skewed distribution of payoffs is twofold. First, although catastrophic outcomes are rare for the U.S. stock market as a whole, individual firms fail quite frequently. Secondly, the properties of the utility function suggest that skewed outcomes will have a much different effect on asset prices than a symmetric distribution with the same variance. In fact, the implied volatility of returns in this case is set to be similar to that in the case of high dividend volatility.

Table 8 is similar to Table 6, but reports results under the assumptions of high dividend volatility, correlated high dividend volatility, and skewed dividends. Panel A reproduces the predicted returns under the base-case set of assumptions for participation rates of 50% and 100%. Relative to panel A, assuming high dividend volatility (panel B) has the effect of decreasing the risk-free rate by 0.61% and 0.82% for participation levels of 100% and 50% respectively. It increases the equity premium by 0.71% and 0.97%, respectively, for the same participation rates. These results are consistent with the view that increased diversification has significantly reduced the required equity premium, although for these parameters it suggests only a slight decrease in the level of the required return on equities. For the case of correlated high dividend volatility (panel C), the effect on the equity premium of an increase in dividend volatility is even larger.

Notice that for high dividend volatility an increase in participation results in a larger decline in the equity premium than for low dividend volatility. This occurs in part because with high dividend volatility case there is more risk to be shared, and hence a greater benefit from spreading

12. As one would expect, predicted returns are sensitive to the assumed degree of correlation between dividends and nonmarketed income. It is not obvious, however, whether the dividends from a poorly diversified portfolio are likely to be more or less highly correlated with nonmarketed income than for a well-diversified portfolio. If, for instance, households own stock primarily in the companies for which they work (a common phenomenon), the correlation may be relatively high.

Table 8 AVERAGE RETURNS AS A FUNCTION OF PARTICIPATION AND THE DIVIDEND PROCESS

Percentage of Stockholders	*Returns (%)*		
	$E(r^b)$	$E(r^s)$	$E(r^s - r^b)$
A. Low Dividend Volatility			
100	4.42	5.47	1.05
50	4.33	5.52	1.19
B. High Dividend Volatility			
100	3.81	5.57	1.76
50	3.51	5.67	2.16
C. Correlated High Dividend Volatility			
100	3.38	5.87	2.49
50	3.36	5.95	2.59
D. Skewed Dividends			
100	1.54	6.17	4.63
50	0.47	6.93	6.46

this risk to new participants with no initial exposure to market risk. For correlated high dividend volatility, however, changes in participation have a smaller effect on the equity premium than for uncorrelated high dividend volatility. This is because the new entrants are less willing to bear stock-market risk when it is correlated with their nonmarketed risk.

Finally, the much more dramatic results in the skewed-dividend case are shown in panel D. The small risk of a catastrophic outcome reduces the risk-free rate to 0.47% and increases the equity premium to 6.46% with 50% participation. With 100% participation, the risk-free rate equals 1.54% and the equity premium is 4.63%. This assumption therefore allows one to match the historical equity premium. It also suggests that in this region of parameter space the premium is more sensitive to changes in participation rates. This points to changes in diversification as a potentially large factor in explaining changes in expected returns.

4.2.4 Preference-Parameter Changes The potential effects of changing risk attitudes are explored by changing the coefficient of relative risk aversion, α_j. Recall that in all the results reported above α_j is set to 5. If α_j is increased to 10, with all else as in the high-dividend-volatility case and at a 50% participation rate, the equity premium rises by only 0.16%. The risk-free rate falls by 0.3%. It is clear that over the range of risk-aversion coefficients usually considered, a change in risk aversion does not account for large changes in stock prices in this model.

As discussed in Section 3, increases in life expectancy may affect the subjective rate of discount. Varying β_j is a proxy for these changes. Unlike in an infinite-horizon model, where β generally does not have a first-order effect on the equity premium, varying β_j here influences the equity premium as well as the general level of returns. The reason is that when β_j increases, the value of future dividends and nonmarketable income increases relative to the value of first-period income. This changes the share of capital in wealth and increases the importance of second-period income risk. For the parameters we consider, this results in a lower equity premium in levels, but a higher premium relative to the risk-free rate. For instance, increasing β from 0.95^{25} to 0.96^{25}, with 50% participation, high dividend volatility, α equal to 5, and η equal to 0.2, moves the equity premium from 2.16% to 2.02%, and the risk-free rate from 3.51% to 3.05%. We interpret the increase in the relative premium as a response to the increased exposure to market risk. The reduction in the absolute premium reflects the increased precautionary demand for savings with the increase in risk, which lowers all required rates of return.

Varying η, the share of nonmarketed income accruing to the elderly, similarly affects risk and hence returns. For instance, increasing η from 0.2 to 0.3, with β_j equal to 0.95^{25} and all else as in the case above, moves the equity premium from 2.16% to 2.49% and the risk-free rate from 3.51% to 4.14%.

4.2.5 Heterogeneity in Idiosyncratic Income Shocks An interesting question is whether background income risk (i.e., nonmarketable risk) is different for stockholders and nonstockholders, and whether this difference interacts with the effect of participation changes on asset returns. In Heaton and Lucas (1998) we present evidence that many large stockholders depend more heavily on income from privately held businesses than on labor income. Business income is more volatile and more highly correlated with stock returns than is labor income. Hence, the equity premium is likely to fall more sharply if new entrants who are otherwise similar to stockholders depend predominantly on labor income. As discussed in Section 3.2, in recent years there has been an increase in participation by middle-income households, which are likely to contain wage earners. We investigate the potential quantitative effect of this change by assuming a different idiosyncratic income process for a subset of the stockholders and for nonstockholders.[13]

13. Ideally we would make participation endogenous and hence a function of the assumed income process, as in Polkovnichenko (1998). This tends reduce the risk-sharing capacity of new entrants, since the most risk-tolerant agents already hold stocks when entry

Table 9 AVERAGE RETURNS AS A FUNCTION OF PARTICIPATION AND THE DIVIDEND PROCESS (HETEROGENEOUS INCOME RISK)

Percentage of Stockholders	*Returns (%)*		
	$E(r^b)$	$E(r^s)$	$E(r^s - r^b)$
A. High Dividend Volatility			
100	3.74	5.49	1.75
50	3.42	5.58	2.16
B. Correlated High Dividend Volatility			
100	3.32	5.79	2.47
50	3.28	5.85	2.57
C. Skewed Dividends			
100	1.18	6.12	4.94
50	0.17	6.82	6.65

To implement this, we assume that a fixed number of participants have nonmarketed income that is correlated with the dividend flow from stocks. New entrants to the stock market and nonparticipants have a less correlated income process. More precisely, we assume that 25% of the population receive idiosyncratic income when old, with a standard deviation of 67.5% and a correlation with dividends' share in aggregate income of 0.2. this group is always assumed to hold stocks.[14] The rest of the population receives idiosyncratic shocks that have a standard deviation of 45% as before, and a correlation with dividends of −0.1. This negative correlation is necessary to produce an average correlation that is consistent with data. In annual data, one does in fact see a slight negative correlation between labor income and stock returns.

Table 9 reports results under these assumptions for high dividend volatility (panel A), correlated high dividend volatility (panel B), and skewed dividends (panel C). In each case, the experiment is to move from a situation in which 50% of the stockholding population is exposed to high background risk to one in which 25% has this exposure. Changes in participation now have only slightly more effect than in Table 8 for high dividend volatility. The effect of a change in participation is slightly smaller for skewed dividends. The effect of an increase in participation on the premium relative to the risk-free rate is higher in each case,

is endogenous. For simplicity, and to put an upper bound on this effect, we assume that participation is completely exogenous.

14. These parameter assumptions are consistent with the estimates reported by Heaton and Lucas (1998).

however, because of the greater volatility of the nonmarketed income of stockholders. As in Table 8, the greatest effect of participation is in the case of skewed dividends, where the equity premium falls by 1.71% when participation increases from 50% to 100%.

4.2.6 Simultaneous Changes As discussed in the introduction, each of the factors that we have looked at individually has been suggested as a fundamental reason for the stock price run-up. We have seen that none of these factors alone is sufficient to produce a large change in required equity returns, and hence the large run-up in stock prices. Here we examine the best case for the model, simultaneously changing a number of parameters. The stylized historical past is characterized by a β of 0.95^{25}, dividends as described in the skewed-dividend case, and a participation rate of 50%. Income processes are heterogeneous as described in the previous subsection, so that 50% of stockholders have highly volatile income that is correlated with dividends. The risk aversion α is fixed at 5, and η is fixed at 0.2. The stylized present is described by a β of 0.96^{25}, reflecting an upward revision of expected life expectancy, low-volatility dividends as in Table 6 reflecting a considerable increase in diversification, and a participation rate of 80%. All else is as in the past. This results in a risk-free rate that rises from 0.17% to 3.73%, and an expected return on stocks that decreases from 6.82% to 4.84%. The equity premium is substantially reduced, from 6.65% to 1.11%. We conclude, then, that assuming reasonable changes in a number of variables simultaneously can account for changes in expected returns in keeping with what appears to be the case in the U.S. economy.

5. Conclusions

In this paper, we have looked at a number of potential fundamentals-based explanations for the recent stock price run-up. In particular, we focused on whether changes in market participation patterns or changes in portfolio diversification are likely to account for a substantial fraction of the rise in stock prices. We conclude that the changes in participation that have occurred over this decade are unlikely to be a major part of the explanation. This conclusion is based both on the data, which suggest only small changes in participation for wealthy households, and the model, which implies that participation changes have to be quite extreme to substantially affect expected returns. Increased portfolio diversification, however, is likely to have had a larger effect. There is empirical evidence that households have significantly diversified their portfolios, selling individual stocks and buying mutual funds. An important difference between poorly diversified portfolios and a market index is the likelihood of catastrophic outcomes. When this difference is reflected in model parameters, the expected equity premium falls by more than 4%.

More generally, we can construct scenarios that are loosely consistent with the data in which the required return on stocks falls by 2%. As shown in Section 3.1 using a calibrated Gordon growth model, this amount of change in expected returns goes at least halfway towards justifying the current high level of the price–dividend ratio in the U.S. market. We interpret this as quite a positive result, especially because it is difficult to produce much variation in the predicted equity premium in this class of models. The model also predicts an increase in the real risk-free rate, which also appears to be consistent with the data.

These results depend in an important way on changes in diversification and, to a lesser extent, on income heterogeneity. There is evidence that entrepreneurs and managers tend to be large stockholders who bear a sizable amount of undiversifiable risk in the form of their own businesses. Still, we do not have a complete picture of the income and wealth characteristics of large stockholders, and we are uncertain about the extent of their diversification. We also do not have a satisfactory understanding of how older stockholders, who own a substantial fraction of the market, view the risk of stock ownership. Looking even more closely at the characteristics of large stockholders remains a useful direction for future research.

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Comment

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1. *Introduction*

During the period 1995–1998 the U.S. stock market experienced four consecutive years with real stock returns above 20%. Suppose as a rough approximation that annual real log gross stock returns are normally distributed and independent over time. With a mean and variance of this distribution equal to the historical values for the period 1871–1994, the probability of observing four years of above 20% returns is 0.4%.[1] The high returns have come primarily from capital gains driving price–dividend and price–earnings ratios to historical highs (the latest numbers from August 9 for the S&P 500 are P/D = 78.5 and P/E = 31.9). Thus, even taking into account statistical fluctuation, it is becoming increasingly unlikely that nothing has changed. The only period since 1871 with as impressive returns was 1924–1928, with five years of above 20% real stock returns. Over the three-year period following that event, real stock returns averaged −15.4% annually.

In the present paper Heaton and Lucas ask whether the recent stock-market boom can be explained by changes in economic fundamentals. Three candidates are considered: changes in corporate earnings growth, changes in consumer preferences, and changes in stock-market participation patterns. Participation is defined broadly as concerning both the level of stock-market participation and the amount of diversification among participants. Poor diversification is found to have large effects on equilibrium returns in an overlapping generations exchange economy. The main conclusion of the paper is that increased diversification by itself can explain at least half of the increase in the adjusted P/D ratio. This is an interesting finding, not only for interpreting the recent past but also seen in the context of the literature on the equity premium

1. Using the data from Robert Shiller's home page, the 1871–1994 mean and standard deviation of $\log(1 + r^{\text{stock,real}})$ are 0.067 and 0.17.

puzzle. Increased participation is found to have only small effects. For readers who attended the presentation of the paper at the NBER Macroeconomics Annual conference, I should mention that the part of the paper which concerns diversification is new and thus was not discussed at that time.

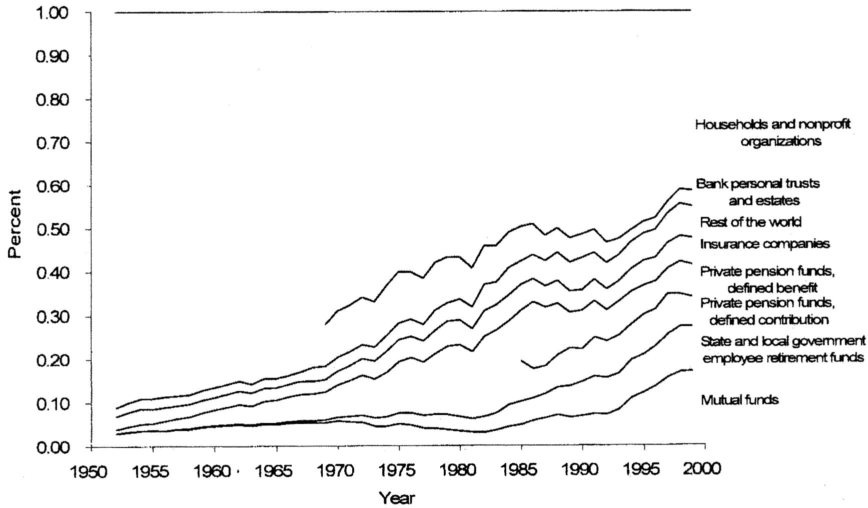
My discussion focuses first in Section 2 on whether the increase in diversification is sufficiently recent and sufficiently large for this to be considered the main reason for the recent stock-market boom. In Section 3 I turn to the overlapping-generations model to address whether the theoretical results regarding large effects of diversification and smaller effects of participation are likely to be robust. Section 4 comments on the authors' calibration of the Gordon growth model and contains current and historical data for analyst earnings forecasts to determine if high earnings growth expectations rather than lower required stock returns could be driving the stock-market boom. Section 5 concludes.

2. *Is the Increase in Diversification Large and Recent Enough?*

In the overlapping-generations model calibrated by Heaton and Lucas a shift from a three-stock portfolio to full diversification generates a decline in the mean real stock return of 1.41 percentage points for participation fixed at 50% (compare cases D and A in Table 8). This is in fact more than needed to explain current valuation ratios according to my calculations in Section 4 below. Should we conclude from this that increased diversification is the main reason behind the stock-market boom? From an empirical perspective it would need to be established that diversification has in fact increased from something close to the level of a three-stock portfolio to close to full diversification and that the timing of the increase coincides to a reasonable extent with the stock-market boom. The evidence presented below shows that the trend in diversification started long before the recent stock-market boom. Thus if diversification is as important as suggested, valuation ratios should have reached historical highs long before the 1990s. P/D and P/E ratios have trended upward since the early 1980s, but much of this was a return to normal levels from very low values in the beginning of the 1980s.[2]

2. In Vissing-Jørgensen (1998) I documented the upward trend in stock-market participation from around 6% of households in the beginning of the 1950s to around 41% in 1995. It is too early to say whether the trend in participation has strengthened significantly since then. It will be interesting to see the latest numbers when the 1998 Survey of Consumer Finances becomes available. However, the increase in participation since 1995 would have to be dramatic, since the effect of increased participation is likely to be

Figure 1 STOCK OWNERSHIP SHARES, 1952–1999, FLOW OF FUNDS ACCOUNTS



The values shown are for the end of the first quarter of the year, except for the last data point for the split of private pension plans between defined contribution and defined benefits, which is for the end of 1998. The data are not seasonally adjusted. Mutual funds include closed-end funds. The category "bank personal trusts and estates" was added in 1969. Before this it was lumped together with direct ownership by households and nonprofit organizations. Four small categories summing to less than 1.5% of the total for all years are left out of the graph for simplicity, but are included in the numbers given in the text. These are state and local governments, commercial banking, savings institutions, and security brokers and dealers. The measure of equity in the Flow of Funds Accounts is the total U.S. stock-market capitalization including closely held companies.

Figure 1 updates Table 5 of Poterba and Samwick (1995), which shows the proportions of the stock market owned through various channels. The source of the data is the Flow of Funds Accounts. Consistent with Heaton and Lucas's Table 4, the share of stocks held through mutual funds has increased over the period since 1995. However, direct stock ownership has declined steadily throughout the period. The corresponding increases are mainly in the shares for pensions and for mutual funds. Stockholding by private and governmental pension plans increased from a negligible share in the beginning of the 1950s to a maximum of 27.0% in 1986:1. It has been fairly stable since then. The upward trend in stockholding through mutual funds started around 1982 after a slight decrease in the 1970s. The increase was 8.9 percentage points from 1982:1 to 1995:1 and 4.9 percentage points from 1995:1 to 1999:1. The mutual fund share for 1999:1 was 16.5%.

nonlinear, with a bigger effect of a given increase in participation at initially low participation levels. It seems more plausible that changes in participation have contributed to a gradual trend in returns than that they are responsible for the recent boom.

Up to the beginning of the 1980s the growth in stockholding through pension plans represented purchases by defined-benefit pension plans. It is likely that stock purchases by governmental defined-benefit plans represent a significant increase in risk sharing. The bearers of the investment risk in this case are the taxpayers. Thus stockholding by these pension plans spreads risk over a broad group of households and thus increases risk sharing.

Since defined-benefit plans are managed by investment professionals, one would expect them to be well diversified. It is however not clear that increased stock ownership by private defined-benefit plans has increased the diversification level of the typical stockholder to a significant extent. Consider a world with workers and capitalists where stocks are in unit net supply, and bonds are in zero net supply. Initially workers save for retirement out of wages. Workers do not like risk and save in the form of bonds issued by capitalists (directly or indirectly through company debt). Capitalists bear all output risk. A defined-benefit plan is then introduced. Workers must accept a reduction in wages in exchange for the pension benefits. The shareholders of each company take this part of wages and invest it in other companies. They pay workers a riskless stream when retired. Thus capitalists still end up bearing all the risk. Workers get riskless retirement benefits in either case. In the situation with a pension plan each shareholder is more diversified: He still only owns a small number of stocks directly, but now there is cross ownership of stocks by companies via the pension plans. Buying one share of a given company now gives you the right to a payment stream representing partly this company's earnings and partly other companies' earnings. However, with cross holding at most equal to the share of private benefit plans in total stock-market capitalization, this effect is small.

Since the introduction of individual retirement accounts (IRAs) in 1981 and 401(k) plans in 1978, there has been a shift from defined-benefit to defined-contribution plans. In these, individual beneficiaries fully or partially decide how to invest their assets. The increased share for 401(k)s and similar plans represents a significant increase in diversification, since these plans typically offer choices of stock portfolios rather than allowing employees to pick individual stocks.[3]

Overall, while the effects are hard to quantify, increased stock ownership by pension plans most likely contributed to increased diversification and risk sharing long before the recent stock-market boom.

The share of stocks held directly remains large. Thus it is important to

3. Since 1993, 401(k) providers have been required by law to include a broad range of equity funds in the investment choices. Large holdings of own-company stock remain an issue for diversification of 401(k) stockholdings.

consider whether diversification has increased significantly for stockholders who hold all or most of their stocks directly. Table 1 gives various measures of diversification based on data from the Survey of Consumer Finances (SCF) for 1983, 1989, and 1995. The numbers for 1971 are from Blume and Friend (1978, Chart 2–5) and are based on a sample of 17,056 federal income tax forms. There is a clear trend towards increased diversification of directly held stocks. The share of directly held equity which is held by households with less than 10 stocks has decreased from 56.5% in 1971 to 37.9% in 1995. For 1989 and 1995 the SCF contains information about how much equity is held in indirect form (mutual funds, pension plans, trusts, and managed investment accounts). If we assume that all such stockholdings are well diversified and that households with 20 or more directly held stocks are well diversified, then 73.8% of household-owned equity is owned by well-diversified investors, up from 60.8% in 1989.

Counting the number of directly held stocks overstates the level of diversification if portfolios are unbalanced. Blume, Crockett, and Friend (1974) found this to be important. Even for high-income households with on average 18.7 different stocks, the level of diversification only corresponded to an equal-weighted portfolio of about two stocks. The SCF contains information about holdings of stock in the company where household members work or have worked (I refer to these as *own-company stock*). The bottom part of Table 1 shows that own-company stockholding is likely to be a main cause of poor diversification. Households with positive holdings of own-company stock owned 40.2% of directly held equity in 1995. Of their direct stockholdings the mean percentage held in own-company stock was 47.8%. Even if one allows for indirect stockholding of these households, they still on average hold 30.8% of their equity portfolio in their own company [this number does not include own-company stockholdings via 401(k) or similar plans]. This suggests that a substantial share of the stock market remains owned by poorly diversified households. It furthermore emphasizes that understanding why so many households hold substantial amounts of wealth in own-company stock is crucial for understanding the effects of poor diversification. Are the results driven by rich households holding large shares of companies they founded? Is delaying payment of capital gains taxes a key reason they do not sell part of these stocks and invest in a more diversified portfolio? Do rich households choose to hold large shares of few companies to have influence on company decisions? Or are people simply overly optimistic about their own company, in which case poor diversification would not warrant higher returns? A better understanding of these issues is crucial for determining the general equilibrium effects on asset returns caused by poor diversification.

Table 1 TRENDS IN DIVERSIFICATION OF DIRECTLY HELD EQUITY[a]

	Number of stocks	1971	1983	1989	1995
1. Percentage of equity held directly		—	—	59.5	41.4
2. Percentage of equity held in mutual funds		—	—	9.3	20.2
3. Percentage of directly held equity owned by households	3	18.3	18.0	15.9	15.2
with less than this number of stocks	5	—	26.1	24.4	22.8
	10	56.5	48.9	44.3	37.9
	15	—	60.9	55.3	51.7
	20	74.9	71.9	65.4	64.9
4. Percentage of equity held by households with half or	3	—	—	91.4	94.1
more of their equity holdings in indirect form or at	5	—	—	86.0	91.3
least this number of stocks	10	—	—	74.0	85.0
	15	—	—	66.8	79.6
	20	—	—	60.8	73.8
5. Own-company stock as percentage of directly held equity		—	23.4	17.1	19.2
6. Own-company stock as percentage of directly and indirectly held equity		—	—	10.2	7.9
Households with positive holdings of own-company stock:					
7. Percentage of directly held equity owned by these households		—	36.0	31.0	40.2
8. Percentage of directly and indirectly held equity owned by these households		—	—	23.1	25.7
9. Mean percentage of own-company stock in direct equity portfolio for these households		—	65.0	55.3	47.8
10. Mean percentage of own-company stock in direct and indirect equity portfolio for these households		—	—	44.1	30.8

Note: For the numbers based on the Survey of Consumer Finances (SCF) observations are weighted using SCF weights. For 1989 and 1995 the numbers shown are averages of the numbers obtained for each of the five SCF imputations. For 1983 the edited and imputed SCF data file is used. "Indirect stockholding" refers to stockholding in mutual funds (half of holdings in combined mutual funds are assumed to be equity), in IRAs, in thrift-type plans as defined in the SCF net-worth program, and in trusts, annuities, and managed investment accounts. In line 9 values are weighted by size of direct stockholdings; in line 10 values are weighted by size of direct and indirect stockholdings.

[a]Tax return sample 1971, Survey of Consumer Finances 1983, 1989, 1995.

In sum, the empirical evidence raises two concerns for the theory that the recent stock-market boom is due to increased diversification: firstly, that the trend in diversification started much earlier than 1995; secondly, that although diversification has improved, the share of equity owned through mutual funds is still only 16.5% and a substantial share of the stock market remains owned by poorly diversified households. It would be interesting to see how large effects on returns Heaton and Lucas's model generate for changes in diversification more in line with this.

3. *Robustness of Theoretical Results from the OLG Model*

I was surprised by the way the authors calibrate the poor-diversification cases (cases B–D). They first use firm-level return data to determine the effects of holding a larger number of stocks on the standard deviation of a portfolio (Table 7). The amount of idiosyncratic dividend risk (and for case D bankruptcy risk) is then chosen such that the model generates a stock return volatility equal to that observed for a typical three-stock portfolio. For this amount of volatility the expected stock return and the equity premium are much higher than in the full-diversification case (case A). But how do we know whether this is a reasonable amount of idiosyncratic dividend and bankruptcy risk? This could be checked against the firm-level data. In fact, a more standard approach would be to first use the firm-level data to determine the dividend risk and the bankruptcy probability for a typical firm, then assume that a portfolio of three such stocks was bought, and determine if the model generates a stock return (a return to such a portfolio) which is much higher than the one for full diversification.

It should also be emphasized that the assumption of risk aversion equal to 5 may be crucial for the large effects of diversification on the mean stock return. If risk aversion were set to 1, there would most likely be little or no effect on the mean stock return of either diversification or participation. To see this, consider the following special case of the model for which a simple closed-form solution for the stock price is available. Suppose there is no idiosyncratic labor income risk and no labor income when old. With risk aversion set to one (and thus equal to the assumed elasticity of intertemporal substitution), Epstein–Zin preferences specialize to CRRA preferences. Then each young agent consumes the constant fraction $a = \beta/(1 + \beta)$ of wages, independent of asset returns. Let λ denote the proportion who are stockholders, ω_t their portfolio share for stocks at time t, and P_{st} the stock price at t. The equilibrium conditions for the stock and the bond market at t are then as follows.

$$\text{Stocks:} \quad \lambda\omega_t(1 - a)(1 - d_t)Y_t = P_{st}, \tag{1}$$
$$\text{Bonds:} \quad \lambda(1 - \omega_t)(1 - a)(1 - d_t)Y_t + (1 - \lambda)(1 - a)(1 - d_t)Y_t = 0. \tag{2}$$

Equation (2) implies $\lambda\omega_t = 1$. Inserting this in (1) gives $P_{st} = (1 - a)(1 - d_t)Y_t$. Thus in this special case the stock price is unaffected by the level of stock-market participation. Furthermore, the stock price is affected by diversification only because this is modeled by a stochastic aggregate dividend share (causing the wage share to be stochastic) rather than using several different stocks. In other words, for this special case increased participation [diversification] affects the equity premium only [mainly] via the bond rate, with no [little] effect on stock price and the stock return. Given this, I would expect much smaller effects of diversification on the mean stock return if risk aversion were set equal to 2 or 3 rather than 5 (in the end the right number may turn out to be 5 or higher, but given that we do not have precise knowledge about this parameter, sensitivity analysis is relevant).

The underlying reason that the stock price is unaffected by participation or diversification in the log utility case is that the model is an exchange economy. With log utility the propensity to save is the same for all households. The bond market therefore requires that stockholders in equilibrium be willing to lend to the nonstockholders as much as stockholders wish to save. This implies $\lambda\omega_t = 1$ and thus, along with a constant, leaves the stock price to be determined by the wage income of the young. In an exchange economy wages are exogenous to both participation and diversification. This suggests that an alternative way of generating a higher stock price upon entry or diversification, even in the log utility case, is to change the model to one in which the resources of the young can be affected by increased participation or diversification. In Vissing-Jørgensen (1998) I analyze an OLG model with production to study the general equilibrium effects of limited participation. In that model (for the log utility case) the riskless rate is unaffected by participation, and the full effect on the equity premium is due to a lower mean stock return. Wages, the capital stock, and the stock price are higher for higher levels of participation. I recalibrated the model to have similar amounts of output risk to Heaton and Lucas's low-dividend-volatility case. Increasing participation from 10% to 60% then decreases the mean stock return by around 0.5 percentage point.[4]

4. The model is fairly standard. The results are not sensitive to whether the production function is assumed to exhibit constant or decreasing returns to scale. One assumption which is central for the results is that in each period, factor input levels and wages are set before the realization of uncertainty. Factors are paid after output is realized. Thus the labor share of output is countercyclical, since workers do not take any of the output risk. Countercyclical labor shares are well documented in the business-cycle literature.

4. *The Gordon Growth Model*

Although I agree that a decrease in the required return is needed to explain recent valuation ratios, the authors' calculation based on the Gordon growth model to some extent overstates the necessary change.

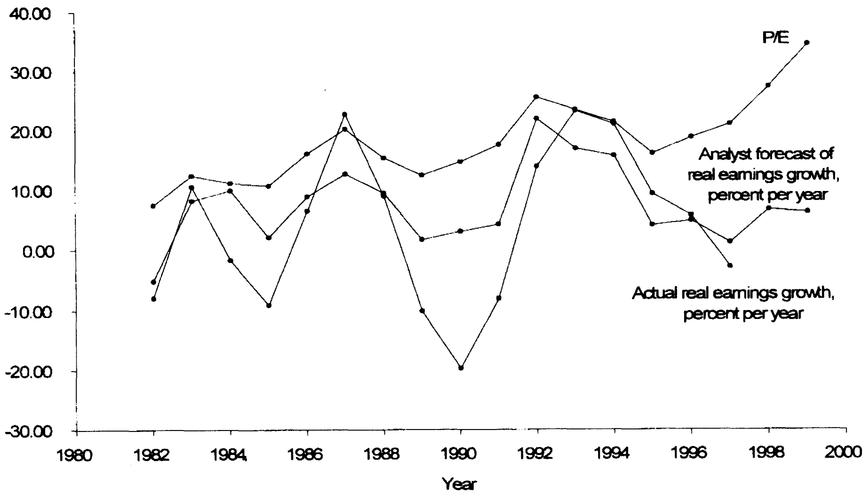
The required stock return in the formula $P/E = 1/(r - g)$ is net of transaction costs, and these have declined significantly. While it is hard to evaluate costs of direct investment, Bogle (1991) finds that equity mutual funds underperformed the S&P 500 by an average of 2.1 percentage points over the period 1969–1989. Rea and Reid (1998) find that the sales-weighted average of total shareholder costs for equity mutual funds has decreased from 2.25% in 1980 to 1.49% in 1997. Indeed, declining transaction costs both for direct investment and for investment via mutual funds are likely to have been a key factor behind the increases in diversification and participation (the issue of lower transaction costs does not arise in the overlapping-generations model, since diversification or participation is changed exogenously). Assuming a 0.75-percentage-point decline in transaction costs, the change in $r - g$ needed to imply a movement in the adjusted P/D ratio from 28 historically to 48 at the end of the authors' sample is not $\frac{1}{28} - \frac{1}{48} = 0.015$ but 0.0075, or 0.75 percentage points. It is worth pointing out in this context that without transaction costs it is very difficult to reconcile the Gordon growth model with the historical-mean-adjusted P/D ratio. With a historical value of g around 2% the model implies a historical required real stock return of $\frac{1}{28} + 0.02 = 0.056$. The actual real stock return was much higher at 8.5% (arithmetic average) for 1871–1994, and 9.1% if we include the recent period up to 1998.

The authors' calibration of the Gordon growth model furthermore assumes that the riskless rate has increased by 2 percentage points. Therefore an increase in g of 3.5 percentage points (or a g of 13.4% for 10 years and 2% thereafter) is required to explain an adjusted P/D of 48 with a constant equity premium. The most relevant interest rate in this context is the real interest rate on long-term bonds. These rates are currently high (around 4% for long-term inflation-indexed U.S. Treasury bonds), but it may be premature to conclude that they are as much as 2 percentage points higher than their historical mean. Blanchard (1993) and the discussion of it by Siegel show that fluctuations in long-term real bond rates have historically been quite dramatic.

As for the dividend growth g, it has in fact been higher than its historical average lately. The geometric and arithmetic averages were 1.5% and 2.4%, respectively, for 1871–1994, but 3.9% and 4.0%, respectively, for 1995–1998.[5] An alternative to considering the recent past is to look at

5. The Gordon growth model assumes that g is nonstochastic and thus does not recommend whether to use geometric or arithmetic means. The numbers for real earnings

Figure 2 I/B/E/S TWO-YEAR-AHEAD EARNINGS GROWTH FORECASTS, 1982–1999



forecasts from market participants. It is well known that analyst earnings forecasts tend to be upward biased. Therefore it is useful to consider earnings forecasts for which historical data are available and focus on whether forecasts are higher than usual. Figure 2 shows I/B/E/S forecasts for two-year-ahead S&P 500 earnings growth for 1982–1999 as well as the subsequent realization and the P/E ratio at the time of the forecast. Forecasts for long-run growth were only available for a smaller number of analysts. The forecasts shown are *top-down* forecasts. This means that the analysts were asked for a single forecast for the index rather than forecasts for each of the companies which make up the index. The latest *bottom-up* forecasts for S&P 500 earnings growth are much higher than the top-down forecasts, but I do not have a time series to determine if they are higher than their previous values. The average number of analysts reporting per year is 10. The minimum number is 4. The forecasts plotted are the means across analysts. For each year the values are for the first month after the previous annual earnings realization is known, usually March. Thus the forecast value for 1999 shows the expected percentage increase in year 2000 earnings over 1998 earnings, right after 1998 earnings became known. The 1999 forecasts are from March. The analysts provide nominal earnings forecasts but no inflation forecasts. To convert the forecasts to real terms, I used the annual inflation rate over the previous five-year period.

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growth are as follows. Geometric means: 1.9% for 1871–1994, 4.0% for 1995–1998. Arithmetic means: 5.0% for 1871–1994, 4.1% for 1995–1998.

Several points are worth noticing. First, analyst earnings growth forecasts are quite good. The R^2 from a regression of the realized earnings growth rates on the forecasts is 0.59 for the real-earnings growth rates and 0.52 for the nominal-earnings growth rates. Second, until 1995 the correlation between the P/E ratio and the two-year-ahead real-earnings growth forecast is surprisingly high, 0.87. But third, this correlation breaks down after 1995. Earnings growth forecasts have stayed essentially constant while the P/E ratio has increased sharply. Thus, if the expectations of the analysts asked by I/B/E/Sare representative of current market expectations, it looks like the stock market boom since 1995 either is driven by a sudden decrease in required returns or is a bubble.

In sum, the required change in $r - g$ to explain an increase in the adjusted P/D from 28 historically to 48 recently is around 0.75 percentage points. Dividend growth and (geometric) earnings growth has been higher since 1995 and thus might warrant an increase in the expected dividend growth rate. However, at least according to one source, market participants have not increased their dividend growth expectations. If, therefore, a change in the required real stock return is left as the sole factor explaining the increase in valuation ratios, the necessary change is around 0.75 percentage points. For given long-term real bond rates the necessary change in the equity premium is of the same size. If we believe long-term real bond rates will be higher in the future, the required decrease in the equity premium is correspondingly larger.[6]

5. *Conclusion*

Heaton and Lucas address an important but difficult question: What caused the recent stock-market boom? They focus on changes in stock-market participation and diversification. Having worked on limited stock-market participation, I found the analysis of the related issue of diversification very interesting. The references given by the authors and the numbers in Table 1 above indicate that poor diversification is in fact a pervasive phenomenon which should be considered seriously in general equilibrium asset pricing models. Understanding why many households concentrate large amounts of wealth in own-company stock seems crucial in this respect.

More work is needed to determine exactly how large the effects on

6. The latest P/D ratio of 78.5 is higher than the value 48 used by Heaton and Lucas, suggesting that larger changes in $r - g$ are needed. This depends on how the P/D ratio is adjusted. Campbell and Shiller (1998) refer to studies suggesting adjustments to D/P of 80 basis points for 1996 and 1997. This would make the latest adjusted P/D equal to 48.2, close to the value 48 used in Heaton and Lucas's calibration.

equilibrium returns of poor diversification are. In the calibration of the OLG model in the present paper, a concern is whether the amount of idiosyncratic dividend and bankruptcy risk is consistent with the data. More analysis regarding sensitivity of the results to changes in risk aversion and the extent of poor diversification would also be useful. From an empirical perspective any explanation of the current boom which relies on changes in either participation or diversification will have difficulties with timing. The upward trend in both participation and diversification started long before the current boom, suggesting that valuation ratios should have reached historical highs much earlier. However, valuation ratios have historically fluctuated substantially, making it difficult to discern gradual trends. Aside from patiently awaiting more data for the United States, it would be interesting to consider evidence from other countries.

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Comment

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1. *Introduction*

The dramatic bull market of the late 1990s has challenged economists to explain why stock prices are so high relative to historical valuation levels. John Heaton and Deborah Lucas begin their interesting paper by reviewing some facts and then using theory to interpret them; I shall organize my discussion in a similar fashion.

2. *How High Is the Stock Market?*

Popular commentary often uses the Dow Jones Industrial Average index (around 11,000 as I write) or the Standard and Poor 500 index (around 1,300) to track the level of stock prices. Of course, index levels can increase because of general price inflation, or growth in the real economy, or changes in the size of the publicly traded corporate sector relative to the economy, or changes in the size of index-included firms relative to other publicly traded firms. Intelligent analysis of stock index levels must begin by scaling them in some way.

Recognizing this point, Heaton and Lucas discuss price–dividend and price–earnings ratios for the S&P 500 index. Both ratios are high relative to historic norms, but the price–dividend ratio is far more extreme; it is almost two-thirds higher than its previous peak in the early 1970s, whereas the price–earnings ratio is close to levels reached earlier in this decade and in several previous decades.

Heaton and Lucas focus on the price–earnings ratio (scaled by the historical average payout ratio of dividends to earnings) rather than the price–dividend ratio. They claim that "earnings are likely to be a more stable proxy for long-run payments to shareholders" (Section 3.1) and that "in the short run dividends can vary due to temporary changes in payout policy (for instance, in response to changes in the tax law). Therefore, it is common to focus on the price–earnings ratio, adjusted for reinvestment rates, to approximate long-run price–dividend ratios" (footnote 5).

It is certainly true that changes in corporate financial policy can affect the price–dividend ratio. Most notably, a shift from paying dividends to repurchasing shares can permanently increase the price–dividend ratio. The Gordon growth model, discussed in the paper, says that the price–dividend ratio is the reciprocal of the difference between the discount rate and the growth rate of dividends per share. A share repurchase program causes the number of outstanding shares to shrink over time; this increases the growth rate of dividends per share and increases the price–dividend ratio. Share repurchases account for some of the increase in the price–dividend ratio over the last decade, although direct estimates of the effect are fairly modest. Cole, Helwege, and Laster (1996), for example, suggest that net repurchases have increased the growth rate of dividends per share by about 0.8%. Their calculation assumes that shares are issued and repurchased at the market price; to the extent that shares are issued at below-market prices as part of executive compensation, then the true repurchase effect is smaller.

Despite these difficulties with the price–dividend ratios, I do not agree that the price–earnings ratio is a superior measure of stock-market valuation. The problem is that earnings are subject to short-term noise arising from the business cycle. One can see the importance of this by inspecting Figure 1 in the paper. Previous peaks of the price–earnings ratio, close to levels today, were reached in the early 1990s, the mid-1930s, the early 1920s, and the 1890s. None of these were peaks in stock prices; instead, they were recession years when corporate earnings temporarily declined.

The issue of noise in current earnings has been recognized at least since the work of Graham and Dodd (1934), who in their famous textbook *Security Analysis* recommended that analysts should use an average of earnings over "not less than five years, preferably seven or ten years" (p. 452). Campbell and Shiller (1998) follow Graham and Dodd's advice and smooth earnings over ten years. They find that the ratio of price to smoothed earnings behaves more like the price–dividend ratio than like the conventional price–earnings ratio. It is currently far above its previous peak reached in 1929.

Heaton and Lucas use the Gordon growth model, adjusting the current price–earnings ratio for the long-run average payout ratio of dividends to earnings, to characterize combinations of earnings growth rates and discount rates that could rationalize the current level of stock prices. They conclude that real earnings growth of 2.4% (1% above the historical average) and a real discount rate of 6.6% (4.1% below the historical average) could do the job. In the rest of the paper, they use alternative theoretical models to try to hit this target.

The problem with this analysis is that the cyclical noise in earnings should lead earnings growth forecasts to be adjusted downwards at cyclical peaks when earnings are temporarily high, and upwards at cyclical troughs when earnings are temporarily low. Rapid earnings growth from a starting point in 1999, after many years of robust economic growth, is less likely than Heaton and Lucas admit.[1] Heaton and Lucas could correct for this problem by using the price–smoothed-earnings ratio instead of the conventional price–earnings ratio.

1. One factor that can produce higher long-run earnings growth is a reduction in the payout ratio. As Heaton and Lucas point out, the earnings growth rate should be the fraction of earnings that is retained (one minus the payout ratio) times the return on equity. If the payout ratio falls, earnings growth should be expected to increase. Unfortunately this effect also increases Heaton and Lucas's adjusted price–earnings ratio, so it does not make it easier to account for the level of stock prices.

Even though rapid earnings growth following a period of strong economic performance would be historically unusual, some commentators do appear to believe that it will occur. Interesting evidence on this point is provided by Steven Sharpe (1999). Sharpe studies the consensus forecasts of stock analysts, and finds that since 1994 forecasts of two-year nominal earnings growth have been high and stable (between 10% and 15%), even though realized two-year earnings growth has been declining. He also finds that forecasts of long-term (five-year) nominal earnings growth have increased from 10.5% in 1989 to over 13% in 1998. Over the same period forecasts of long-term (ten-year) inflation have decreased from 4.5% to 2.5%, implying a remarkable increase of 4.5 percentage points in the expected long-run growth rate of real earnings.

Of course, analysts' earnings forecasts are hard to interpret. It may be that they reflect a rational assessment of the prospects for a "new era" of corporate profitability in the twenty-first century. It may be, as Sharpe suggests, that analysts have failed to adjust their nominal earnings forecasts for the effects of declining inflation and thus are subject to a form of money illusion first proposed by Modigliani and Cohn (1979). Finally, a cynic might say that Wall Street analysts do not have incentives to produce the most accurate earnings forecasts, but rather to produce forecasts that justify the current level of stock prices.

3. *Modeling Declining Discount Rates*

While reasonable people can disagree about the prospects for future earnings growth, it is almost impossible to rationalize the current level of stock prices without some decline in the discount rate applied to investors to future earnings. Heaton and Lucas devote most of their paper to an exploration of alternative mechanisms that could produce such a decline. They rightly concentrate on effects that could reduce the equity premium (the expected excess return on equities over short-term debt), since real interest rates have not historically moved closely with the stock market.

Heaton and Lucas first consider an increase in the stock-market participation rate. Intuitively, if aggregate equity risk is now shared more broadly, then the amount of risk borne by any single investor has declined, justifying a decline in the equity premium. In thinking about this effect, it is important to keep in mind that investors should be weighted by their wealth. The right measure of the participation rate is not the fraction of individuals who invest in stocks, but the fraction of wealth controlled by individuals who invest in stocks. As Heaton and Lucas admit, wealthy individuals have always tended to participate in the stock market, so there is little evidence for a dramatic increase in the wealth-weighted participation rate.

Heaton and Lucas take the participation rate as exogenous, determined by unmodeled forces such as transaction and information-processing costs. They build a fairly realistic, but correspondingly complicated, model to explore the effects of the participation rate on the equity premium. Unfortunately they find it very hard to generate a large equity premium when the participation rate is above 30% or so. The reason for this is hard to see in their model, but Gollier (1999) suggests a simpler framework that can be used to gain insight.

Gollier assumes a static atemporal market in which a claim to random output $\tilde{y}$ is traded for a riskless claim. The price of the output claim is P. Agents have utility u over final wealth and choose the portfolio share of the output claim, α, to maximize

$$V(\alpha) = \mathrm{E}[u(P + \alpha(\tilde{y} - P))]. \tag{1}$$

The first-order condition is

$$\mathrm{E}[(\tilde{y} - P)u'(P + \alpha(\tilde{y} - P))] = 0. \tag{2}$$

Equilibrium requires that the total supply of the output claim (normalized to one) be held. When all agents participate in the financial market, this requires $\alpha = 1$, or

$$\mathrm{E}[(\tilde{y} - P)u'(\tilde{y})] = 0. \tag{3}$$

If only a fraction k of wealth is controlled by agents who can hold equity, however, then for these agents equilibrium requires $\alpha = 1/k$, so we get

$$\mathrm{E}\left[(\tilde{y} - P)u'\left(\frac{\tilde{y}}{k} + \left(\frac{k-1}{k}\right)P\right)\right] = 0. \tag{4}$$

Gollier calibrates these equations to data on real per capita output in the United States over the period 1963–1992. Consistent with the results of Heaton and Lucas, he finds little effect of the participation rate k on the expected return of the output claim for RRA = 2 and $k > 0.3$.

To understand the source of this result, I now take a second-order Taylor approximation of marginal utility around the mean of output, $\bar{y}$:

$$u'(\tilde{y}) \approx u'(\bar{y}) + u''(\bar{y})(\tilde{y} - \bar{y}) + \tfrac{1}{2}u'''(\bar{y})(\tilde{y} - \bar{y})^2. \tag{5}$$

Substituting into (3), assuming that $\tilde{y}$ has a symmetric distribution, and assuming constant relative risk aversion γ, I find that with full equity participation ($k = 1$), the expected return on equity is

$$\frac{\bar{y}}{P} - 1 = \frac{1}{1 - \gamma\sigma^2[1 + \gamma(\gamma + 1)\sigma^2/2]} - 1 \approx \gamma\sigma^2, \qquad (6)$$

where $\sigma^2 \equiv \mathrm{Var}(\tilde{y})\bar{y}^2$ is the proportional volatility of output, and the second approximation is accurate for small σ^2. This can be understood by recalling the well-known rule of thumb that the optimal portfolio share in a risky asset is the expected excess risky return, divided by relative risk aversion times the variance of the excess risky return.[2] To achieve an optimal portfolio share of one, the expected excess risky return must equal relative risk aversion times the variance.

Similar analysis of the case with limited participation ($k < 1$) shows that in general,

$$\frac{\bar{y}}{P} - 1 \approx \frac{\gamma\sigma^2}{k}. \qquad (7)$$

Limited participation by investors who control a fraction k of wealth is equivalent to scaling up the variance of dividends by a factor $1/k$. Once again, this can be understood by using the rule of thumb for optimal risky investment. To achieve an optimal risky portfolio share of $1/k$, the expected excess risky return must be $1/k$ times larger than it would be if the optimal risky portfolio share were only one.

Equation (7) has two important implications. First, a change in equity participation has a larger effect on the equity premium if the participation rate is initially low than if it is already high. A doubling of participation from 5% to 10% cuts the equity premium in half in just the same way as a doubling from 50% to 100%; and the absolute change in the equity premium is much larger in the former case. This explains why both Gollier, and Heaton and Lucas in their more elaborate model, find little participation effect for k larger than about $\frac{1}{3}$. Second, limited equity participation has a larger effect on the equity premium if relative risk aversion and dividend volatility are high than if they are low. Limited participation can amplify a high equity premium caused by high dividend volatility or high risk aversion, but an unrealistically small k is

2. This rule of thumb is exact in a continuous-time model in which the risky asset's price follows a geometric Brownian motion (Merton, 1969). Friend and Blume (1975) used this approach to estimate risk aversion.

required to produce a high equity premium in the absence of these conditions.[3]

Given their finding that increases in participation from medium to high levels have little effect on the equity premium, Heaton and Lucas emphasize an alternative story. They argue that the typical investor used to hold a poorly diversified portfolio containing only a few stocks. With the growth of mutual funds and especially index funds over the last few decades, however, the typical investor is now better diversified. Diversification makes equities a more appealing investment by reducing the risk associated with any given average return. Heaton and Lucas show that a simultaneous increase in participation and reduction in equity risk can account for a large decrease in the equity premium. In terms of equation (7), Heaton and Lucas simultaneously reduce σ^2 (by a factor of 4) and increase k (by a factor of 2) to get a much more powerful effect on the equity premium than can be achieved by a change in k alone.

Heaton and Lucas also argue that an undiversified portfolio is likely to have a negatively skewed return because any single firm can go bankrupt. They find that negative skewness further increases the equity premium. To understand this effect within the simple framework presented above, one can drop the assumption that $\tilde{y}$ has a symmetric distribution. This adds a term $-\gamma(\gamma + 1)\mathrm{SK}/2k^2$, where SK is the proportional skewness of $\tilde{y}$, to the equity premium in equation (7). Negative skewness increases the equity premium, and this effect is more powerful when stock-market participation is limited.

Although many investors are undoubtedly better diversified today, I doubt that this is the cause of a major decline in the equilibrium equity premium. The problem is that diversification, like equity participation, should be measured on a wealth-weighted basis. Most stocks have always been held by wealthy investors who are more likely to diversify their holdings. Even if the typical *portfolio* has been undiversified, the typical *share of stock* is likely to have been held in a diversified portfolio. Increased diversification by small investors need not have a large effect on equilibrium asset prices.

Furthermore, diversification can only have had a large impact on the equity premium if the gains from increased diversification were historically large, certainly much larger than the direct costs of increasing the number of stocks held in a typical portfolio. Thus the diversification story creates a new puzzle—why were investors historically reluctant to hold diversified portfolios?—and this seems little easier to resolve than

3. In a similar spirit, Campbell (1999) uses the results of Constantinides and Duffie (1996) to argue that heterogeneous risk in labor income cannot have a large effect on the equity premium unless risk aversion is high.

the original equity-premium puzzle—why were investors historically reluctant to hold equities?

Both the effects that Heaton and Lucas emphasize—increased participation and diversification—are long-run trends that may help to explain why valuation ratios are higher now than they were in the early postwar period, but do not specifically explain the runup in prices during the late 1990s. An important clue, ignored by Heaton and Lucas, is the fact that this runup has occurred during a period of robust economic growth. This is also characteristic of bull markets in previous decades such as the 1920s and the 1960s.

Campbell and Cochrane (1999) present a model of stock-market behavior in which valuation ratios are driven entirely by cyclical variation in consumption. Increases in consumption drive up risky-asset prices relative to dividends, not by increasing expected future dividend growth (which is constant by assumption), nor by decreasing real interest rates (which are also constant in the model), but by increasing the risk tolerance of investors. Investors' preferences are assumed to display *habit formation:* they have power utility whose argument is not the absolute level of consumption, but the level of consumption relative to a subsistence level, which is a nonlinear moving average of current and past consumption. When consumption is close to the subsistence level, only a small fraction of consumption is available as a surplus to generate utility, and even small shocks to consumption can have a large effect on this surplus. In such circumstances, investors become extremely risk-averse. As consumption increases relative to the subsistence level, however, their risk aversion declines and the equity premium is driven down.

The use of habit formation to generate time variation in the equity premium is appealing because there are other reasons to think that people judge their well-being by relative rather than absolute consumption. For example, it is common to compare a recession period unfavorably with a much earlier period of strong growth, even if the absolute level of consumption is higher in the recession than in the earlier boom. Habit formation explains this by the fact that surplus consumption, which generates utility, may be lower in the recession.

One objection to Campbell and Cochrane's model is that it requires high risk aversion to explain the historical average value of the equity premium. Barberis, Huang, and Santos (1999) have recently proposed a variant of the model in which investors are "loss-averse" (Kahneman and Tversky, 1979). Investors derive utility from the level of wealth relative to a reference point, which adjusts only gradually in response to changes in wealth. Furthermore, there is a kink in preferences at the reference point: the absolute value of marginal utility is higher for losses than for gains. In periods of weak economic growth, investors' wealth is close to the reference point and the kink in the preferences at that point makes them extremely risk averse. In cyclical expansions, however, wealth increases far above the reference point and risk aversion declines. The Barberis–Huang–Santos model uses loss aversion to generate high aversion to wealth risk even with moderate aversion to consumption risk.

Both these models have an additional advantage relative to the framework used by Heaton and Lucas. Because risk aversion varies in these models, risky asset prices more relative to dividends and so the volatility of stock returns can be much higher than the volatility of dividend growth. This is a feature of the data that is not easily matched by models with constant risk aversion. Heaton and Lucas do not report the volatility of stock returns in their constant-risk-aversion model, but it is probably close to the underlying volatility of dividend growth. Even though Heaton and Lucas calibrate their model with greater dividend volatility than has historically been observed, the model probably understates the volatility of stock returns, and this makes it harder to generate a large equity premium.

In my view cyclical factors of the sort emphasized by Campbell and Cochrane and by Barberis, Huang, and Santos are at least as important for stock prices as the secular changes in participation and diversification emphasized by Heaton and Lucas. But in the end, it is important to recognize that the recent runup in stock prices is so extreme relative to fundamental determinants such as corporate earnings, stock-market participation, and macroeconomic performance that it will be very hard to explain using a model fit to earlier historical data. The relation between stock prices and fundamentals appears to have changed, and it may be a long time before a definitive interpretation of this change is possible. In the meantime investors should keep in mind that a return to historical valuation ratios would imply extremely large negative returns, while a continuation of current ratios would imply mediocre returns unless there is a historically unprecedented acceleration of corporate earnings growth.

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Discussion

In replying to the discussants, both authors agreed that increasing participation rates alone could not explain the current level of stock prices. John Heaton emphasized that much of the effect of increasing participation occurs as the economy moves from low to moderate participation, but we are now moving from moderate to high participation. Deborah Lucas expressed skepticism that adding capital accumulation to the model would change this result. As an alternative explanation, which is more fully developed in the published version of the paper, she noted that stock investors are now holding more diversified portfolios, which increases their aggregate risk-bearing capacity.

Mark Gertler asked whether there might be some benefit to studying stock prices at a more disaggregated level. For example, there is a great deal of variation among stocks in price–earnings ratios, with internet stocks like Amazon.com at the upper extreme. John Campbell remarked that explaining the pricing of "growth" stocks raises interesting issues: One hypothesis is that such stocks are priced high because optimistic investors with upward-biased earnings expectations are more likely to hold them. Another story is that, as the discount rate falls for whatever reason, growth stocks experience large effects because of the long average duration of their expected earnings streams.

Martin Feldstein argued that it is important to incorporate tax considerations. Because of their tax treatment, share buybacks are a much more efficient way to pay out to individual shareholders. To the extent that buybacks are becoming a more important share of payouts, net-of-tax returns have increased.

Martin Eichenbaum asked whether participation is defined to include holding stocks in a retirement account. Heaton responded that the contribution data reflect holdings of defined-contribution retirement accounts, and that the increase in such accounts may explain part of the measured rise in participation. Jonathan Parker noted that some people who are technically participants in the market at earlier times held only one or two stocks, whereas today they might hold one or two well-diversified mutual funds. This would support the idea that average diversification rather than participation per se is what is important. As another example of how financial innovation can reduce required yields, Michael Mussa mentioned the "liquification" of the below-investment-grade bond market by Michael Milken.

The identity of the "the marginal stockholder" was the subject of some discussion. Julio Rotemberg suggested that the marginal stockholder might be very rich and not very risk-averse. Heaton remarked that the characteristics of stockholders' noninvestment income are important, particularly the correlation of this other income with the market. For example, if the marginal stockholder is a wage earner rather than the owner of a business, the reduction in the required risk premium may be greater, all else equal.