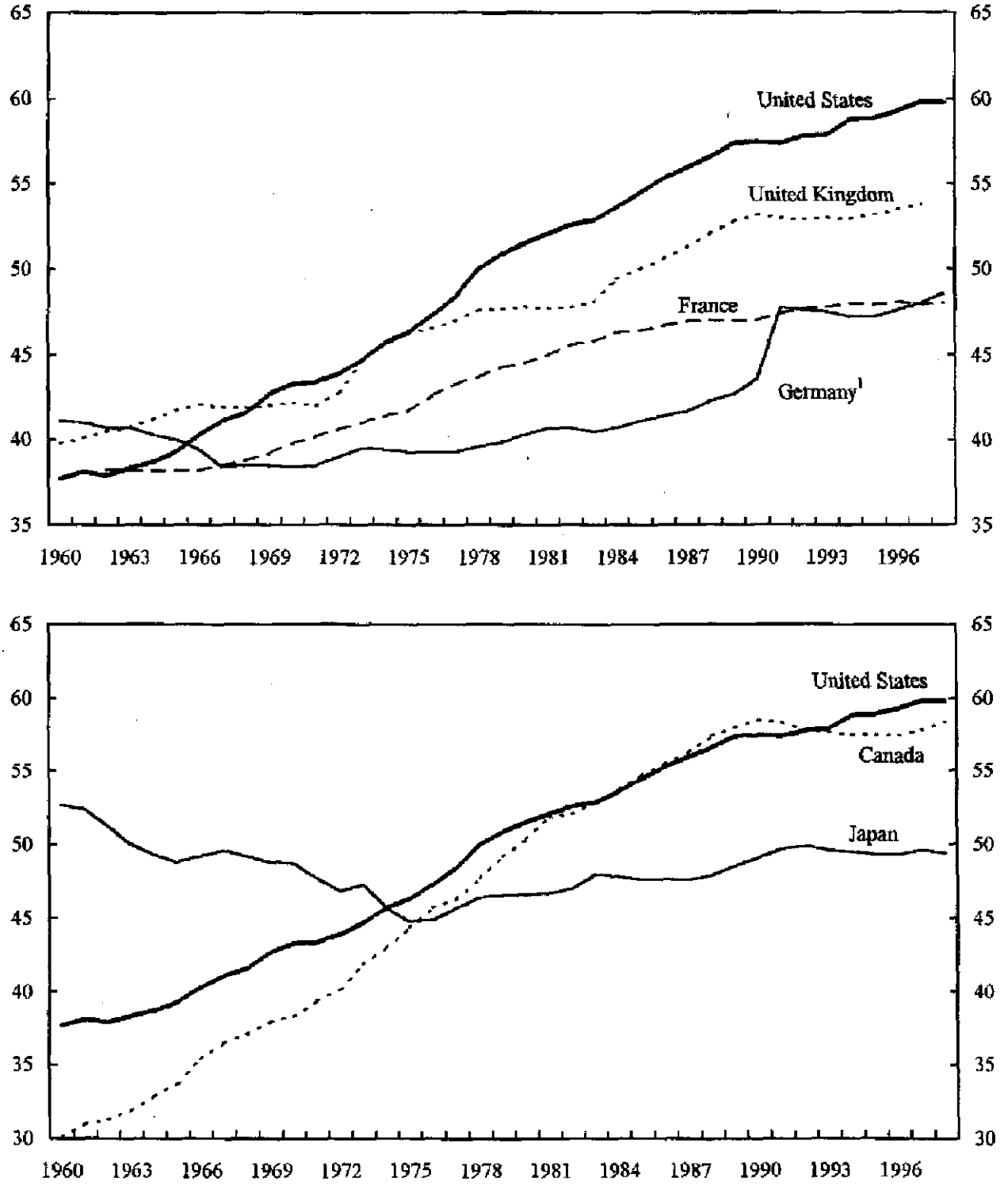
Figure 10. United States: Female Labor Force Participation Rates, Selected Countries, 1960-98
(percent of working-age population)



Source: Bureau of Labor Statistics.

[1] Unified Germany, 1991 onward.

IV. U.S. Equity Prices and the Technology Boom[1]

1. Current U.S. equity market valuations have raised considerable concern and debate about the underlying factors driving them and the role played by the sharp rise in the development and applications of new technologies in the U.S. corporate sector. Traditional indicators, such as the dividend yield and the price-earnings (P/E) ratio, indicate that equity prices have moved significantly out of line with historic values. During 1999, the average P/E ratio for S&P500 stocks was 31, almost twice the post-World War II average value of 17 (Table 1).[2] However, while current market valuations are difficult to justify in terms of historic averages for those variables, reconciling current market valuations for S&P500 stocks with investors' expectations regarding real-earnings growth and the risk premium on equities is possible, especially given the impressive performance in corporate profits since end-1994.[3] Nevertheless, current market valuations, particularly for technology stocks, appear to be highly elastic to changes in expected earnings growth and discount factors, which would suggest increased volatility in equity prices if earnings growth does not meet investors' expectations.

2. Based on a constant-growth valuation model,[4] the current P/E ratio for S&P500 stocks would imply that investors expect real-earnings growth to remain close to its annual

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[1] Prepared by Martin Cerisola and Gustavo Ramirez.

[2] This average is calculated for the period 1954–94, excluding the higher inflation sub-period 1970–84. High inflation biases P/E ratios downwards because it tends to adversely affect the quality of reported earnings. In particular, high-inflation periods tend to overstate reported earnings through the effect on depreciation allowances and inventory valuation.

[3] The growth rate of earnings per share in real terms is calculated by deflating the growth in nominal earnings per share with the chain-type GDP price deflator. Growth in real earnings per share has been broadly in line with the growth rate of real GDP in the United States, reflecting the fact that the share of capital in national income has been relatively stable over time.

[4] For a constant dividend-payout ratio d and a constant rate of growth in earnings per share g, the price-earnings ratio can be expressed as follows:

$$\frac{P}{E} = \frac{d}{r - g}$$

where r is the expected return on equity capital. In the results presented here, r is approximated by the yield on a risk-free asset (the ten-year U.S. government bond) plus a risk premium.

average rate of 7¾ percent since end-1994, assuming that the dividend-payout ratio and the equity premium return to their historic averages of 55 percent and 4½ percent, respectively (Table 2).[5] Such a high rate of growth in real earnings would imply a significant and sustained increase in the share of corporate profits in GDP. Alternatively, investors may be willing to accept a lower rate of return on equity capital if the riskiness of equities relative to other assets has been perceived to decline. If real earnings for the S&P500 stocks were to grow by 2¾ percent, in line with their average in 1954–94, the current P/E ratio would suggest that the equity-risk premium has declined markedly, to roughly ½ percent. Possibly, current U.S. equity prices reflect some combination of above historic expected growth in real earnings in the coming years and some reduction in the equity premium.

A. What Does the Sectoral Evidence Suggest?

3. A breakdown of the S&P500 stocks into industrial, financial, transportation, and utilities reveals that P/E ratios, dividend-payout ratios, and growth in real earnings have varied considerably across sectors (see Table 1). While most of these sectors have experienced a marked increase in P/E ratios and real earnings growth since 1995 and a decline in dividend-payout ratios—relative to their historic values—the dispersion of P/E and dividend-payout ratios, and real earnings points to significant differences for what current U.S. equity prices imply in terms of expected real-earnings growth and investors' risk premia across sectors.

4. The high valuation of S&P500 stocks reflects primarily high equity prices in the industrial sector, where most of the new technologies are being developed and applied. The P/E ratio for the S&P500 industrial stocks suggests that the growth in real earnings would be expected to remain very strong and even accelerate in the period ahead, exceeding by 10 to 30 percent its growth performance since 1995, depending on the equity-risk premium. Likewise, a slowdown in real earnings to historical growth rates would suggest that the equity-risk premium for the industrial sector has been virtually eliminated.[6]

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[5] The real return on U.S. equities was 7.1 percent between 1946 and 1996 (Siegel (1998)). The real return on ten-year U.S. government bonds was about 2½ percent during the same period, which would suggest an equity premium of roughly 4½ percent. However, as noted by Siegel, depending on which risk-free asset is chosen, the equity premium could be as high as 6 percent on average. If the equity premium were 6 percent, a P/E ratio of 31 would suggest that investors expect real earnings to grow by 8¾ percent per year.

[6] Price-earnings ratios for the industrial, transportation, utilities, and financial sectors, declined somewhat during the first quarter of 2000. However, the decline does not change the main results and conclusions presented in the paper. In particular, most of the industrial subsectors have experienced a decline in their P/E ratios, but these ratios remain significantly above their long-term average. In addition, while the P/E ratio for the technology subsector has risen

(continued...)

5. In contrast, the estimates show that current P/E ratios for S&P500 firms in the financial, transportation, and utilities sectors appear to be more realistic in terms of the implied expected growth in real earnings and investors' risk premia, and provide no clear indication of overvaluation. For most of these sectors, the estimates suggest that the current P/E ratios would be consistent with some acceleration in real-earnings growth and a lower risk premium required by investors. Even though the implied expected real-earnings growth for S&P500 financial stocks would exceed its historic average, it would still be significantly below the average growth rate observed since 1995. If real-earnings growth were to return to its historic average, the implied equity premium for S&P500 financial stocks would be 3¾ percent, slightly lower than the historic average for the overall S&P500 index. In the case of S&P500 transportation stocks, the implied expected growth in corporate profits seems to be broadly in line with its historic average, and significantly below the strong performance since 1995. If the average growth of real earnings in transportation were to return to its historic average, the current P/E ratio would be consistent with an equity premium of 7¼ percent, higher than the historic average for S&P500 stocks. This apparent increase in the relative riskiness of the transportation sector may reflect the effects of the deregulation of this sector over the past two decades. As for S&P500 utilities stocks, the model does not provide a clear view on whether current valuations are significantly out of line. While the model suggests expected growth rates in real earnings broadly in line with the performance since 1995, the implied risk premium appears to be too low in terms of the historic average for the overall S&P500 stocks. Nonetheless, such a low equity-risk premium for utilities could reflect the fact that this sector has traditionally been highly regulated, and therefore, may not be perceived as risky as other sectors in the economy.[7]

B. What Do Current Valuations for the Industrial Sector Suggest?

6. A breakdown of the S&P500 industrial sector index shows that most of the subsectors had high P/E ratios on average, with technology, health care, and energy firms having the highest P/E ratios (Table 3). In addition, the industrial sector shows a wide dispersion of growth rates in real earnings per share and in dividend-payout ratios across subsectors since 1994 and, particularly, in 1999. While most of the subsectors experienced a marked increase in real earnings per share growth, the performance of the technology subsector since 1994 stands out from the rest. Real-earnings growth in technology firms has risen from about ¼ percent annual rate during 1987–94 to an average of 11½ percent per year since 1995, including a 54 percent increase in 1999.

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markedly in the first quarter, price developments since then would suggest that the P/E may have declined sharply.

[7] The situation is likely to change, as more states move forward in deregulating utilities, particularly in the energy sector.

7. The estimates show that the current P/E ratios for the subsectors in the S&P500 industrial index would imply the expectation of continued above-normal growth in real earnings or almost no equity-risk premium, if earnings were to return to historic averages (Table 4). The expectation of sustained above-normal earnings growth seems particularly pronounced for sectors which have not experienced sustained high rates of growth in real earnings over a long period of time, such as basic materials, communication services, and consumer cyclicals and staples, as well as for others, such as technology, energy, and health care, which have experienced an upward trend in profitability since 1987. Nevertheless, the estimates show that, if real-earnings growth in the industrial sector were to slow down to its historic annual average of 3¼ percent, current P/E ratios would imply an equity-risk premium that has been virtually eliminated for most subsectors, especially for technology and health care.

C. What Can be Inferred from Current Valuations for Technology Stocks?

8. The high level of P/E ratios for technology subsectors reflect buoyant real-earnings growth since 1995, which has been particularly pronounced in computers, electronics, and communications equipment (Table 5). Nevertheless, the technology sector has retained a large proportion of its earnings to finance investment, as the dividend-payout ratios have been extremely low in technology stocks, particularly when compared with other industrial stocks. The combination of high P/E and low dividend-payout ratios would suggest that investors expect high dividends in the future for technology stocks.

9. While the current configuration of technology stock prices would suggest that investors may have developed unrealistic expectations of long-term earnings growth or risk, the recent performance of technology firms has been remarkable and could be sustained in the period ahead (Table 6). As noted by Whelan (1999), the application of computing technologies has exploded in the United States during recent years, which has induced a sharp boost to productivity in the computer-producing sector. The current pace of development in new technologies, together with an acceleration in the pace of adopting and adapting them, would likely help maintain high profit margins in the technology sector in the period ahead. However, as technology firms exhaust investment opportunities and face increased competition, investors should expect to see some erosion of profit margins and earnings growth over time.

10. In fact, technology stocks appear to be the most sensitive to changes in earnings growth, the risk-free interest rate, and the equity premium.[8] The constant growth valuation model shows that the price-earnings ratio is extremely sensitive to changes in the discount interest rate (r) or the growth rate of earnings per share (g), when these variables have values close to each other, as seems to be the case for most of the S&P500 industrial stocks. The results (Table 7) show that the elasticity of price-earnings ratio to changes in expected earnings growth, the risk-free interest rate, and the equity premium, is higher for industrial stocks than for financials, transportation, and utilities. These high elasticities in the industrial sector primarily reflect extremely high price levels for technology, health care, and consumer cyclicals and staples (Table 8).

List of References

Whelan, K., 1999, "Computers, Obsolescence, and Productivity" Finance and Economics Discussion Series, February, Federal Reserve Board, Washington DC.

Siegel, J., 1998, "Stocks for the Long-Run" McGraw Hill, second edition.

[8] The elasticities of the price-earnings ratio to earnings per share growth (η_g), the risk-free rate (η_{rf}), and the equity premium (η_ρ), are defined as follows:

$$\eta_g = \frac{\partial(P/E)}{\partial g} \cdot \frac{g}{P/E} = \frac{g}{r-g}$$

$$\eta_{rf} = \frac{\partial(P/E)}{\partial rf} \cdot \frac{rf}{P/E} = \frac{-rf}{r-g}$$

$$\eta_\rho = \frac{\partial(P/E)}{\partial \rho} \cdot \frac{\rho}{P/E} = \frac{-\rho}{r-g}$$

where ρ is the equity-risk premium and $r = rf + \rho$.

Table 1. United States: Price-Earnings Ratio, Dividend-Payout Ratio, and Real Earnings for S&P500 Stocks

	S&P500 Index				
	Overall	Industrial	Financial	Trans-portation	Utilities
Price-earnings ratio					
1954–94 1/	16.7	17.4	12.5	22.2	15.8
1999	31.2	37.0	18.7	17.0	17.9
Dividend-payout ratio					
1954–94 1/	55.4	54.1	44.0	48.0	80.2
1999	38.9	40.0	31.1	18.7	72.5
Real earnings 2/ (annual growth)					
195494 1/	2.8	3.1	5.7 3/	8.9 3/	0.8
1995–99	7.7	6.9	11.4	16.3	2.7

Source: Staff estimates.

1/ Average over 1954–94, excluding the higher inflation subperiod of 1970–84.

2/ Earnings per share deflated by the chain-type GDP deflator. Data since 1954, except for financials.

3/ For financial based on NIPA figures for corporate profits. For transportation, based on EPS during 1978–94.

Table 2. United States: Alternative Scenarios for Real Earnings and Risk Premium

	S&P500 Index				
	Overall	Industrial	Financial	Trans-portation	Utilities
I. Expected Real-Earnings Growth					
Equity-risk premium					
At 3 percent	5.5	5.9	5.0	4.5	2.9
At 4.5 percent	7.2	7.5	6.5	6.1	4.6
At 6 percent	8.7	9.0	8.1	7.6	6.0
II. Implied Equity-Risk Premium					
Real-earnings growth (1954–94 average)	0.4	0.4	3.7	7.2	1.0

Source: Staff estimates.

Table 3. United States: Price-Earnings Ratio, Dividend-Payout Ratio, and Real Earnings for S&P500 Industrial Stocks

S&P500 Industrial Index

	Basic Materials	Capital Goods	Communication Services	Consumer Cyclicals	Consumer Staples	Energy	Health Care	Technology
Price-earnings ratio								
1994–99 1/	24.6	29.5	26.0	18.9	28.1	27.2	30.1	33.0
1999	35.9	29.6	37.6	23.6	33.7	54.3	39.6	51.2
Dividend-payout ratio (in percent)								
1994–99 1/	48.2	45.1	62.7	28.3	43.8	75.9	42.3	12.9
1999	67.5	38.9	54.5	25.5	44.8	132.0	42.6	11.2
Real earnings2/ (annual growth)								
1987–94	...	...	...	...	...	6.2	7.9	0.3
1994–99 1/	-4.1	20.6	5.9	6.6	6.4	7.0	8.2	11.5
1999	6.6	20.0	44.7	23.1	10.6	116.1	15.3	53.9

Source: Staff estimates.

1/ Average over 1954–94, excluding the higher inflation subperiod of 1970–84.
2/ Earnings per share deflated by the chain-type GDP deflator. Data since 1954, except for financials.

Table 4. United States: Alternative Scenarios for Expected Real Earnings and Risk Premium

S&P500 Industrial Index

	Basic Materials	Capital Goods	Communication Services	Consumer Cyclicals	Consumer Staples	Energy	Health Care	Technology
Equity-risk premium								
At 3 percent	6.0	5.8	5.7	6.1	6.0	5.9	6.2	7.0
At 4.5 percent	7.5	7.3	6.7	7.6	7.5	7.4	7.7	8.5
At 6 percent	9.1	8.9	8.8	9.2	9.1	9.0	9.4	10.2
Real-earnings growth (1954–94 average for industrial sector)	0.3	0.5	1.0	0.2	0.3	0.3	0.0	-0.7

Source: Staff estimates.

Table 5: United States: Price-Earnings Ratio, Dividend-Payout Ratio, and Real Earnings for S&P500 Technology Stocks
S&P500 Technology Index

	Communications Equipment	Computers				Electronics				Equipment Semi Conductors 1/	Photography Imaging	Services	
		Hardware	Networking	Peripherals 1/	Software & Services	Distributors	Component Defense	Instrumentation	Semi Conductors			Computer Systems	Data Processing
Price-earnings ratio													
1994–99	46.0	27.8	67.4	40.8	45.8	20.1	22.4	35.4	27.8	30.8	27.4	29.7	31.3
1999	78.8	39.0	95.6	42.6	59.2	20.9	27.6	69.0	45.7	58.6	24.0	42.4	32.1
Dividend-payout ratio (in percent)													
1994–99	15.9	...	...	...	2.8	25.9	34.4	38.8	6.0	...	57.0	43.0	12.1
1999	16.8	...	...	...	0.9	27.2	44.0	61.9	6.4	...	46.9	42.8	17.0
Real earnings 2/ (annual growth, in percent)													
1985–94	0.9	-13.3	...	...	9.2	...	...	6.3	11.5	...	...	...	...
1994–99	9.5	30.9	50.1	24.4	24.1	7.2	-4.9	0.9	11.9	17.5	17.5	0.5	10.3
1999	139.3	70.2	96.1	178.8	10.4	-22.3	-56.4	55.2	47.6	681.6	59.6	-29.8	43.4

Source: Staff estimates.
1/ Price-earnings ratio and real earnings based on average during 1996–99.
2/ Earnings per share deflated by the change in the chain-type GDP deflator.

Table 6. United States: Alternative Scenarios for Expected Real Earnings and Risk Premium
S&P500 Technology Index

	Communications Equipment	Computers				Electronics				Equipment Semi Conductors	Photography Imaging	Services	
		Hardware	Networking	Peripherals	Software & Services	Distributors	Component Defense	Instrumentation	Semi Conductors			Computer Systems	Data Processing
						I. Expected Real-Earnings Growth							
Equity-risk premium													
At 3 percent	7.1	9.3	9.6	9.4	9.6	8.5	8.4	9.1	9.6	9.5	7.3	8.7	9.3
At 4.5 percent	8.6	10.9	11.2	11.0	11.2	10.1	10.0	10.7	11.2	11.1	8.9	10.3	10.9
At 6 percent	10.2	12.5	12.8	12.6	12.8	11.7	11.6	12.3	12.8	12.7	10.5	11.9	12.5
						II. Implied Equity-Risk Premium							
Real-earnings growth													
1954–94 average for Industrial sector	-0.8	-0.6	-0.8	-0.7	-0.9	0.2	0.2	-0.4	-0.8	-0.8	1.3	0.0	-0.6

Source: Staff estimates.

Table 7. United States: Estimated Elasticity of Current Price-Earnings Ratio 1/

	S&P500 Index				
	Overall	Industrial	Financial	Trans-portation	Utilities
I. To Changes in Expected Real-Earnings Growth					
Equity-risk premium					
At 3 percent	4.5	5.6	3.1	2.4	1.2
At 4.5 percent	5.4	6.7	3.8	3.0	1.5
At 6 percent	6.3	7.8	4.5	3.6	1.9
II. To Changes in the Equity-Risk Premium					
Equity-risk premium					
At 3 percent	-1.7	-2.1	-1.3	-1.1	-0.7
At 4.5 percent	-2.5	-3.1	-1.9	-1.6	-1.0
At 6 percent	-3.4	-4.1	-2.6	-2.1	-1.3
III. To Changes in the Risk-Free Rate					
Risk-free rate at 6.5 percent	-3.7	-4.4	-2.8	-2.3	-1.5

Source: Staff estimates.

1/ In theory, and based on historical data for the S&P500, the elasticities of the P/E ratio to changes in expected real earnings and the risk-free rate should range between 0.9–1.9 (depending on the equity premium, which ranges from 3 to 6 percent). The estimated elasticity with respect to changes in the equity Premium should be -1.