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ABSTRACT

U.S. stock prices have increased much faster than gross domestic product (GDP) in the postwar period. Between 1962 and 2000, corporate equity value relative to GDP nearly doubled. In this paper, we determine what standard growth theory says the equity value should be in 1962 and 2000, the two years for which our steady-state assumption is a reasonable one. We find that the actual valuations were close to the theoretical predictions in both years. The reason for the large run-up in equity value relative to GDP is that the average tax rate on dividends fell dramatically between 1962 and 2000. We also find that, given legal constraints that effectively prohibited the holding of stocks as reserves for pension plans, there is no equity premium puzzle in the postwar period. The average returns on debt and equity are as theory predicts.

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1. Introduction

U.S. stock prices have increased much faster than gross domestic product (GDP) in the postwar period. Between 1962 and 2000, corporate equity value relative to GDP nearly doubled. (See Figure 1.) Stock market analysts view this as puzzling because there has been little or no change in market fundamentals. The increase in equity values is not the result of a decrease in the importance of debt financing; in both periods, debt was a little over 3 percent of the value of corporate equity. The increase is not due to an increase in the value of productive tangible assets owned by corporations relative to GDP; the corporate capital-output ratio has stayed remarkably constant. The increase is not the result of an increase in the after-tax corporate profits share of GDP; this share is approximately the same now as it was in the early 1960s.

There is another important factor that affects the value of corporate equity, however. This factor is the U.S. tax system, which changed and changed a lot. Once the change in tax system is taken into account, we find that the value of corporate equity is very close to the predictions of theory in both 1962 and 2000.

The key feature of the tax system that affects the value of corporate equity is the average tax rate on dividends. This rate has fallen from 44 percent in the 1955–1962 period to 18 percent in the 1987–2000 period. There are two reasons for the big decline in this rate. First, there were three important cuts in individual income tax rates between 1962 and 1987. The first was the 1964 Kennedy tax cut that reduced the highest marginal income tax rate from 91 percent to 70 percent. Next, there was the 1981 Reagan tax cut that reduced the highest rate to 50 percent. Finally, there was the 1986 Tax Reform Act that reduced the highest rate to 33 percent.

Second, and more importantly, there was a dramatic increase in the share of corporate equity held by non-tax-paying entities. The percentage of corporate equity held by these entities – namely pension funds, individual retirement accounts, and nonprofit organizations – increased from a few percent in 1962 to around 50 percent in 2000.

In the early 1960s virtually no equity was held in non-taxed retirement accounts, in large part because of strict regulations on fiduciaries. Regulations governing investment by pension funds were changed in 1974 with the passage of the Employment Retirement Income Security Act (ERISA).[1] Prior to 1974, fiduciaries managing a pension fund portfolio were liable if the portfolio included equity and the value of this equity fell.[2] With ERISA, pension funds became regulated intermediaries; if regulators approved investments, then the fiduciary managing the portfolio was not liable for losses. During the period following the change in law, there was a significant increase in pension fund equity holdings.

Beginning with ERISA and continuing into the early 1980s, there were major changes in tax law that fostered individual retirement accounts (IRAs) and defined contribution pension plans. The funds in these retirement plans are invested in individual accounts, with the individual typically having considerable latitude in how these funds will be invested. A consequence of these tax law changes is that these plans grew rapidly in the 1980s and 1990s with a large share of assets being corporate equity.

Contributions to most retirement accounts are not taxed and grow tax-free until they are withdrawn for consumption. Although these funds are taxed upon withdrawal, this tax is in effect a consumption tax, not a dividend tax. Consequently, the marginal tax rates on these distributions have no consequence for the steady-state value of corporate equity relative to GDP.

Using the basic growth model, we derive a formula for the value of equity. The value of equity is different from the value of corporate productive capital because of taxes. Given

U.S. tax policy, the most important tax for pricing equity is the tax on dividend income. In theory, a decrease in the marginal rate on dividends should increase the price of capital used in the corporate sector, but leave the quantity of capital unaffected. This is exactly what we observed: prices of equities rose between 1962 and 2000, while the capital-output ratio remained roughly constant. Furthermore, if the capital-output ratio does not change, then we would not expect a rise in after-tax corporate earnings as a share of GDP unless the corporate tax rate fell. Over the postwar period, the corporate tax rate did not fall significantly, and after-tax earnings remained roughly constant as a share of GDP.

Another implication of the theory is that the real before-tax return on the stock market should have been about 8 percent on average, as it was. The real before-tax return on equity is the sum of three returns: the income return, the anticipated capital gain, and the unanticipated capital gain. The income return is the ratio of dividend to price. This ratio has been high, over 3 percent, for much of the postwar period because high tax rates have implied a low price of equity. Recently it has come way down and is now a little over 1 percent.

The anticipated capital gain is equal to the growth rate of productive assets, which was roughly 3.5 percent per year and is now down to around 3.3 percent. The unanticipated capital gain is the growth in the price of equity due to unanticipated changes in tax rates. This growth rate has changed, falling from the range of 1 to 2 percent to 0 percent. Adding these rates, we would expect an 8 percent (e.g., 3+3.5+1.5) real before-tax stock return in the early postwar period and, barring any further unexpected changes in tax rates, a return in the future that is a little over 4 percent (e.g., 1+3.3+0).

This raises the question, why was debt held if equity earned such a high return? In the early 1960s, over one-third of the 1.1 GDP of debt held directly or indirectly by households was held as pension and life insurance reserves. At that time, almost all of the assets held in these reserves were debt assets. The reason is that there were legal constraints imposed on fiduciaries to ensure sufficient liquidity for timely distributions and to ensure prudent investing. A large amount of debt assets were also held directly by households for liquidity purposes. For some households in the early postwar period, debt assets were their main avenue for saving because transaction costs made holding a diversified stock portfolio infeasible.

An important corollary of our findings is that there is no equity premium puzzle in the postwar period. Mehra and Prescott (1985) found that the high return on equity relative to debt was puzzling because theory says that the premium for bearing non-diversifiable risk is small. Their finding lead many to conclude that growth theory cannot account for the historical facts concerning asset prices and returns, unless a fundamentally different preference ordering is assumed.[3] We find that this is not the case once we take into account observed changes in taxes and regulations.[4]

In Section 2, we describe the basic growth model that we use for our analysis. We start with a version of the model that highlights our main results. We then extend the analysis to include many features of the U.S. economy. In Section 3, we describe the U.S. data that we use. In Section 4, we compare the model's predictions for corporate equity values with the actual market valuations. Finally, in Section 5, we discuss the implications for asset returns.

2. Theory

In this section, we derive a formula that relates the value of corporate equity to the value of the productive assets in the corporate sector.[5] We use the value of the productive assets of U.S. corporations to estimate what the value of their equity should be. If the value of a firm's productive assets is lower than the market value of its shares, then we would say that its equity is overvalued. Conversely, if the value of its productive assets is higher than the market value of its shares, then its equity is undervalued.

We first present a simple model that highlights our key theoretical results. We include only personal income taxes and corporate income taxes. We also assume that the economy has only one sector, a corporate sector. This is all that we need to show how taxes affect the relation between the value of corporate assets and the value of corporate equity. In the second step, we extend the analysis to include sufficient details of the U.S. economy – especially in relation to the tax code – to allow us to take the theory to the data. We match the model up with national income and product account (NIPA) capital stock data from the *Survey of Current Business* (SCB) and tax data from the Internal Revenue Service's *Statistics of Income* (SOI). The result is a prediction for the value of corporate equity that does not rely on any financial data. This prediction can then be compared to the actual stock market valuation.

A. Income Taxation and the Value of Corporate Equity

Consider the following model economy. The economy is inhabited by infinitely lived households with preferences ordered by

$$\max \sum_{t=0}^{\infty} \beta^t U(c_t, \ell_t) \tag{1}$$

where t indexes time, c is per-capita consumption, and ℓ is the fraction of productive time allocated to nonmarket activities. The fraction of time allocated by households to market activities is denoted by $n = 1 - \ell$.[6]

Each household chooses sequences of consumption and leisure to maximize utility subject to its budget constraint,

$$\sum_t p_t\{c_t + V_t(s_{t+1} - s_t)\} = \sum_t p_t\{(1 - \tau_{pers})(d_t s_t + w_t n_t) + \xi_t\}. \tag{2}$$

This constraint says that the present discounted value of expenditures must be less than or equal to the present discounted value of after-tax income. Expenditures of the household are consumption and purchases of shares in stocks, $V_t(s_{t+1} - s_t)$, where s_t is the number of shares held in period t and V_t is the price per share. Income for the households is from three sources: dividends, wages, and government transfers. We denote dividends per share by d, the wage rate by w, and government transfers by ξ. The households pay personal taxes on dividend and wage income. The tax rate is equal to τ_{pers}.

Firms have capital and hire labor to produce output with a constant-returns-to-scale production technology,[7]

$$y_t = f(k_{m,t}, k_{u,t}, z_t n_t). \tag{3}$$

This specification assumes that firms use both tangible assets, which are measured, k_m, and intangible assets, which are unmeasured, k_u. Tangible assets include structures, equipment, inventories, and land. Intangible assets include brand names, patents, and forms of organizational capital. In addition to capital, labor services n are required. The z_t's are technology parameters, which are assumed to grow at rate γ.

Firms choose capital and labor to maximize:

$$\begin{aligned}\sum_{t=0}^{\infty} \quad & p_t\{f(k_{m,t}, k_{u,t}, z_t n_t) - w_t n_t - x_{m,t} - x_{u,t} \\ & \qquad -\tau_{corp}\left[f(k_{mt}, k_{ut}, z_t n_t) - w_t n_t - \delta_m k_{m,t} - x_{u,t}\right]\}(1 - \tau_{pers})\end{aligned} \tag{4}$$

$$\text{s.t.} \qquad k_{m,t+1} = (1-\delta_m)k_{m,t} + x_{m,t} \tag{5}$$

$$k_{u,t+1} = (1-\delta_u)k_{u,t} + x_{u,t} \tag{6}$$

where x_m is new investment in measured tangible capital and x_u is new investment in unmeasured intangible capital.

We are interested in the competitive equilibrium for this economy. A requirement for equilibrium is that all markets clear. Labor markets clear if $\ell_t + n_t = 1$. The goods market clears if

$$c_t + x_{m,t} + x_{u,t} = f(k_{m,t}, k_{u,t}, z_t n_t). \tag{7}$$

Finally, dividends of the household are equal to what firms have after paying wages, paying taxes, and making new investments; that is,

$$d_t = (1-\tau_{corp})\left[f(k_{m,t}, k_{u,t}, z_t n_t) - w_t n_t - \delta_m k_{m,t} - x_{u,t}\right] - k_{m,t+1} + k_{m,t}. \tag{8}$$

The number of shares outstanding is one so equity markets clear if $s_t = 1$.

In a competitive equilibrium, the following relations hold:

$$\frac{p_t}{p_{t+1}} = \frac{V_{t+1} + (1-\tau_{pers})d_{t+1}}{V_t} \tag{9}$$

$$\frac{p_t}{p_{t+1}} = (1-\tau_{corp})(f_1(k_{m,t+1}, k_{u,t+1}, z_{t+1}n_{t+1}) - \delta_m) + 1 \tag{10}$$

$$\frac{p_t}{p_{t+1}} = f_2(k_{m,t+1}, k_{u,t+1}, z_{t+1}n_{t+1}) - \delta_u + 1. \tag{11}$$

Conditions (10) and (11) say, among other things, that the returns to stocks and the two types of capital must be equal.

Proposition 1. In equilibrium, the value of corporate equity is

$$V_t = (1 - \tau_{pers})\left[k_{m,t+1} + (1 - \tau_{corp})k_{u,t+1}\right]. \tag{12}$$

Proof: This follows from the definition of dividends in (8) and relations (9)-(11). ∎

The price of tangible capital for the shareholders is $(1 - \tau_{pers})$, not one. It is less than one because a dollar reinvested is not taxed, but a dollar distributed is taxed. The price of intangible capital is $(1 - \tau_{pers})(1 - \tau_{corp})$. Thus, intangible capital is cheaper than tangible capital when there is a tax on corporate income. The reason is that investments in intangible capital are expensed and reduce taxable corporate income.

We note that our formula in (12) is not the standard formula in the public finance literature.[8] The standard formula for the price of measured capital is $(1 - \tau_{pers})/(1 - \tau_{cg})$, where τ_{cg} is a tax on accrued capital gains. In the U.S. tax system, however, capital gains are taxed upon realization. The price of measured capital is $(1 - \tau_{pers})$ if corporations make distributions to households by paying dividends, and it is $(1 - \tau_{cg})$ if corporations make distributions by buying back shares. If a combination of the two is used, the price will be intermediate to these two prices.

If we divide both sides of (12) by output, we have a relation between the ratio of corporate equity relative to GDP, V/y, and the capital-output ratios. In the United States, there was a large increase in the ratio of corporate equity to GDP, but little change in the capital-output ratios. We argue that these observations are consistent with theory. The large increase in equity values is the result of a dramatic decline in personal income tax rates. As we show in the next proposition, a decline in tax rates has an effect on the price of equity but not the capital-output ratios.

Proposition 2. Steady-state ratios k_m/y and k_u/y do not change with a change in τ_{pers}.

Proof: To see why, we need only consider equations (10) and (11). By our assumption that f is a constant-returns-to-scale technology, we can rewrite its derivatives f_1 and f_2 as functions of k_m/y and k_u/y only. The left-hand sides of these equations, both given by p_t/p_{t+1}, can be written in terms of the growth rate γ, the discount factor β, and the parameters of $U(\cdot,\cdot)$. This yields two equations in the two unknown capital-output ratios. The equations do not depend on the personal income tax rate τ_{pers}. They do depend on the corporate income tax rate τ_{corp}. ■

In this economy, to get a large rise in the value of equities with little change in capital-output ratios, we would need a large fall in the personal tax rate and little or no change in the corporate tax rate.

B. The U.S. Tax System and the Value of Corporate Equity

We now extend the model to include details relevant to the U.S. economy. There are two main extensions. First, we allow for two sectors – corporate and noncorporate. Even though our primary focus is on corporate equity, the corporate sector accounts for less than 60 percent of U.S. value added and has only one-third of tangible assets. Second, we include the primary sources of U.S. tax revenues. We include taxes on consumption, taxes on labor income, taxes on dividend income, taxes on corporate income, and taxes on property.[9] We will show that the basic pricing formula does not change for this more general model economy.

We will denote the corporate sector as sector 1 and the noncorporate sector as sector 2. The outputs of these two sectors are inputs in production of a composite good that can be used for consumption and investment,

$$c_t + g_t + x_{1m,t} + x_{1u,t} + x_{2,t} \leq y_t = F(y_{1,t}, y_{2,t}) \tag{13}$$

where t indexes time, c is private consumption, g is government consumption, x_{1m} is gross investment in tangible capital in the corporate sector (sector 1), x_{1u} is gross investment in intangible capital in the corporate sector, x_2 is gross investment in the noncorporate sector (sector 2), and $F(y_1, y_2)$ is total output.

We assume that the only inputs used in the noncorporate sector are tangible capital and labor. R&D takes place in the pharmaceutical company but not at the corner drugstore. The noncorporate production technology is therefore simpler:

$$y_{2,t} \leq f^{nc}(k_{2,t}, z_t n_{2,t}). \tag{14}$$

Here y_2 is sector output, k_2 is capital services, n_2 is labor services, and z is a technology parameter that grows at the rate γ. With two sectors, output in the corporate sector is now denoted

$$y_{1,t} \leq f^{c}(k_{1m,t}, k_{1u,t}, z_t n_{1,t}). \tag{15}$$

Here y_1 is the output of sector 1, k_{1m} is capital services for measured tangible capital, k_{1u} is capital services for unmeasured intangible capital, n_1 is labor services, and z is a technology parameter which is assumed to be the same in the two sectors.

As before, corporate firms choose capital and labor sequences to maximize

$$\begin{aligned}\sum_{t=0}^{\infty} p_t \{ & p_{1,t} y_{1,t} - w_t n_{1,t} - x_{1m,t} - x_{1u,t} \\ & -\tau_1[p_{1,t} y_{1,t} - w_t n_{1,t} - \hat{\delta}_{1m} \hat{k}_{1m,t} - \tau_{1k} k_{1m,t} - x_{1u,t}] - \tau_{1k} k_{1m,t}\}(1-\tau_d)\end{aligned} \tag{16}$$

subject to constraints (15) and

$$k_{1m,t+1} \quad = \quad [(1-\delta_{1m}) k_{1m,t} + x_{1m,t}]/(1+\eta) \tag{17}$$

$$\hat{k}_{1m,t+1} = [(1-\hat{\delta}_{1m})\hat{k}_{1m,t} + x_{1m,t}]/(1+\eta) \tag{18}$$

$$k_{1u,t+1} = [(1-\delta_{1u})k_{1u,t} + x_{1u,t}]/(1+\eta) \tag{19}$$

where p_1 is the price of corporate goods, w is the wage rate, τ_1 is the corporate tax rate, τ_{1k} is the tax rate on corporate property, k_{1m} is the actual tangible capital stock, and $\hat{k}_{1m}$ is the book value of tangible capital.[10] The right side of the capital accumulation equations (17)-(19) are divided by the growth in population, $(1+\eta)$, because stocks and investments are in per capita units.

In writing the corporate firm's problem, we have distinguished depreciation used in the firm's calculation of corporate income tax, $\hat{\delta}_{1m}\hat{k}_{1m}$, and true economic depreciation, $\delta_{1m}k_{1m}$. These values are also distinguished in the U.S. national accounts.

Noncorporate firms solve a similar problem but face a different set of taxes. The problem that they solve is

$$\max \sum_{t=0}^{\infty} p_t\{p_{2,t}y_{2,t} - w_t n_{2,t} - x_{2,t} - \tau_{2k}k_{2,t}\}(1-\tau_2) \tag{20}$$

subject to the production technology (14) and

$$k_{2,t+1} = [(1-\delta_2)k_{2,t} + x_{2,t}]/(1+\eta) \tag{21}$$

where p_2 is the price of noncorporate goods, τ_2 is the tax rate on noncorporate income, and τ_{2k} is the tax rate on property in the noncorporate sector.

Firms make distributions to households, who are the shareholders in the case of corporate firms, or proprietors, in the case of noncorporate firms. The household maximizes utility subject to its budget constraint,

$$
\begin{aligned}
\max \quad & \sum_{t=0}^{\infty} \beta^t U(c_t, \ell_t) N_t & (22) \\
\text{s.t.} \quad & \sum_{t=0}^{\infty} p_t \{(1+\tau_c)c_t + V_{1s,t}(s_{1,t+1} - s_{1,t}) + V_{2s,t}(s_{2,t+1} - s_{2,t}) + V_{b,t} b_{t+1}\} & \\
& \qquad \leq \sum_{t=0}^{\infty} p_t \{(1-\tau_d) d_{1,t} s_{1,t} + d_{2,t} s_{2,t} + b_t + (1-\tau_n) w_t n_t + \xi_t\} & (23)
\end{aligned}
$$

with $n_t + \ell_t = 1$ and $b_t \geq \bar{b}_t$. In this version of the problem, we also allow for population growth. We assume that there are $N_t = (1+\eta)^t$ household members in period t. Per capita distributions from corporate and noncorporate firms are denoted $d_{1,t}$ and $d_{2,t}$, respectively. The values of shares held in corporate and noncorporate firms are $V_{1s,t}s_{1,t}$ and $V_{2s,t}s_{2,t}$, respectively, where V is the price and s is the number of shares held. The total number of shares outstanding is normalized to 1 in each sector. Government bonds are also held and denoted by b.[11] The price of these bonds is V_b. Taxes are paid on corporate dividends at rate τ_d. Taxes are also paid on wage income at rate τ_n. Earlier we assumed that these rates were the same. But, in comparing this model to the U.S. economy, we want to allow for the fact that the marginal rate paid on dividend income is higher than that paid on labor income since it is paid on average by households in higher income brackets. Transfers of the government in (23) are denoted by ξ.

The constraint on debt in (23) is a reduced-form way to capture certain restrictions that historically were imposed on U.S. fiduciaries. Pension fund managers face stiff penalties for imprudence and misconduct. Prior to the ERISA in 1974, there were few guidelines on what constituted imprudent behavior. Fiduciary breaches were dealt with in the U.S. courts, case by case. During this period, pension fund portfolios were primarily debt assets. Penalties were likely to be avoidable if pension fund managers simply chose debt assets with different maturities. This choice would facilitate the timing of distributions and would avoid large movements in asset returns. ERISA clarified fiduciary responsibilities and thus encouraged greater investment in equity assets. We think of this change in the law as a change in the constraints on debt holdings.[12]

If debt constraints are not binding, then the equilibrium return on debt is equal to the interest rate, which is pinned down by preference parameters. If the constraints are binding, however, then the equilibrium return on debt falls below the interest rate.

Government production is included in the noncorporate sector. Government purchases and transfers are financed by tax receipts and debt issues. The period t government budget constraint must be satisfied each period and is given by

$$\begin{aligned} g_t + \xi_t + b_t \;\leq\; & V_{b,t} b_{t+1} \\ - \; & \tau_1 [p_{1,t} y_{1,t} - w_t n_{1,t} - \delta_{1m} k_{1m,t} - \tau_{1k} k_{1m,t} - x_{1u,t}] - \tau_{1k} k_{1m,t} \\ - \; & \tau_2 [p_{2,t} y_{2,t} - w_t n_{2,t} - \delta_2 k_{2,t} - \tau_{2k} k_{2,t}] - \tau_{2k} k_{2,t} \\ + \; & \tau_c c_t + \tau_d d_{1,t} s_{1,t} + \tau_n w_t n_t . \end{aligned}$$

Note that tax rates are constant and proportional in our model economy.

Proposition 3. The total value of corporate equity, $V_t \equiv V_{1s,t} N_t$, is

$$V_t = (1 - \tau_d) \left[(1 - \tau_\delta) K_{1m,t+1} + (1 - \tau_1) K_{1u,t+1} \right] \tag{24}$$

where capital letters denote aggregates,

$$\tau_\delta = \frac{\tau_1 \hat{\delta}_{1m} (\hat{\delta}_{1m} - \delta_{1m})}{(\hat{\delta}_{1m} + i)(\hat{\delta}_{1m} + \gamma + \eta)} \tag{25}$$

and i is equal to the after-tax real return on the steady-state balanced growth path.

Proof: See Appendix A. ∎

If the rate of depreciation allowed by the IRS is equal to the true rate of depreciation, the formula in (24) is the same as that derived earlier in (12). This follows from the fact that τ_d is the personal income tax on dividends and τ_1 is the corporate income tax. It is important to note that no other tax rates affect the corporate equity value.

In most years, depreciation allowances for corporate tax filers exceed true economic depreciation. In other words, corporations can subtract $\hat{\delta}_{1m}\hat{k}_{1m}$ from their profits when computing their taxable income, where $\hat{\delta}_{1m}\hat{k}_{1m} > \delta_{1m}k_{1m}$. The more generous the depreciation allowances, the lower the consumption cost of tangible capital.

Proposition 4. k_{1m}/y and k_{1u}/y do not change with a change in τ_d.

Proof: See Appendix A. ∎

We find, as in the simpler model with only income taxes, that the steady state capital-output ratio does not change if we change the tax rate on personal dividend income, τ_d. In fact, if the effective tax rate on labor income (τ_n) does not change when we change τ_d and if tax payments are lump-sum rebated, then we find that the levels of capital and output do not change. *This says that a change in the tax rate on dividend income affects only the price of corporate equity and nothing else.* This will be important when we consider the U.S. data.

3. U.S. Tax Rates and Capital Stocks

We analyze two time periods: the period after the Korean War and before the Kennedy tax cuts and the period after the Tax Reform Act of 1986. The specific years that we use are 1955 through 1962 and 1987 through 2000. During these periods, there were no major changes in tax policy or regulations concerning asset markets. Thus, we view these periods as stable and suitable for steady-state analysis. We also think that it is reasonable to assume that individuals in the early 1960s did not anticipate the large tax and regulatory changes that would come later.

For this analysis, we need measures of U.S. tax rates and U.S. capital stocks. We use these measures in our key formula, equation (24).

A. Tax Rates

There are three rates that we need to estimate in order to calculate our predicted equity value. The first and quantitatively most important rate is the tax rate on dividend income, τ_d. Dividends are taxed as ordinary income, and individual income tax rates – especially for the top income brackets – have changed dramatically since World War II. The top marginal rate in 1947 was 91 percent; it remained at this level until 1962, except for a slight increase to 92 percent in 1952 and 1953. The Kennedy tax cut reduced the top rate to 70 percent. The Reagan administration further decreased it, first to 50 percent in 1981 and then to 33 percent after 1986. Under Clinton, the top rate rose to 39.6 percent.

Tax Rate on Dividend Income

For our purposes, the relevant tax rate is the marginal rate paid on an additional dollar of dividend income. An empirical issue is how to estimate this rate given there are many types of taxpayers in the U.S. economy and only one type in our model. Using taxable incomes reported to the IRS, we compute a marginal rate for each type of filer reported in the *Statistics of Income* and then weight each rate by the fraction of dividend income that this group earned. In effect, we compute an average marginal rate with the weights conditional on the amount of dividend income earned. Thus, if the only group that earned dividend income was the highest income group, then the tax rate we would compute would be the top marginal rate.

We use both 1040 returns filed by individuals and 1041 returns filed by fiduciaries. For individuals, we can compute marginal rates by adjusted income class and by marital status. For fiduciaries, we compute tax rates by income class. In Appendix B, Table B1, we report the marginal rates for the 1040 filers and 1041 filers for each year and provide more details on our computation.

The average marginal rates for 1040 filers fell in the range of 45 to 48 percent during the early period that we consider. The average rate was 46.6 percent. It is important to note that the rates remain roughly constant. Our analysis is only appropriate for stable policy regimes. In the later years, for which we have data through 1997, we see rates in the range of 24 to 29 percent with the average equal to 26.3. Again, we see that the rates stay roughly constant – but at a much lower level than in the 1950s and 1960s. To compute an overall rate, we average the estimates for 1040 and 1041 forms, again using the dividend incomes earned as weights. Quantitatively, the averaged rates are close to the rates from the 1040 forms since most dividend income is earned directly by individuals.

The IRS forms 1040 and 1041 cover personal income taxes paid to the federal government. There has been a shift over time with federal income tax receipts falling and state and local income tax receipts rising. So that we do not bias our estimates, we adjust the rates to account for state and local taxation. In doing so, we assume that the tax schedules are similarly sloped. Thus, we can simply multiply the rates by the ratio of total personal income tax receipts to federal personal income tax receipts. In 1955–1962, state and local tax receipts were roughly 5 percent of all personal receipts. In 1987–1997, this average grew to 19 percent.

We make a second adjustment to our rates. We multiply our average marginal rates in each year by the fraction of corporate equity outside of nontaxed accounts. Income from equity held by pension funds, individual retirement accounts, and nonprofit organizations is not taxed. In Appendix B, Table B2, we report the fraction of equity held in nontaxed accounts by category. As is clear from the table, there was little equity sheltered in these types of accounts in the late 1950s and early 1960s. More recently, we see that a lot of equity is tax-sheltered. The total in the period 1987–1997 is close to 50 percent. Thus, it is quantitatively important in the later period.

We should note that the tax rate on dividends in the case of tax-deferred retirement accounts is zero even though the contributions are taxed when they are withdrawn. Because wage income is reduced by the amount of the contribution, one dollar invested in the equity fund of the retirement account costs $(1-\tau_{pers})V$, where τ_{pers} is the personal income tax rate. When d of it is withdrawn, the household keeps $(1-\tau_{pers})d$. In terms of pricing equity, these taxes have no effect. Effectively, the tax on the withdrawn income is a tax on consumption and is like τ_c.

Our estimate for the average marginal tax rate on dividend income is 45.4 percent over the period 1955–1962 and 44.2 percent in 1962. (See Table B1 in Appendix B.) Our estimate in the period 1987–1997 is 16.9 percent on average and 18.2 percent in 1997. We may be overstating the rates in the later period because we have not taken into account the effect of tax-managed funds. In McGrattan and Prescott (2000), we assumed the current rate on dividends is effectively zero because individuals can avoid taxes on dividends and capital gains by managing their portfolios in an efficient way. But it is difficult to estimate how much more tax-sheltering can and is being done. Thus, we take 18.2 percent as a baseline and discuss later how changes in this estimate affect our results.

Tax Rate on Corporate Income

The second tax rate that we compute is the corporate income tax rate, τ_1. Corporate tax rates are constructed as the ratio of the NIPA corporate profits tax liability to corporate profits. There has been some decline in this ratio between the early postwar period and today, but it has not been as dramatic as the decline in dividend tax rates. The rates in 1962 and 2000 are 45.2 percent and 36.2 percent, respectively. Thus, the tax on dividends and the tax on corporate profits are about the same level in 1962, but are quite different in 2000. In 2000, the tax rate on dividends is half of the corporate income tax rate. If we used average rates, it would be even more dramatic because the average corporate income tax rate in 1987–2000 was 39.1 percent and the average tax on dividends was 16.9 percent.

Depreciation Allowances

Finally, we have to make a small adjustment to the price of tangible capital because of the tax treatment of depreciation. In particular, we need to compute τ_δ. (See equation (25).) In Appendix A, we derived a relation for τ_δ; in Appendix C, we provide details on our estimation of the rate. It turns out that the adjustments to the price are small. In the period 1955–62, the price must be multiplied by $1 - .002$, and in 1987–2000, the price must be multiplied by $1 - .021$. The adjustment has a larger effect on our estimate of the intangible capital stock.

We turn next to our estimates of capital stocks.

B. Capital Stocks

Corporate productive capital includes tangible capital – like factories, office buildings, and machines – and intangible capital – like patents, brand names, and firm-specific human and organizational capital. A good measure of the value of these assets must include not only those owned by U.S. corporations in the United States itself, but also those owned by U.S. corporations' foreign subsidiaries. In Appendix C, we describe how we estimate capital stock values, and in this section, we describe our estimates. The values we describe are the conventional values, namely resource costs.

Tangible Capital

Estimates of the value of some corporate assets are reported by the U.S. government. The Commerce Department's Bureau of Economic Analysis (BEA) provides estimates of the value of tangible corporate assets located in the United States. Adding in land and inventories, we have an average estimate for K_{1m} of 1.092 times GDP for 1955–1962. In 1987–2000, out estimate is 1.027 times GDP. The fact that these capital-output ratios have changed little has led many to conclude that the recent rise in equity values is puzzling.

Intangible Capital

To construct our estimate of V, we also need values for intangible capital. To compute the value of intangible capital, we exploit the equilibrium conditions that equate after-tax returns for all assets. (See Appendix A.) This condition along with NIPA corporate profits, the stock of tangible assets, and the after-tax interest rate obtained from the noncorporate sector suffice to determine the stock of intangible capital. In the calculations, there are two key adjustments. First, intangible investment must be added to the NIPA concept of profits. Second, the return to tangible capital has to be adjusted to reflect the fact that IRS depreciation is not equal to true depreciation. (See Appendix C.)

When we work through these details, we find an estimate for K_{1u} of 0.422 times GDP in the period 1955–62 and 0.819 times GDP in 1987–2000. These estimates indicate that there has been a doubling in the stock of intangible capital. We may be overstating the increase somewhat because it depends crucially on our estimates of the interest rate less the growth rate. Our empirical estimates imply a decline in the after-tax interest rate less the growth rate, $i - \gamma - \eta$, from 1.1 percent to 0.8 percent. This is significant given the fact that we divide profits by this term. But we compute these rates over short time periods and may have a noisy estimate of the difference.

U.S. Foreign Subsidiary Capital

We now have estimates of tangible and intangible capital located in the United States. We also need to include tangible and intangible capital of foreign subsidiaries because our measure of the total market value of U.S. corporations includes the value of their foreign subsidiaries. Thus, there is a mismatch between the BEA capital stock data and the corporate equity value of the *Flow of Funds Accounts*.

To avoid this mismatch, we construct a measure of the capital stock of foreign subsidiaries using data on foreign profits. In measuring foreign profits, the BEA assumes the same tax treatment for foreign and domestic capital. We do the same. Thus, we make the assumption that the ratio of after-tax profits to the capital stock is the same for domestic and foreign operations. Therefore, we can estimate the value of total foreign corporate capital before taxation of distributions using observations on domestic and foreign after-tax profits and domestic capital. The result is an after-corporate-tax estimate of value of foreign capital, which we denote by K^*, equal to 0.152 times GDP for the period 1955–62 and 0.437 times

GDP for the period 1987–2000. These estimate of foreign capital are then included in our formula as follows:

$$V_t = (1 - \tau_d)\left[(1 - \tau_\delta)K_{1m,t+1} + (1 - \tau_1)K_{1u,t+1} + K^*_{t+1}\right]. \tag{26}$$

We can now add up terms and compare the theoretical predictions for corporate equity with the actual market valuations.

4. Theory and Data

In Table 1, we report our main findings. Theory's prediction for the value of corporate equity in 1962 is 0.82 times GDP. Theory's prediction for the value of corporate equity in 2000 is 1.61 times GDP. Thus, our estimates of tax rates and capital stocks imply a *doubling* of the value of corporate equity. This is very close to what actually occurred in the United States. The actual values in 1962 and 2000 were 0.83 times GDP and 1.51 times GDP, respectively.

We compute the predicted contributions from the three types of capital. The after-tax value of domestic tangible capital was 0.608 times GDP in the early period but grew to 0.822 times GDP. This increase was due entirely to the drop in dividend tax rates. The value of domestic intangible capital was 0.129 times GDP and grew to 0.427 times GDP. Close to half of this increase was due to the fall in tax rates, both the rate on dividend income and the rate on corporate profits. Finally, there was a significant increase in the value of capital in foreign subsidiaries from 0.085 to 0.357, but given our data, it is not possible to know for sure the main source of the change. Our analysis and NIPA measurement assumes that the tax treatment is the same for both domestic and foreign capital.

If we use our predictions for corporate equity, we can compute a price-earnings ratio. We report predicted and actual price-earnings ratios in Table 1. In our calculations, we use observed after-tax earnings as is done in the finance literature. We estimate a ratio of 14.1 in

1962 and 29.8 in 2000. These estimates are very close to the actual ratios of 14.2 and 28.0, respectively. They are also close to estimates of Campbell and Shiller (2001), who look only at the S&P 500 companies.

Importance of Decline in Dividend Tax Rate

Quantitatively, the most important change over the postwar period was the decline in the dividend tax rate. If the rate had remained at 44.2 percent, our prediction for the corporate equity value would have been 1.10 times GDP rather than 1.61 times GDP. (See Appendix C for details.)

Importance of Increase in Intangible Capital

Hall (2000) has argued that a rise in the stock of intangible capital accounts for the large increase in equity prices. We estimate that the stock of intangible capital doubled, and its price rose significantly because of the decline in tax rates. If the stock of intangible capital had remained at its 1955–1962 average level of 0.422 times GDP, our prediction for the corporate equity value would have been 1.34 times GDP instead of 1.61 times GDP. Thus, the change in the stock of intangible capital can account for only a modest part of the large rise in equity values since the 1960s. It is part of the story, but quantitatively by far the most important factor is the change in the tax on dividends.

Importance of Increase in Foreign Capital

The stock of foreign capital nearly tripled, but it is still much smaller than domestic capital. If the foreign stock had remained at 0.152 times GDP, then our prediction for the corporate equity value would have been 1.37 times GDP.

The overall message of Table 1 is that taxation, especially taxation of dividends, can account for the large rise in the value of U.S. corporations.

5. Implications for Asset Returns

A large change in tax rates on dividends has a significant effect on equity returns. Note, first, that what is typically reported by organizations like the Center for Research in Security Prices (CRSP) or Ibbotson Associates is

$$\frac{V_{t+1} + d_{t+1}}{V_t} - 1 \tag{27}$$

whereas the relevant return for households is the post-tax return

$$\frac{V_{t+1} + (1 - \tau_d) d_{t+1}}{V_t} - 1. \tag{28}$$

If the theory can account for the large rise in equity values, and if dividends are of the same order of magnitude as in the data, then theory can account for the high reported returns of the postwar.

The change in tax rates on dividends can deliver a large increase in equity values. Dividends relative to GDP are roughly constant in the United States for much of the postwar period. The same is true in the model since steady-state values of capital and investment do not depend on the tax rate on dividends. We need only pick production parameters that give roughly the right capital-output ratios.

What then is our prediction for pre-tax returns, namely (27), reported by CRSP? This return is the sum of capital gains, $V_{t+1}/V_t - 1$, and dividend yields, d_{t+1}/V_t. The capital gains has two components: the anticipated gain and the unanticipated gain. The anticipated capital gain is the trend growth rate of productive assets. In the 1950s and early 1960s, we estimated this growth to be about 3.5 percent per year. It is currently a bit lower at 3.3 percent.

The unanticipated capital gain is the growth in the price of equity due to unanticipated changes in tax rates. Most of this gain was due to the decline in tax rates on dividend income, but there was also a decline due to the fall in corporate income tax rates. Furthermore, part of the increase in foreign subsidiary capital might also have been due to the lowering of trade barriers, which increases the price of equity.

As a baseline, consider the decline in the marginal rate on dividend income alone. It fell from 44 percent to 18 percent in 40 years. This decline alone implies that the growth in equity prices will be roughly $[(1 - .18)/(1 - .44)]^{1/40}$ or 1 percent per year higher than growth in GDP. If we add in all tax changes and assume a doubling of the price, then the unanticipated gain is $2^{1/40}$ or 1.8 percent per year higher than growth in GDP.

The last component of the return is the dividend yield. In the early 1960s, the dividend yield was about 3 percent. It is currently a little over 1 percent. Most of this change is due to the rise in equity prices, not to a decline in dividend income relative to GDP, which is consistent with our theory. Adding the dividend yield to the capital gains, we would expect an average pre-tax return after prices started falling in the range of 7.5 to 8.3 percent. These predictions are consistent with the estimates of CRSP.

Eventually, the equity returns have to come down as the dividend yield falls and the tax rates level out. Our prediction for future returns is a little over 4 percent.

If we additionally assume that households had a liquidity motive for holding debt and constraints on their retirement assets, we predict low bond returns and large equity premia.[13] In the first half of the postwar period, pension funds and life insurance reserves were almost entirely debt. There are good reasons for this. There were no clear guidelines for fiduciaries, who could be penalized for imprudent investments. In 1974, ERISA was passed and fiduciary responsibilities and liabilities were specified very clearly. Before 1970, less than 10 percent of retirement assets were equity assets. Today, they are close to 50 percent. There has been a significant shift over the postwar period.

6. Conclusions

With the large reduction in individual income tax rates, the increased opportunities to hold equity in nontaxed pension plans, and the increases in intangible and foreign capital, theory predicts a large increase in equity prices between 1962 and 2000. In fact, theory predicts a *doubling* of the value of equity relative to GDP and a *doubling* of the price-earnings ratio.

A corollary of this finding is that there is no equity premium puzzle in the postwar period. Mehra and Prescott (1985) found that the high return on equity relative to debt was not due to a premium for bearing non-diversifiable risk. This led them to label the difference in average returns a puzzle. They did not consider changes in tax and regulatory policies or institutions affecting asset markets. We do, and we find that the data – at least over the postwar period – are not puzzling.

Appendix A. Proofs of Propositions

In this appendix, we provide proofs for propositions 3 and 4 of Section 2.

Proof of Proposition 3. Use (17) and (19) to replace $x_{1m,t}$ and $x_{1u,t}$, respectively, in the corporate firm's problem (16). The maximization problem then is to maximize (16) subject to

$$(1+\eta)k_{1m,t+1} - (1-\delta_{1m})k_{1m,t} = (1+\eta)\hat{k}_{1m,t+1} - (1-\hat{\delta}_{1m})\hat{k}_{1m,t}. \tag{A1}$$

The first-order conditions for the firm with respect to $k_{1m,t+1}$, $\hat{k}_{1m,t+1}$, and $k_{1u,t+1}$ are

$$(1+\eta)\frac{p_t}{p_{t+1}} = \frac{(1-\tau_1)(p_{1,t+1}f^c_{1,t+1} - \tau_{1k})}{1-\lambda_t} + (1-\delta_{1m})\left(\frac{1-\lambda_{t+1}}{1-\lambda_t}\right) \tag{A2}$$

$$(1+\eta)\frac{p_t}{p_{t+1}} = \left[\lambda_{t+1}(1-\hat{\delta}_{1m}) + \tau_1\hat{\delta}_{1m}\right]/\lambda_t \tag{A3}$$

$$(1+\eta)\frac{p_t}{p_{t+1}} = p_{1,t+1}f^c_{2,t+1} + 1 - \delta_{1u} \tag{A4}$$

where λ_t is the multiplier on (A1) normalized by p_t and $f^c_{j,t}$ is the partial derivative of $f^c(k_{1m,t}, k_{1u,t}, z_t n_{1,t})$ with respect to its jth argument.

From the household's problem, we can derive

$$\frac{p_t}{p_{t+1}} = \frac{V_{1s,t+1} + (1-\tau_d)d_{1,t+1}}{V_{1s,t}} \tag{A5}$$

which relates the inverse of the marginal rate of substitution to the gross return on equity.

Multiply (A2) by $(1-\tau_d)(1-\lambda_t)k_{1m,t+1}$, (A3) by $(1-\tau_d)\lambda_t\hat{k}_{1m,t+1}$, and (A4) by $(1-\tau_d)(1-\tau_1)k_{1u,t+1}$. The resulting equation is consistent with (A5) if and only if

$$V_{1s,t} = (1-\tau_d)(1+\eta)\left[(1-\lambda_t)k_{1m,t+1} + \lambda_t\hat{k}_{1m,t+1} + (1-\tau_1)k_{1u,t+1}\right]. \tag{A6}$$

We now show that on a balanced growth path

$$(1-\lambda)k_{1m,t+1} + \lambda\hat{k}_{1m,t+1} = (1-\tau_\delta)k_{1m,t+1} \tag{A7}$$

where τ_δ is defined in (25). On a balanced growth path, the net interest rate, which we denote as i, is equal to $(1+\eta)p_t/p_{t+1} - 1$. Using (A3), we have

$$\lambda = \frac{\tau_1\hat{\delta}_{1m}}{i+\hat{\delta}_{1m}}. \tag{A8}$$

Using (A1), we have

$$\hat{k}_{1m,t+1} = \left(\frac{(1+\eta)(1+\gamma)-1+\delta_{1m}}{(1+\eta)(1+\gamma)-1+\hat{\delta}_{1m}}\right)k_{1m,t+1}. \tag{A9}$$

Substituting (A8) and (A9) into the left-hand side of (A7) gives the expression for τ_δ.[14] Substituting (A7) into (A6) gives us the expression for the equity price that we seek. ∎

Proof of Proposition 4. Since we assume that it is constant, the tax rate on dividend income, τ_d, only affects the household first-order condition relating the marginal rate of substitution and the return on equity. See (A5). It appears in no other first-order condition of the households and no first-order conditions of the firms. To compute the steady-state quantities for this economy, (A5) is not used. Therefore, the capital-output ratios do not depend on τ_d. ∎

Appendix B. Tax Rates on Dividend Income

In this appendix, we describe how we estimate tax rates on dividend income for the periods 1955–1962 and 1987–1997. The data for 1997 are the latest available.[15] The sources of our data in this exercise are the Internal Revenue Service's (IRS) *Statistics of Income* (SOI), the Bureau of Economic Analysis' national income and product accounts (NIPA) in the *Survey of Current Business* (SCB), the Federal Reserve Board's *Flow of Funds Accounts of the United States*, and the Investment Company Institute's *Mutual Fund Fact Book*.

Personal taxes on dividend income are paid by individuals who file the 1040 form with the IRS and by fiduciaries who file the 1041 form. The IRS compiles information from these tax forms in its *Statistics of Income*. It reports sources of income and taxable income from the filed returns for many income categories. In the case of individual returns (1040), the IRS also reports information by marital status: married filing jointly, married filing separately, single, surviving spouse, or head of household.

From the SOI data, we can construct the marginal tax rate paid by a typical filer in each income and marital category. For each group, we take reported taxable income for a typical filer, and we use the IRS tax schedule relevant to this group. To compute an average marginal rate in a given year, we weight the rate for each income-marital group by the fraction of dividend income earned by this group.[16] In the case of nontaxable returns, we use a marginal tax rate of 0 and the dividend income these filers report. In Table B1, we report the results of these computations for the years 1955 through 1962 and 1987 through 1997.

For fiduciary returns, we have much less data available. We have statistics for even years in the early period and for 1997 only in the later period. For the tax rates in the early odd years, we use the tax rates in the subsequent year. For example, for the tax rate in 1955, we use our estimate from 1956. In the later period, we use the 1997 tax rate in all years.

To construct a single rate for both types of returns, we use the fraction of dividend income reported on the 1040s and the 1041s to weight the respective tax rates. We have to estimate the taxable dividend income on the 1041s because part of the income is distributed to individuals (who then report it on their Form 1040). We know the total amount of income distributed. We assume that all types of income (dividends, interest, etc.) are distributed proportionally. Taxable dividend income for a particular 1041 filer is therefore assumed to be total dividend income multiplied by the fraction of income that is not distributed. The average of the 1040 rates and 1041 rates is reported under "average marginal rate for both 1040 and 1041."

Income taxes are also paid to state and local governments. To adjust for state and local taxes in a particular year, we multiply our estimate of the average marginal rate in that year by the ratio of total personal income tax receipts to federal personal income tax receipts. Data on receipts are taken from SCB NIPA Tables 3.2 and 3.3. This is a reasonable procedure for adjusting the rates if federal, state, and local tax schedules have similar slopes.

To get our final estimates, we make one final adjustment. We multiply the marginal rates by the fraction of equity held outside of tax-sheltered accounts. In Table B2, we report fractions of total equity held in sheltered pension funds, IRAs, and portfolios of tax-exempt nonprofit organizations.

Data on non-IRA pension funds are taken from the *Flow of Funds Accounts*. To estimate the equity holdings in these funds, we add corporate equities of private pension funds (FOF Table L.119), state and local government employee retirement funds (FOF Table L.120), and tax-exempt life insurance reserves (FOF Table B.100e).

Some corporate equity in the pension funds are held in the form of mutual funds. We estimate the equity fraction of mutual fund holding by taking the ratio of all mutual fund equity to total mutual fund assets (FOF Tables B.100 and B.100e).

To estimate equity holdings of IRA accounts, we use data reported in the Investment Company Institute's *Mutual Fund Fact Book*. It reports total IRA asset holdings back to 1981. Our estimate of the share of equity holdings is 77 percent, which is the actual share the Institute reports for 2000.

The third category of nontaxed equity is equity held by nonprofit organizations. These data are reported in the *Flow of Funds Accounts* for the years 1987–1997. Adding the retirement equity and the nonprofit equity, we get our estimate of the fraction of equity that is tax-sheltered. We use this estimate to adjust our marginal tax rate. This is how we get the last column of Table B1.

Table B1. Derivation of the Tax Rates on Dividend Income, 1955-62 and 1987-97

Year	Average Marginal Rate: Form 1040	Average Marginal Rate: Form 1041[a]	Average Marginal Rate for Both 1040 & 1041[b]	Adjustment for State and Local Income Taxes	Adjustment for Tax-Sheltered Accounts
1955	47.9	34.4	46.5	48.5	46.8
1956	47.8	34.4	46.4	48.6	46.9
1957	46.7	29.5	44.9	47.1	45.2
1958	46.1	29.5	44.3	46.6	44.6
1959	47.7	31.7	46.1	48.7	46.4
1960	45.1	31.7	43.7	46.3	43.8
1961	46.0	33.6	44.7	47.7	44.9
1962	45.1	33.6	43.9	47.0	44.2
Avg. 1955-62	46.6	32.3	45.1	47.5	45.4
1987	28.3	36.3	28.9	35.2	18.5
1988	24.9	36.3	25.8	31.5	17.2
1989	24.3	36.3	25.2	31.0	16.7
1990	24.3	36.3	25.2	31.0	15.2
1991	24.7	36.3	25.6	31.8	16.6
1992	24.8	36.3	25.7	32.2	16.7
1993	26.5	36.3	27.3	34.1	17.0
1994	26.7	36.3	27.4	34.2	15.8
1995	27.4	36.3	28.1	34.9	16.8
1996	28.9	36.3	29.5	36.3	17.5
1997	29.0	36.3	29.6	36.2	18.2
Avg. 1987-97	26.3	36.3	27.1	33.5	16.9

[a] Data on fiduciary returns are only available for years 1956, 1958, 1960, 1962, and 1997. Our estimate for the tax rates in 1955, 1957, 1959, and 1961 is the tax rate in each subsequent year. Our estimate of tax rates in years 1987 through 1996 is the 1997 estimate.

[b] For years 1955, 1957, 1959, and 1961, we assume that the ratio of 1040 dividend income to 1041 dividend income is the same as in each subsequent year. For years 1987 through 1996, we assume that the ratio of 1040 dividend income to 1041 dividend income is the same as in 1997.

Table B2. Fraction of Equity Held in Retirement Accounts and by Nonprofit Organizations, 1955-62 and 1987-97

Year	Pensions	IRAs	Nonprofits[a]	Total
1955	3.5	0	NA	3.5
1956	3.5	0	NA	3.5
1957	4.0	0	NA	4.0
1958	4.3	0	NA	4.3
1959	4.8	0	NA	4.8
1960	5.3	0	NA	5.3
1961	5.8	0	NA	5.8
1962	5.8	0	NA	5.8
Avg. 1955-62	4.6	0	NA	4.6
1987	30.2	11.9	5.3	47.4
1988	27.9	12.2	5.2	45.4
1989	28.1	12.0	6.0	46.1
1990	29.6	15.1	6.3	51.0
1991	29.3	13.4	5.0	47.7
1992	29.6	13.4	5.0	48.0
1993	31.4	13.7	5.0	50.0
1994	33.4	14.7	5.7	53.8
1995	33.1	13.2	5.5	51.8
1996	33.7	12.6	5.7	51.0
1997	33.0	11.4	5.4	49.8
Avg. 1987-97	30.8	13.1	5.5	49.4

[a] Data on nonprofit equity holdings are only available for the period 1987-1997. See the *Flow of Funds* for details.

Appendix C. Derivation of Corporate Equity Value

In this appendix, we describe how we estimate the corporate equity value using data from the Bureau of Economic Analysis' (BEA) *Survey of Current Business* (SCB), the Federal Reserve Board's *Flow of Funds Accounts of the United States* (FOF), and our estimates of tax rates on dividend income. (See Appendix B.) Data from the SCB include the national income and product accounts (NIPA) and their estimates of fixed assets (FA).

We first show how we organize the national accounts to be consistent with our theory. In Table C1, we report average values of domestic income for the United States for the periods 1955–1962 and 1987–2000. All values are relative to GDP (SCB NIPA Table 1.1).

We split income into "corporate" and "noncorporate," where noncorporate income is the difference between total domestic income and the domestic income of corporate business. Values for corporate income are taken from NIPA Table 1.16 in SCB. Values for noncorporate capital consumptions are the difference between the total (SCB NIPA Table 1.9) and corporate capital consumption (SCB NIPA Table 1.16). Values for other noncorporate income are taken from SCB NIPA Tables 1.14 and 1.15.

The middle column of Table C1 relates the NIPA system of accounts to the model system of accounts. The notation is consistent with our model of Section 2B. We have introduced notation for the rental rates on capital. These rates are $r_{1m} = p_1 \partial f^c / \partial k_{1m}$, $r_{1u} = p_1 \partial f^c / \partial k_{1u}$, and $r_2 = p_2 \partial f^{nc} / \partial k_2$.

The gross domestic income (line 19) shows the relation between the model's concept of income and the NIPA concept of income. There are four differences. First, NIPA income includes sales and excise taxes. These taxes are consumption taxes in the model and are excluded from both income and product. Second, NIPA income does not include intangible investment. U.S. corporations can expense intangible investment, but we treat it as an investment in our model. We therefore add it to our model's corporate income and to investment. Third, NIPA income excludes capital consumption of durable goods. Purchases of durable goods are treated as consumption in NIPA and investment in our model. We therefore must include capital consumption on durable goods in our income concept. We denote this by $\delta_2 k_{cd}$, where k_{cd} is the stock of consumer durables. Fourth, NIPA does not impute services to durable goods or to government investment goods. These are investments in our model, and we therefore impute services to them. We denote the after-tax return by i and the stock of government capital by k_g.

In Table C2, we report the product side of the NIPA accounts, values for domestic capital stocks, and net foreign profits. Values for domestic product are taken from SCB NIPA Table 1.1. The measures of corporate and noncorporate investment are taken from the *Flow of Funds Accounts*, Table F6. In both the model and NIPA accounts, incomes and products must equal. In line 7, we show that the difference between model and data incomes is equal to the difference between model and data products.

The *Survey of Current Business* also reports estimates of capital stocks (or, fixed assets) which we use for our estimation of corporate equity. In Table C2, we report ratios of corporate and noncorporate stocks to GDP. Our measured corporate capital includes structures, plant and equipment, inventories, and land. Structures and plant and equipment account for most of the capital; with nonresidential and residential included, the average value of these stocks as measured by the BEA was 0.816 times GDP in 1955–1962 and 0.829 times GDP in 1987–2000 (SCB FA Tables 7KCU and 9KCU). We include inventories taken from the national accounts (SCB NIPA Table 5.12) in our measure of corporate capital. The value of inventories was 0.242 times GDP in 1955–1962 and 0.165 times GDP in 1987–2000.

The BEA reports estimates for the structures but not for the land they are on. To get an estimate of the value of corporate land, we took values from corporate tax returns. In both periods, we found similar estimates, namely 0.034 times GDP in 1955–1962 and 0.033 in 1987–2000.

We need estimates for the value of noncorporate capital because we use them to estimate interest rates in our two periods. In Table C2, we report BEA estimates for total noncorporate capital and show how much of this is government capital and consumer durables. As noted above, we use capital stocks for government capital and consumer durables to adjust the national accounts.

We do not include land values in our noncorporate capital stock measure because most of the return on land over the postwar period was due to capital gains, which are difficult to estimate. Since these gains are not included in the noncorporate profits measure of the SCB, we exclude land from our noncorporate capital measure.

The only capital stock measures that we have from the BEA are for capital stocks located in the United States. Many corporations have capital in foreign subsidiaries, and foreign production affects their stock values. In order to estimate the capital stocks of foreign subsidiaries we capitalize their profit flows. In Table C2, we report net after-tax foreign profits (SCB NIPA Table 6.16).

We use net after-tax profits from abroad because shares for firms like Toyota are issued through the parent company in Japan and trade on the New York Stock Exchange as issues of American Depository Receipts (ADR). These ADRs are not included in the *Flow of Funds* market value of domestic corporations. They appear separately as "rest of the world" issues. (See FOF Table L.213.) Therefore, we need to net out the profits of these corporations when computing our capital stocks.

Table C3 shows how we use the SCB and SOI data to construct our estimate of corporate equity values. We first compute the growth rate of real GDP. We then compute tax rates on corporate income and income distributed to households. The corporate tax rate is derived from the income side of the national accounts, which reports before- and after-tax profits. The distribution tax derivation is described in Appendix B.

In order to compute service flows for our accounts and to compute our intangible capital, we need an estimate for the after-tax real interest rate. We use noncorporate profits and capital for this calculation. To make the model and NIPA accounts consistent, we have to make two adjustments to noncorporate profits. First, we add imputed services to consumer durables and to government capital, which is equal to $i(k_{cd}+k_g)$. Notice that this depends on i so we are in effect solving a fixed point problem. Second, we subtract intermediate financial services that are not included in our model accounts. These services are primarily the interest received by households who lend to financial institutions issuing mortgages. They are equal to roughly half of the net interest reported in noncorporate income. The remainder includes forgone interest of individuals holding currency and checking accounts.[17]

Next, we need to make adjustments to the return and price of tangible capital because the IRS allowable depreciation is different from the true economic depreciation reported in the *Survey of Current Business*. In Table C1 (line 7), there is an adjustment to profits that is the estimate of the difference between IRS depreciation and economic depreciation. We use this term along with observed tangible capital to estimate the book value of capital and the depreciation rate used by the IRS. These estimates can be used to determine the needed adjustments to the price of capital and the return to corporate measured capital. The price of capital is adjusted by $1 - \tau_\delta$. The after-tax return on tangible capital is also adjusted by $\hat{i} - i$. These terms are equal to 0 if the depreciation allowed is equal to true economic depreciation.

To compute intangible capital, we assume that after-tax real returns to all assets, namely corporate measured capital, corporate unmeasured capital, and noncorporate capital are the same. The expression for intangible capital requires some algebra, but the main steps are as follows. First, note that for the model in equilibrium, $(r_{1m} - \delta_{1m} - \tau_{1k})k_{1m} = \hat{i}k_{1m}/(1-\tau_1)$, which are before-tax profits accruing to tangible capital. Second note that $r_{1u}k_{1u} - x_{1u} = (i - \gamma - \eta)k_{1u}$, which are before-tax profits accruing to intangible capital less intangible investment. The sum of these two is what NIPA reports for corporate profits (after adjustments for depreciation). If we add them, we can use our estimates of $\hat{i}$, k_{1m}, τ_1, i, and $\gamma+\eta$, along with the NIPA profits to estimate k_{1u}. Note that this calculation does not require us to know the rate of depreciation of intangible capital.

With measures of domestic tangible corporate capital and domestic intangible corporate capital, we can construct a measure of the value of total domestic corporate capital before taxation of distributions, k. The prices of tangible and intangible capital are not the same because they are taxed differently. The total value of domestic capital is equal to $(1-\tau_\delta)k_{1m} + (1-\tau_1)k_{1u}$. The τ_δ term is the adjustment to the price of corporate measured capital due to depreciation allowances described above. The price of intangible is one minus the corporate tax rate because of the fact that intangible investment can be expensed and therefore avoids income taxation.

For foreign subsidiaries, we observe only profit flows. We make the assumption that the ratio of after-tax profits to the capital stock is the same for domestic and foreign operations. Therefore, we can estimate the value of total foreign corporate capital before taxation of distributions, k^*, using observations on domestic and foreign after-tax profits and domestic capital.

To compute our predicted value of corporate equity, we multiply $k + k^*$ by $1 - \tau_d$, where τ_d is the tax rate on dividend income described in Appendix B. To compute the price-earnings ratio, we divide the total value by measured after-tax earnings. We use measured after-tax earnings because this is what is reported in other studies. (See, for example, Campbell and Shiller 2001.) The results are reported in the last two rows of Table C3.

Table C1. U.S. Domestic Income, 1955:1962 and 1987:2000

		Model Expression	Averages for[a] 1955-62	Averages for[a] 1987-00
	Corporate Domestic Income			
1	Capital consumption	$\delta_{1m}k_{1m}$	0.046	0.069
2	IBT+transfers−subsidies[c]	$\tau_{1k}k_{1m} + \omega_1\tau_c c$	0.054	0.057
3	Compensation	wn_1	0.357	0.380
4	Profits	$(r_{1m}-\delta_{1m}-\tau_{1k})k_{1m}+r_{1u}k_{1u}-x_{1u}$	0.097	0.071
5	Profits tax liability	$\tau_1[(r_{1m}-\tau_{1k})k_{1m}-\hat{\delta}_{1m}\hat{k}_{1m}+r_{1u}k_{1u}-x_{1u}]$	0.045	0.026
6	Profits after tax	$(1-\tau_1)[(r_{1m}-\tau_{1k})k_{1m}-\hat{\delta}_{1m}\hat{k}_{1m}+r_{1u}k_{1u}-x_{1u}]$	0.052	0.042
7	Adjustments to profits	$\hat{\delta}_{1m}\hat{k}_{1m} - \delta_{1m}k_{1m}$	0.000	0.003
8	Net Interest[b]		-0.001	0.018
	Noncorporate Domestic Income			
9	Capital consumption	$\delta_2(k_2 - k_{cd})$	0.062	0.054
10	IBT+transfers−subsidies[c]	$\tau_{2k}k_2 + \omega_2\tau_c c$	0.030	0.023
11	Compensation	wn_2	0.282	0.246
12	Wages and salaries		0.199	0.192
13	80% of proprietor's income		0.083	0.054
14	Profits	$r_2k_2 - \delta_2k_2 - \tau_{2k}k_2 - i(k_{cd}+k_g)$	0.070	0.080
15	20% of proprietor's income		0.021	0.014
16	Rental income		0.030	0.012
17	Net interest[b]		0.019	0.054
18	**Statistical Discrepancy**		0.001	0.002
19	**Gross Domestic Income**[b]	$\underbrace{r_{1m}k_{1m}+r_{1u}k_{1u}+r_2k_2+wn}_{\text{Model income}} + \underbrace{\tau_c c-x_{1u}-\delta_2k_{cd}-i(k_{cd}+k_g)}_{\text{NIPA income}-\text{Model income}}$	1.000	1.000

[a] All values are relative to gross domestic product.

[b] This category includes intermediate financial services which are not included in our model concept.

[c] Fraction ω_i of sales and excise taxes are included in sector i's indirect business tax.

TABLE C2. U.S. DOMESTIC PRODUCT, CAPITAL STOCKS, AND FOREIGN PROFIT, 1955:1962 AND 1987:2000

		Model Expression	Averages for[a] 1955-62	Averages for[a] 1987-00
	Domestic Product			
1	Private consumption[b]	$c(1+\tau_c) - \delta_2 k_{cd} - i k_{cd}$	0.542	0.585
2	Govt. consumption	g	0.164	0.157
3	Investment		0.294	0.258
4	Corporate			
5	Measured	x_{1m}	0.073	0.100
6	Noncorporate	x_2	0.221	0.158
7	Gross Domestic Product[b]	$\underbrace{c + x_{1m} + x_{1u} + x_2 + g}_{\text{Model product}} + \underbrace{\tau_c c - x_{1u} - \delta_2 k_{cd} - i(k_{cd} + k_g)}_{\text{NIPA product}-\text{Model product}}$	1.000	1.000
	Domestic Capital Stocks			
	Corporate			
8	Measured	k_{1m}	1.092	1.027
9	Noncorporate	k_2	2.363	2.176
10	Government	k_g	0.720	0.598
11	Consumer durables	k_{cd}	0.332	0.290
12	Other		1.310	1.288
13	**Foreign After-tax Profits**	$ik^* - (1-\tau_1)x^*_{1u}$	0.006	0.012

[a,b] See footnotes for Table C1.

Table C3. Calculations for Corporate Equity Value, 1955:1962 and 1987:2000

	Model Expression and Calculation	1955-62	1987-00
Average Growth in Real GDP	$100\,(\gamma+\eta)$	3.523	3.312
Corporate Tax Rates[a]			
Income tax	τ_1 = (Table C1, line 5)/(Table C1, line 5 + line 6)	0.452	0.362
Distribution tax[b]	τ_d	0.442	0.182
Interest Rate (%)	$i = r_2 - \delta_2 - \tau_{2k}$	4.630	4.120
Noncorporate profits	Table C1, line 14	0.070	0.080
Plus: imputed capital services	i (Table C2, line 10 + line 11)	0.049	0.037
Less: intermediate financial services	1/2 (Table C1, line 17)	0.009	0.027
Divided by: capital stock	Table C2, line 9	2.363	2.176
Depreciation Adjustments			
Corporate measured capital	k_{1m} = Table C2, line 8	1.092	1.027
Book capital	$\hat{k}_{1m} = k_{1m} -$ (Table C1, line 7)/ $(\gamma+\eta)$	1.103	0.942
Economic depreciation	δ_{1m} = (Table C1, line 1)/ k_{1m}	0.042	0.067
Depreciation allowance	$\hat{\delta}_{1m}$ = (Table C1, line 1 + line 7) / $\hat{k}_{1m}$	0.043	0.077
Capital price adjustment	$\tau_\delta = \tau_1\hat{\delta}_{1m}(\hat{\delta}_{1m}-\delta_{1m})/[(\gamma+\eta+\hat{\delta}_{1m})(i+\hat{\delta}_{1m})]$	0.002	0.021
Corporate return adjustment (%)	$\hat{i} = i + \tau_1[\delta_{1m} - \hat{\delta}_{1m}(i+\delta_{1m})/(i+\hat{\delta}_{1m})]$	4.642	4.005
Intangible Capital	k_{1u} = [Table C1, line 4 $-\hat{i}k_{1m}/(1-\tau_1)]/(i-\gamma-\eta)$	0.422	0.819
Domestic Capital	$k = (1-\tau_\delta)k_{1m} + (1-\tau_1)k_{1u}$	1.321	1.528
Foreign Subsidiary Capital	$k^* = k$ (Table C2, line 13)/(Table C1, line 6)	0.152	0.437
Corporate Equity Value	$V = (1-\tau_d)[k+k^*]$	0.822	1.608
Price-Earnings Ratio	V / (Table C1, line 6 + Table C2, line 13)	14.118	29.823

[a] Rates in last year of period.

[b] See Appendix B for details on the distribution tax.

Notes

[1]Here pension funds include annuities provided by life insurance companies.

[2]One exception was CREF, whose creation required a special New York State law.

[3]See, for example, Abel (1990), Boldrin, Christiano, and Fisher (2000), Constantinides (1990), Campbell and Cochrane (1999), Epstein and Zin (1989,1991), Gali (1994), Hansen, Sargent, and Tallarini (1999), and Jermann (1998). See also Kocherlakota (1996) for an excellent survey of the literature.

[4]New theories emphasizing risk premia have largely ignored an older literature that emphasizes the interaction of public finance and finance. See, for example, Feldstein (1980a, 1980b) and Feldstein and Green (1983).

[5]We abstract from corporate debt because corporations were close to 100 percent equity-financed in the time periods we consider.

[6]Here, we abstract from all forms of heterogeneity in individuals. We view this as a first step toward understanding the interaction of stock values and the U.S. tax system. Obvious extensions would allow for individuals of different ages, incomes, and abilities. See, for example, the work of Alvarez and Jermann (2000), Constantinides, Donaldson, and Mehra (2000), and Heaton and Lucas (1996).

[7]Because of our emphasis on taxation as a key factor for postwar asset prices, we analyze a production economy. See also Boldrin, Christiano, and Fisher (2000), Cochrane (1991), Hall (1999), and Jermann (1998), who study asset pricing in production economies.

[8]See for example, King (1977), Auerbach (1979), Summers (1981), and Summers and Poterba (1985).

[9]We have not included investment tax credits or accelerated depreciation in this analysis because they were not a factor during the periods we consider. However, increased investment credits and accelerated depreciation do affect the price of capital, both make investing cheaper. Part of the fall in equity prices during the 1970s and 1980s can be attributed to increased investment tax credits and accelerated depreciation allowances.

[10]In writing the corporate firm's problem, we have ignored debt financing. In both the 1960s and the 1990s debt-equity ratios were very low. There is a good theoretical explanation

for the 1960s. If $\tau_d > \tau_1$, then the firm would choose only equity financing because the household has a heavy tax burden when initially shifting from equity to debt and this cost is not outweighed by future benefits from tax deductions of interest payments. In the 1990s, $\tau_d < \tau_1$, which would imply that debt financing should dominate equity financing. The fact that firms did not debt-finance in this case is not really well understood. See Auerbach (2000).

[11]U.S. households also have net holdings of corporate and foreign debt, but the value of these holdings is quantitatively small. To avoid cumbersome notation, we do not explicitly introduce them.

[12]See *Employee Benefits Law* (1991) and *Primer on ERISA Fiduciary Duties* (1994) for more details on the history of benefits law.

[13]Our model abstracts from factors giving rise to a liquidity demand for debt assets. See Bansal and Coleman (1996) who introduce a wedge between cash and debt assets held for pure investment purposes.

[14]Here and elsewhere we ignore the term $\gamma\eta$ since it is too small to affect any of our estimates.

[15]In the early period that we consider, most distributions were made by issuing dividends rather than by buying back shares. Any pro rata redemptions were considered equivalent to a taxable dividend. In the later period, capital gains were taxed as ordinary income so there was no advantage to buy-backs. See Chapter 9 of Bittker and Eustice (2000).

[16]In the years 1987–1997, the IRS reports dividend income by adjusted income class only for all returns. We compute a marginal rate for each marital class by using taxable income from all returns along with that marital class' tax schedule. We weight the results using total dividend income earned by that marital group.

[17]See McGrattan and Prescott (2000) for more details on estimation of intermediate financial services.

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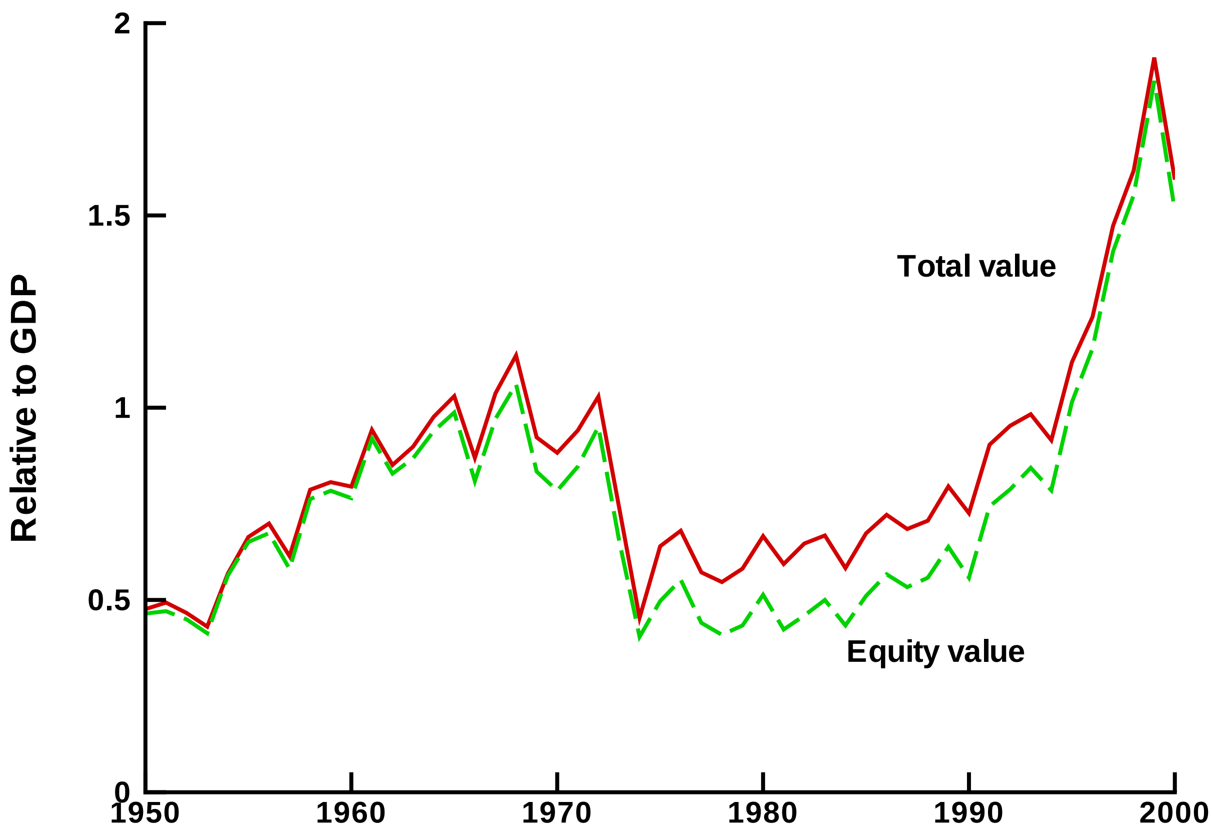

Figure 1. Value of U.S. Corporations

TABLE 1. CORPORATE EQUITY VALUE AND PRICE EARNINGS RATIO

	1955-1962	1987-2000
CORPORATE EQUITY VALUE[a,b]		
Predicted contribution from		
Domestic tangible capital	.608	.822
Domestic intangible capital	.129	.427
Foreign capital	.085	.357
PREDICTED TOTAL	.822	1.61
ACTUAL	.828	1.51
PRICE-EARNINGS RATIO[b]		
PREDICTED	14.1	29.8
ACTUAL	14.2	28.0

[a] Corporate equity values are relative to the value of gross domestic product.

[b] Capital stocks and earnings are averaged over the periods, and corporate equity values are end-of-period.