The Boom-Bust Cycle in Japanese Asset Prices

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Abstract

The Japanese economy experienced a substantial increase and a subsequent crash in land and stock prices in the 1980s and 90s. I use a neoclassical growth model to determine how much of these asset price movements can be accounted for by the observed changes in fundamentals of the Japanese economy; in particular changes in productivity growth and government policy regarding land taxation. In the model, corporations issue land-collateralized debt to reduce their tax liabilities and the government follows a land-taxation policy that is countercyclical to land prices. These features substantially magnify the effect of small shocks by reducing the required return on land. With the model calibrated to Japanese data, I find that the observed

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changes in fundamentals cannot simultaneously account for the movements in asset prices and macroeconomic variables. In particular, with persistent changes in fundamentals, the observed asset prices can be justified, but at the cost of counter-predicting macroeconomic variables.

Keywords: Japan, land prices, asset pricing, land taxation, general equilibrium.

JEL Classification: G12, C68, O40, E62

1 Introduction

Japan experienced a significant increase in land prices in late 1980s. The total value of Japanese land increased by 70% relative to GDP between 1984-1990.[1] This movement is even more striking given the fact that land values were already quite high in early 80s; the Japanese archipelago was valued at more than three times the size of GDP. For the U.S., the corresponding figure is only 0.6 for the same period.[2]

The behavior of land prices has important implications for the market value of Japanese corporations. More than a fourth of land value in Japan is held by corporations and land constitutes almost a half of the total value of corporate tangible assets (see Figure 1). For comparison, land accounts for less than 10% of tangible assets for U.S. corporations. Given the importance of land in corporate balance sheets, it is not surprising that the market value of corporations in Japan also experienced a boom after 1984. By 1989, the

[1] See the appendix for all data sources and data construction.

[2] See Boone (1989) for more on the differences in land value to GDP ratios across countries. In this paper, I do not directly explore cross-country differences; instead I take the general level of Japanese land value as given and explore its time variation.

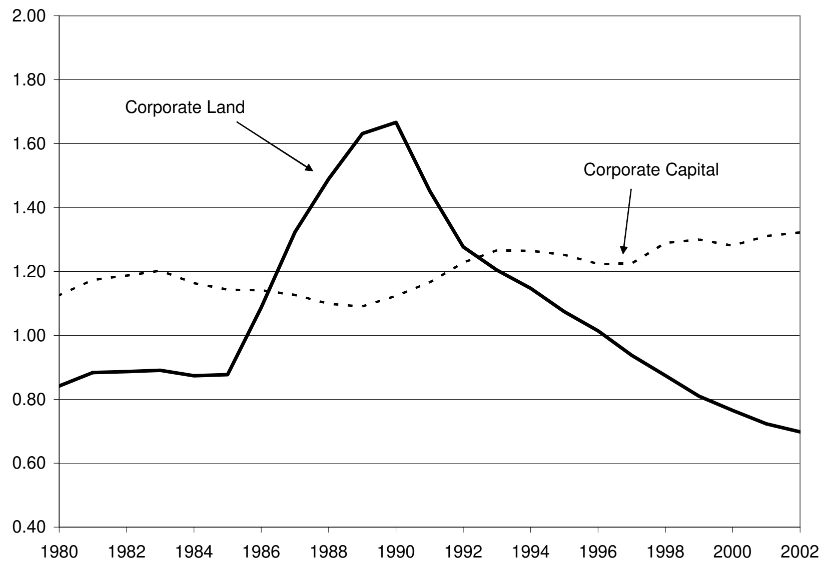

Figure 1: Value of corporate land and capital relative to GDP

major Japanese stock indexes had almost tripled in value relative to GDP (see Figure 2).[3] Unlike the U.S., where the financing-mix of corporations is heavily tilted towards equity, Japanese corporations are highly levered and debt-financing (mainly through banks) constitutes about two thirds of total market valuation. A substantial amount of new debt was accumulated by Japanese corporations in this period as higher land prices translated into new collateral against which they could borrow from banks.[4]

Land and equity prices sharply declined in the 90s, however, and the asset price phenomenon of the late 80s has since been labeled a *bubble* [c.f. Ito and Iwaisako (1995)]. In this paper, I use an applied general equilibrium

[3] The stock market peaked in 1989, a year before land prices. The lag in land values could partially be due to delays in official reporting however [Ishi (2001)].

[4] See Dinc and McGuire (2004) and also Gan (2003) on this issue.

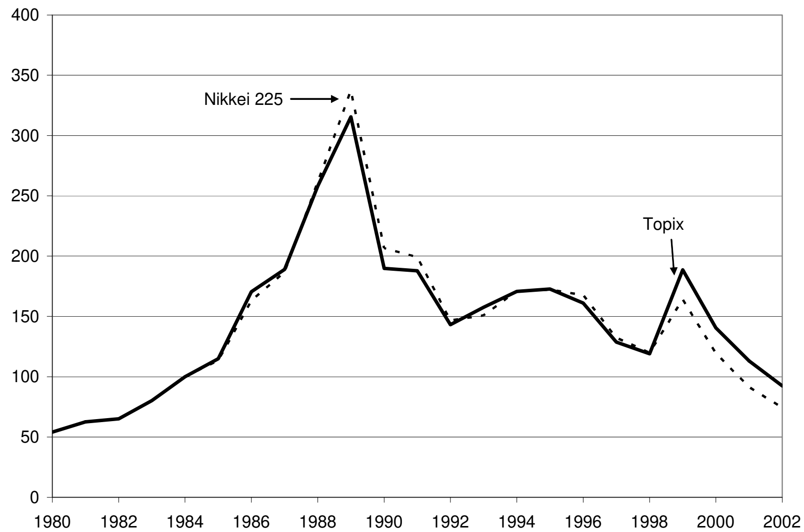

Figure 2: Stock market indexes relative to GDP (1984=100)

model similar to McGrattan and Prescott (2002) to determine how much of these asset price movements can be accounted for by the observed changes in *fundamentals* of the Japanese economy. In particular, I consider the effects of changes in total factor productivity (TFP) and government policy regarding land-taxation.

The behavior of asset prices in this period closely mirror the overall growth performance of the Japanese economy. Figure 3 plots Japanese GDP detrended by 2.45%, the average growth rate of GDP between 1980-2002. By 1990, the Japanese GDP was 16% above trend. A simple growth accounting exercise reveals that the main culprit for this was the increase in TFP growth. TFP grew at about 3.1% per year between 1984-1990 compared to only 1.2% in the decade preceding it. This increase may have

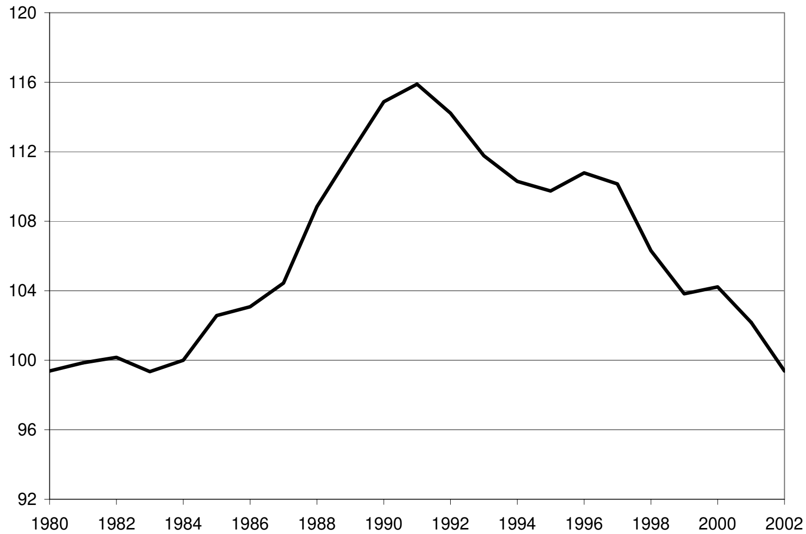

Figure 3: Detrended GDP (1984=100)

also generated expectations of restoring the growth performance of the 60s (when TFP grew by 6.9%). TFP growth, however, reversed in the 90s and averaged only 1.0% per year between 1990-2002.

There were also important changes in government policy regarding land taxation during the 80s and 90s. The effective tax rate paid on Japanese land holdings declined by almost two-fold between 1984-1991 (see Figure 4).[5] The main culprit for this was not changes in the official tax rate *per se*, but rather the changes in *assessed values* of land for taxation purposes. As market prices for land increased, the government raised the assessment values at a lower pace so as not to increase the tax burden of landowners. The effective marginal tax rate on land holdings gradually declined

[5] See the appendix for more on land taxation in Japan in general and the construction of the effective tax rate on land. The main source used was Ishi (2001).

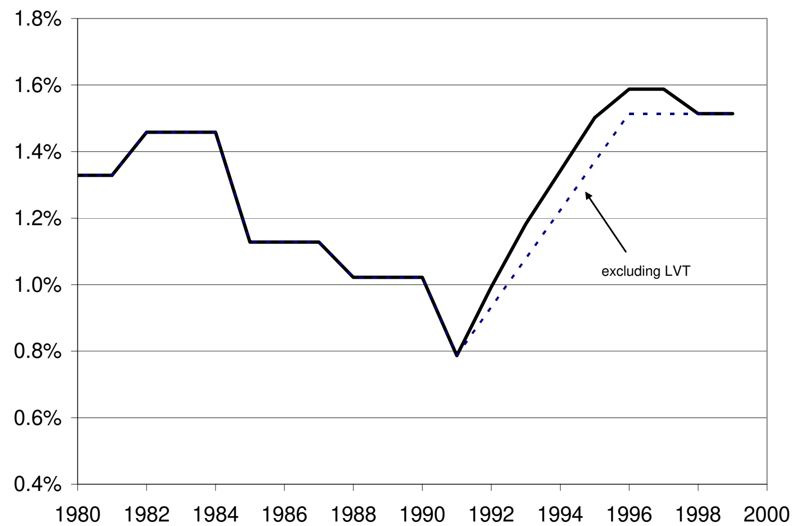

Figure 4: Effective marginal tax rate on corporate land holdings

from 1.4% to 0.8% between 1984-1991. In 1991, the Japanese government legislated a comprehensive reform on land taxation which gradually raised assessments of land values for tax purposes, and introduced a new national Land Value Tax (LVT) at a rate of 0.3%. With these changes, the effective tax rate rose back to about 1.5% by 2000.[6]

The existing literature has reached mixed conclusions regarding the question of whether the increase in Japanese land and stock prices in the late 80s and their subsequent reversal can be explained by fundamentals. French and Poterba (1990) and Ito and Iwaisako (1995) both argue that the asset price increases cannot be explained by fundamentals alone; specifically the decrease in the required rate of return is not large enough. Boone (1989)

[6]The LTV applied only to large landowners and was later phased out. As shown in Figure 4, the exclusion of the LTV does not significantly change the overall picture however.

and Stone and Ziemba (1993) argue that credit market and tax conditions justify the bulk of the rise in asset prices in the late 80s. Mera (2000) argues that the government's response to the asset price increases, especially strengthening of the land related taxation, is the major culprit for the fall of asset prices in the 90s. Nishimura et al. (1999) argues that the tax-shelter and collateral services of land are quasi-rents and hence should be included in analyzing land valuation. My paper differs from the above in that it utilizes a calibrated general equilibrium model instead of starting from a reduced-form asset pricing equation. This clarifies the contribution of each factor considered, makes the role of expectations more transparent, and forces the model to be consistent with other macroeconomic aggregates (such as investment and output) while accounting for asset prices.[7]

In the model, corporations issue land-collateralized debt similar to Kiyotaki and Moore (1997) and deduct their interest payments from their tax liabilities. The resulting tax-savings reduce the required rate of return on land. With this feature, land values are high and more responsive to small changes in the required return. An additional and important magnification is due to the response of government to land price movements. The government reduces the effective tax rate on land as land prices increase and raises them as land prices decline. This policy exacerbates the movements in land prices. I calibrate the parameters of the model to match certain features of Japanese data and run simulations. I find that the observed changes in fundamentals cannot simultaneously account for the movements

[7] Cochrane (2008), for example, argues that when evaluating an asset pricing explanation, consistency with macroeconomic aggregates is as important as consistency with financial variables.

in asset prices and macroeconomic variables. In particular, if agents correctly expect the changes in TFP growth to be temporary, the model can account for the movements in macroeconomic aggregates, but not in asset prices. If, however, agents expect persistent changes in TFP growth, the movements in land values can be fully and the movements in equity values can be partially justified. This comes at the cost of counter-predicting macroeconomic variables however.

The next section lays out the model economy. Section 3 derives the main theoretical results on land and corporate valuation from the model. Section 4 presents the calibration of the model to Japanese data. The quantitative findings from the model are presented in section 5. Section 6 concludes.

2 The Model Economy

In this section, I present a general equilibrium asset pricing model with production and capital accumulation similar to McGrattan and Prescott (2002). Infinitely-lived households are shareholders of corporations which carry out production activities. Land is used as an input in production as well as collateral for corporate borrowing. There is also a government that taxes households and firms to finance its expenditures.

2.1 The Stand-in Household

The population in period t is denoted by N_t and η is the constant growth factor of population, so $N_{t+1} = \eta N_t$. Agents are endowed with a unit of time each period which they allocate between labor and leisure. The stand-in household's preferences over the consumption good and leisure are described by the following utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t, h_t\right) N_t$$

where

$$u\left(c_t, h_t\right) = \begin{cases} \left[c_t^{\alpha}\left(1-h_t\right)^{1-\alpha}\right]^{1-\sigma} / \left(1-\sigma\right) & \text{if } \sigma \neq 1 \\ \\ \alpha \log c_t + \left(1-\alpha\right) \log\left(1-h_t\right) & \text{if } \sigma = 1 \end{cases}$$

t indexes time, $\beta < 1$ is the constant discount factor, α regulates the importance of consumption relative to leisure within period utility, σ is the inverse of the intertemporal elasticity of substitution, c is the consumption good and h is labor time.

Household members own the corporations, and participate in an asset market where perfectly divisible shares of these firms are traded. They earn labor income and receive dividends from their ownership of the firms. They also lend to corporations and receive interest income from their lending. The household's period budget constraint is given by

$$\begin{aligned} & \left(1+\tau_c\right) N_t c_t + v_t\left(s_{t+1}-s_t\right) + b_{t+1} - b_t \\ \leq \; & \left(1-\tau_h\right) w_t N_t h_t + \left(1-\tau_d^h\right) d_t s_t + \left(1-\tau_b\right) r_{b,t-1} b_t + T_t \end{aligned}$$

where s is the amount of firm shares, v is the price of a share and d is per-share dividends paid out by corporations. Dividend income is taxed at a rate of τ_d^h at the household level. b denotes the amount of lending to corporations from which households earn interest at a rate of r_b. Households cannot borrow from corporations, hence $b_t \geq 0$ for all t. w denotes the wage rate. Households receive lump-sum transfers T from the government and pay proportional taxes τ_b on their interest income, τ_h on their labor income and τ_c on their consumption expenditures.

2.2 Corporations

Corporations operate a constant-returns-to-scale technology that uses services of capital k, land l, and labor h as inputs to produce the output good y. Their technology is described by

$$y_t = e^{(1-\theta_k)a_t} k_t^{\theta_k} l_t^{\theta_l} \left(N_t h_t\right)^{\theta_h}, \ \theta_k + \theta_l + \theta_h = 1$$

where $\exp\left\{(1-\theta_k)\, a_t\right\}$ is the level of total factor productivity (TFP) in the corporate sector, and θ_k, θ_l and θ_h are the shares of capital, land and labor in production respectively. Without loss of generality, I set the initial level of TFP to 1 (i.e. $a_0 = 0$).

The law of motion of capital accumulation is described by

$$k_{t+1} = (1-\delta)\, k_t + x_t$$

where x is new investment and δ is the depreciation rate of capital.

Corporations own the capital and land they use as inputs in production and in turn pay dividends to their shareholders. I assume there is a single unit of shares outstanding each period, and the corporations do not engage in issuance of new shares or stock buybacks. They also borrow from households and pay interest on their borrowing. Shareholders are the residual claimants on the income of corporations, hence dividends paid to shareholders (after corporate income tax on distributed earnings) are equal to firm income plus new borrowing less payments for wages, investments, interest on debt and taxes on corporate income and property holdings:

$$\begin{aligned} d_t &= y_t - w_t N_t h_t - (1-\tau_x)\, x_t - q_t\,(l_{t+1} - l_t) + b_{t+1} - (1 + r_{b,t-1})\, b_t \\ &\quad -\tau_k k_t - \tau_l\,(\Omega_t, q_t)\, q_t l_t - \tau_y\,[y_t - w_t N_t h_t - \delta k_t - r_{b,t-1} b_t] + (\tau_y - \tau_d^c)\, d_t \end{aligned}$$

Corporations receive subsidies from the government at a rate of τ_x; also pay proportional taxes at a rate of τ_k on their capital holdings, and $\tau_l\,(\Omega_t, q_t)$ on the value of land holdings. Note that the tax schedule on land holdings is dependent on the price of land, q, and the target land tax revenue of the government, Ω. Corporate profits are taxed at a rate of τ_y except for the portion that is paid out as dividends which is taxed at a lower rate of τ_d^c. Note that the firm can deduct depreciation of capital and interest payments on its debt when calculating the base for their income tax, however they cannot deduct property taxes paid on capital and land holdings.[8]

Corporate borrowing is nonnegative and is constrained above by a certain fraction $\phi > 0$ of the value of their tangible asset holdings similar to Kiyotaki

[8] These are features of the tax code in Japan and differ slightly from the U.S. system.

and Moore (1997):[9]

$$0 \leq b_{t+1} \leq \phi \left[(1 - \tau_x) k_{t+1} + q_t l_{t+1} \right]$$

Corporations' problem is to maximize the present value of after-tax dividend earnings of households,

$$E_0 \sum_{t=0}^{\infty} p_t (1 - \tau_d) d_t$$

where p_t denotes the rate at which corporations discount future dividend payments.[10]

2.3 The Government

The government runs a balanced budget each period financing its consumption, transfers to households and subsidies to corporations by tax receipts. The budget constraint of the government is given by

$$g_t + T_t + \tau_x x_t \leq tax\ revenue.$$

The government expenditures as a share of output is a constant ψ, hence

$$g_t = \psi y_t.$$

[9] Note that the price of a unit of capital in terms of the output good is $(1 - \tau_x)$.

[10] As customary, I assume corporations discount at the same rate with their shareholders; i.e. p_t is equal to the stand-in household's marginal utility of period t consumption at period 0.

The government follows a countercyclical land-taxation policy given by

$$\tau_l\left(\Omega_t, q_t\right) = \frac{\Omega_t}{q_t \bar{l}}$$

where $\bar{l}$ is the total amount of land in the economy, and Ω_t is the amount of tax revenue the government targets to collect from land taxation. I assume that this target grows at a rate of $\eta^{\left(\frac{\theta_h}{1-\theta_k}\right)} e^{\Delta a_t}$, hence

$$\Omega_t = \overline{\Omega}\left[\eta^{\left(\frac{\theta_h}{1-\theta_k}\right)t} e^{a_t}\right]$$

where $\overline{\Omega}$ denotes the initial target level at $t = 0$. This ensures that on a balanced growth path, the target land tax revenue grows at the same rate with all the other aggregate variables in the model.

2.4 Market Clearing Conditions

The final good y can be used for household consumption, c, investment in new capital, x, or government consumption, g:

$$N_t c_t + x_t + g_t = y_t$$

The total amount of land in the economy is fixed at $\bar{l}$ (which is set at unity without loss of generality); hence the clearing condition for the land market is

$$l_t = \bar{l} = 1.$$

The market clearing condition for corporate shares is given by

$$s_t = 1.$$

2.5 Technology Shocks

There's an AR(1) process on the change in the productivity factor, Δa, given by

$$\left(\Delta a_{t+1} - \overline{\Delta a}\right) = \rho \left(\Delta a_t - \overline{\Delta a}\right) + \varepsilon_{t+1}$$

where

$$\Delta a_{t+1} = a_{t+1} - a_t$$

$\overline{\Delta a}$ is the mean of the process, and ε is an i.i.d. normal shock with mean zero. Note that the innovations to the technology shock are not on the level, but on the growth of TFP similar to King et al. (1988).

Competitive equilibrium for this model economy is then defined as a sequence of prices and allocations such that the stand-in household maximizes utility subject to its budget constraint, corporations maximize the present value of after-tax dividends, and the government's budget constraint and the market clearing conditions are satisfied.

3 Valuation of Land and Corporate Equity in the Model

In this section, I first discuss the debt-financing decision of corporations and then derive expressions for land and corporate equity valuation in the model. I also explore the *qualitative* effects of changes in productivity growth and taxes on asset prices.

3.1 Debt-Financing Decision

In the model, the decision regarding the level of corporate debt is based solely on tax incentives. With no taxes, the debt level is indeterminate since the Modigliani-Miller propositions hold and the debt-equity mix is irrelevant. In the presence of taxation, however, debt-financing may be favored by the tax code. Since the interest paid on debt is deductible from corporate taxable income, debt-financing creates a tax shelter for corporations [Modigliani and Miller (1958) and Miller (1977)]. On the other hand, interest income is taxed at the household level. Since households are shareholders as well as lenders to corporations, the optimal level of corporate debt depends on taxation of corporate income vs. interest income. This argument is formalized by the following proposition:

Proposition 1 *In equilibrium, the level of corporate debt is*

$$b_{t+1} = \begin{cases} \phi\left[(1-\tau_x)\,k_{t+1} + q_t l_{t+1}\right] & \text{if } \tau_y > \tau_b \\ 0 & \text{if } \tau_y < \tau_b \\ \left[\,0\,,\ \phi\left[(1-\tau_x)\,k_{t+1} + q_t l_{t+1}\right]\,\right] & \text{if } \tau_y = \tau_b. \end{cases}$$

Proof. *See the appendix.* ■

When corporate profits are taxed more heavily than interest income (as is the case for Japan), there is an incentive for issuing corporate debt to reduce the overall tax burden.[11] If there were no constraints on borrowing, debt would increase up to a level that would make taxable income zero and hence exhaust all the tax shelter opportunity. Given the collateral constraint on debt, however, corporations borrow only up to this constraint; hence the collateral constraint binds in every period.[12]

3.2 Land Valuation

It is not possible to characterize the equilibrium land value in the model analytically (short of writing it as an infinite sum), therefore I derive an expression for land value relative to output along the balanced growth path of the model.

[11] See the appendix for more on taxation in Japan.

[12] The collateral constraint is assumed to be tight enough such that taxable income never reduces to zero in equilibrium. This is indeed the case given the calibrated parameters of the model.

Definition Balanced Growth Path

The balanced growth path of the model economy is such that

1. Aggregate variables capital, k, investment, x, government expenditure, g, debt, b, value per share, v, land price, q, dividends, d, transfers, T, and target land-tax revenue, Ω, all grow at the same rate with growth factor γ.

2. Per-capita variables consumption, c, and per-hour wage, w, grow with γ/η.

3. Per-capita labor hours, h, total shares, s, interest rate, r_b, and quantity of land, l, stay constant.

When the productivity factor grows at a constant rate, i.e. $\Delta a_t = \overline{\Delta a}$, the model economy has a balanced growth path with

$$\gamma = \eta^{\frac{\theta_h}{1-\theta_k}} e^{\overline{\Delta a}}.$$

Proposition 2 *Given $\tau_y > \tau_b$, the value of land relative to output along the balanced growth path is*

$$\frac{q\bar{l}}{y} = \frac{(1-\tau_y)\,\gamma\theta_l}{(1+r-\gamma) - \phi\,(\tau_y - \tau_b)\,r_b + \gamma\overline{\tau_l}}$$

where

$$r = (1-\tau_b)\,r_b = \frac{(\gamma/\eta)^{1-\alpha(1-\sigma)}}{\beta} - 1$$

and $\overline{\tau_l}$ is the tax rate on land holdings that prevails along the balanced growth path when Ω and q grow at the same rate.

Proof. *See the appendix.* ■

Note that since the production function is Cobb-Douglas, the share of income that accrues to land (shadow rental income) is equal to the share of land in production, θ_l. The above proposition states that the value of land relative to output is the present value of the (after-tax) income share of land discounted by the appropriate required rate of return. The tax shelter benefit from the debt collateralized by land lowers the required rate of return (as implied by the second expression in the denominator), while the tax on land holdings increases it, relative to the required return on other assets. The tax shelter benefit, as expected, depends on the fraction of assets that can be collateralized, the tax differential between corporate income and interest income, and the interest rate on corporate bonds.

The required return on land also includes a risk-premium component which is ignored in the above expression. Note, however, that the risk premiums generated from this model (and from similar models that abstract from features such as habit formation utility and costs to capital adjustment) is rather small [c.f. Jermann (1998)].[13]

In the above land pricing equation, the γ next to θ_l in the numerator, and the γ next to $\overline{\tau_l}$ in the denominator appear due to the fact that the land price in the model is the *end-of-period* price and hence current land price,

[13] Habit formation utility and adjustment costs to capital have not been added not to complicate the model any further. Whether changes in risk premia can account for the observed changes in asset prices is left for further research.

q_t, excludes the value of the current returns from land at period t. This is explained further in the next subsection where I generate the above land pricing equation using a dividend growth model similar to Gordon (1962).

3.2.1 Land Price using a Dividend Growth Model

The price (actually the intrinsic value) of an asset is determined by the present value of the future stream of payments it generates. For the case of land, the relevant payment includes not only the (after-tax) return earned from renting land, but also the tax shelter benefits generated from using land as collateral for debt. Property taxes paid on land holdings are subtracted from each period's payment.

Consider a unit of land whose price at the end of period t (i.e. excluding period t payments) is designated as q_t. At each period t, it generates D_t units of rental income, which is taxed at a constant rate of τ_y, and also a tax-shelter benefit of size $\phi\left(\tau_y - \tau_b\right) r_b q_{t-1}$. Note that the period t tax shelter benefit depends on debt acquired last period, b_t, which is a function of q_{t-1} not q_t. At each period t, landowners also pay land taxes of size $\tau_l q_t$. Assume that the rental income D (and hence land price q) increases each period by a constant growth factor γ, hence $D_{t+1} = \gamma D_t$. Also assume that future payments are discounted by a constant gross interest rate, $1 + r$.

Land price at period 0 can then be written as

$$\begin{aligned} q_0 &= \frac{(1-\tau_y) D_1 + \phi (\tau_y - \tau_b) r_b q_0 - \tau_l q_1}{1+r} \\ &+ \frac{[(1-\tau_y) D_1 + \phi (\tau_y - \tau_b) r_b q_0 - \tau_l q_1] \gamma}{(1+r)^2} \\ &+ \frac{[(1-\tau_y) D_1 + \phi (\tau_y - \tau_b) r_b q_0 - \tau_l q_1] \gamma^2}{(1+r)^3} + ... \end{aligned}$$

Imposing $D_1 = \gamma D_0$ and $q_1 = \gamma q_0$, the above infinite sum can be solved to get[14]

$$q_0 = \frac{(1-\tau_y) \gamma D_0}{1 + r - \gamma - \phi (\tau_y - \tau_b) r_b + \gamma \tau_l}.$$

Multiplying both sides of the above expression by the total quantity of land, and dividing by total output gives precisely the land-price expression generated from the steady-state of the model presented in section 2.[15]

3.2.2 The Effect of Growth on Land Value

In this subsection, I explore the qualitative effects of a change in the growth factor on land prices. For the discussion here, I assume that land taxes stay constant and discuss the magnification effects due to endogenous land taxes in the next subsection.

A higher growth rate does not necessarily generate a higher asset price in this model (and in similar models). The effect of growth on land valuation is ambiguous because a higher growth rate not only translates into higher rents from land but may also increase the real interest rates with which

[14] Note that the condition, $\gamma < 1 + r$, is needed for this infinite series to converge.

[15] Note that the $D_0 l_0 / y_0$ is the income share of land which is a constant and is equal to the share of land in production, θ_l.

these rents are discounted.[16] To generate an increase in land values with higher growth, the model essentially requires the interest rate to increase less than the increase in the growth rate. This argument, of course, assumes a constant land tax.[17]

The parameter σ, which is the inverse of the elasticity of intertemporal substitution, is important in determining the extent to which the interest rate reacts to changes in the growth factor. Note that

$$1 + r = \frac{(\gamma/\eta)^{1-\alpha(1-\sigma)}}{\beta}.$$

With unit intertemporal elasticity of substitution (i.e. $\sigma = 1$), the increase in the interest rate is almost of the same magnitude as the increase in the growth rate; hence permanently higher growth has almost no impact on land values across steady-states. That is not true of the transition path, however. The interest rate adjusts upwards as the economy goes from one balanced growth path to another, but only slowly since the capital stock cannot jump. This implies that during the transition, the increase in growth overtakes the increase in the interest rate and can create an increase in the value of land even with $\sigma = 1$.

Note that σ is also the coefficient of relative risk aversion in this model. The equity premium literature typically finds that risk aversion needs to be rather high to account for the observed equity premiums in the data [Mehra and Prescott (1985)]. Increasing σ, however, decreases the elasticity of

[16] See also Boldrin and Levine (2001) and Peralta-Alva (2003) on the same issue.

[17] Note that effects of the γ next to θ_l in the numerator, and the γ next to $\overline{\tau_l}$ in the denominator of the asset pricing equation are small and can be ignored for the purpose of this discussion.

intertemporal substitution, which causes the steady-state interest rate to rise more in the face of an increase in the growth factor. In fact, for large enough σ, the model generates a *decrease* in asset prices as growth of the economy picks up.[18] With higher elasticity of intertemporal substitution, (i.e. when $0 < \sigma < 1$), the increase in the steady-state interest rate is lower than the increase in the growth factor. This can potentially generate a sizable increase in asset prices, especially during the transition. The caveat here, however, is the implication of very low risk aversion.[19]

3.2.3 Magnification of the Effect of Growth due to Endogenous Land Taxation

As argued in the previous subsection, the model with a constant tax rate on land, can generate an increase in land values across steady-states (and along the transition path) as a result of an increase in the growth rate of the economy. This increase is quantitatively small however, unless one assumes an unreasonably low elasticity of intertemporal substitution.

Endogenous land taxes, whereby the tax rate on land is countercyclical to land prices, amplify this initial impact of growth on land values. The initial increase in land values reduces the tax rate on land. This reduces

[18] This seems to be at odds with the land price data in Japan, where changes in land prices are correlated positively with changes in growth rates. The urban land price indexes of the Japanese Real Estate Institute increased during the high growth years of the 60s and late 80s, and fell during the low growth periods of 70s and 90s.

[19] Epstein-Zin or habit formation preferences could potentially solve this problem since they break the link between risk aversion and intertemporal elasticity of substitution. See Cochrane (2008) for more on this issue.

the required return on land, which causes land values to increase further, which, in turn, causes a further reduction in the land tax rate and so on. The equilibrium as a result of this circular interaction of land tax rates and land values, encompasses a much higher increase in land values relative to an equilibrium with constant land taxes.

To assess the quantitative importance of this magnification in my model, I conduct a rough back-of-the-envelope calculation using the land pricing equation of Proposition 2. As discussed in the next section on calibration, the value of corporate land relative to corporate output, ql/y, is about 1.5 and the after-tax income share of land, $(1-\tau_y)\,\theta_l$, is about 2.5%. This implies a required return on land of about 1.7%.[20] The observed decrease in the land tax rate from 1.4% to 0.8% reduces this required return to 1.1%. This, in percentage terms is a 35% decrease in the required return and hence generates a 35% increase in the land value to output ratio across steady-states. Note that this calculation ignores the effects of the increase in the growth rate of the economy and considers the effect of a change in the land tax as if it is exogenously imposed. The increase in growth would drive the initial required return below 1.7%, and hence a 0.6 percentage point decrease in the land tax would translate into a bigger reduction in the required return and hence a bigger increase in land values, especially along a transition path.

[20] Note that with the calibrated values, the required return after accounting for growth, $r-\gamma$, is about 1.5%. The tax shelter component, $\phi\,(\tau_y-\tau_b)\,r_b$, reduces the required return by about 1.2%, and the land tax increases it by about 1.4%.

3.3 Valuation of Corporate Equity

In the model, the first order condition of the stand-in household with respect to corporate shares is given by

$$E_t \left\{ p_{t+1} \left[\left(1 - \tau_d^h\right) d_{t+1} + v_{t+1} \right] \right\} = p_t v_t .$$

This expression can be solved forward to yield the familiar result that the price of a share is equal to the present value of after-tax dividends the share generates:

$$v_t = \sum_{m=1}^{\infty} \left(\frac{p_{t+m}}{p_t} \right) \left(1 - \tau_d^h\right) d_{t+m}$$

When we also consider the first order conditions of the firm, the current price of a share can be expressed as the current after-tax value of the tangible assets owned by a corporation minus its debt (see Proposition 3). This result hinges on the assumption of perfect competition among corporations. With market power, corporate equity value would reflect not only the value of the tangible (and intangible if applicable) assets, but also the present value of the pure rents resulting from market power.

Proposition 3 *In equilibrium, the equity value of corporations is*

$$v_t = (1 - \tau_d)(1 - \phi)\left[(1 - \tau_x) k_{t+1} + q_t l_{t+1}\right]$$

where

$$\tau_d = \frac{\tau_d^h + \tau_d^c - \tau_y}{1 + \tau_d^c - \tau_y}.$$

Proof. *See the appendix.* ■

Note that τ_d is the effective tax rate on dividends taking into account the preferential treatment that dividends receive at the corporate level vis-à-vis corporate income taxation. With equal corporate income tax rates on retained earnings and dividend payments, τ_d equals the dividend income tax paid at the household level, τ_d^h.

To gain some intuition for the above equity pricing expression, consider a firm that sells a (real) dollar worth of its tangible assets to another firm. The firm spends a fraction, ϕ, of the revenue to buy back debt in order to avoid violating its collateral constraint. The rest of the revenue, $1-\phi$, is taxed at an effective rate of τ_d when it is distributed back to shareholders. The remainder is attributed to the value of corporate equity.

Since land constitutes about half of corporate holdings, a doubling of land prices should result in about a 50% increase in equity values according to the equity pricing formula above. This implies that even if the model is able to fully generate the observed increase in land values, it will not be able to generate the doubling (or even tripling) of equity values observed in the data.

4 Calibration

To calibrate the parameters of the model economy, I follow Cooley and Prescott (1995) and match the balanced growth path of the model to the corresponding features of Japanese data. I calibrate all parameters using data from the early 80s, to match the initial conditions prior to the rise in the asset prices, except for the growth parameters which are calibrated using averages from 1980-2002.

The parameters to be calibrated are the growth parameters γ, η and $\overline{\Delta a}$, preference parameters β, σ and α, technology parameters δ, θ_k, θ_l and θ_h, collateral constraint parameter ϕ, government policy parameters ψ and $\overline{\Omega}$, and tax rates $\overline{\tau_l}$, τ_c, τ_h, τ_b, τ_d^h, τ_y, τ_d^c, τ_k and τ_x.

I start with the tax parameters which are further discussed in detail in the Appendix. The effective marginal tax rate on corporate income averaged 55.2% for retained earnings and 44.9% for income paid out as dividends between 1980-1984; hence I set τ_y equal to 0.552 and τ_d^c to 0.449. The steady-state effective marginal tax rate on corporate holdings of land, $\overline{\tau_l}$, and on corporate holdings of capital, τ_k, were similarly found as 1.41% and 1.17% respectively. I set τ_x to match the ratio of business subsidies to investment in 1980-84 which is 4.88% and τ_c to the ratio of indirect taxes on products to consumption which is 7.44%. The individual income taxes on interest τ_b, dividends τ_d^h and labor income τ_h are set at 19%, 45% and 43% respectively given the considerations laid out in the appendix.

Between 1980-2002, Japanese real GDP grew at an average rate of 2.45% per year, and its working age population (age 15-64) grew by 0.40% per year.[21] I therefore set the growth factor parameters γ and η equal to 1.0245 and 1.0040 respectively.

The preference parameter, σ, is set equal to 1 which implies unit in-

[21] See the Appendix for data sources.

tertemporal elasticity of substitution following Prescott (1986) and Cooley and Prescott (1995). I conduct sensitivity analysis on this parameter in the results section due to its importance in determining asset prices as argued previously in section 3.

The remaining parameters $\overline{\Delta a}$, β, α, δ, θ_k , θ_l, θ_h, ϕ, ψ and $\overline{\Omega}$ are then recursively calibrated using the model economy's balanced growth path relationships and the data counterparts of the following variables: the share of total consumption in output (Nc/y), the share of labor in total income (wNh/y), the debt to equity ratio (b'/v), the ratio of depreciation of corporate fixed capital to corporate capital $(\delta k/k)$, the capital-output ratio (k/y), the total land value relative to output $\left(q\bar{l}/y\right)$, and labor hours per person (h). The next subsections discuss how the data counterparts of these variables are obtained from the Japanese National Accounts and are used to calibrate the remaining parameters.

4.1 The Japanese National Accounts

Table 1 summarizes the Japanese expenditure and income accounts obtained from the *National Income Accounts* (NIA) of Japan. An adjustment has been made to private consumption data on the expenditure side and to net indirect business taxes on the income side to conform the data with the model's expenditure and income accounts.[22] I subtract tax on products from total private consumption and discard it from net indirect business taxes. This adjustment reduces total expenditure and income by 4%.

[22] Note that in the data, consumption is valued at market price which includes the tax on products.

NIA Concept *(relative to output)*	**Data** (1980-84)
Expenditure	
Consumption	
Private	0.534
Government	0.143
Investment	
Corporate	0.172
Noncorporate (incl. gov.)	0.141
Net Exports	0.010
Total Expenditure	1
Income	
Labor Compensation	0.566
Operating Surplus	
Corporate	0.132
Noncorporate	0.141
of which owner-occ. housing	0.038
Depreciation	
Corporate	0.087
Noncorporate	0.058
Net Indirect Taxes	0.025
Statistical Discrepancy	-0.009
Total Income	1

Table 1: National Income Accounts

Private consumption constituted 53.4% of total expenditure in Japan between 1980-1984. I assume the share of consumption goods in *corporate* output is the same as the total and set Nc/y equal to 0.534. To calculate the labor share in income, wNh/y, I distribute the non-housing part of non-corporate operating surplus (o.s.) and the statistical discrepency proportional to the rest of the economy; hence labor share is given by

$$\text{labor share} = \frac{\text{labor comp.}}{\text{labor comp.+corp. o.s.+non-corp. housing+net ind. taxes}}.$$

The labor share averaged 64.2% between 1980-1984, hence I set wNh/y equal to 0.642.

Table 2 summarizes the Japanese sectoral balance sheet data again obtained from NIA.[23] The corporate sector includes all financial and non-financial corporations. Intercorporate holdings of debt and equity have been netted out in the calculation of the market value of corporations.[24]

Balance Sheet Concept *(relative to output)*	**Data** (1980-84)
Capital Stocks (beginning of period)	
Corporate	1.217
Noncorporate	1.175
Total Value of Capital	2.392
Value of Land (end of period)	
Corporate	0.910
Noncorporate	2.511
Total Value of Land	3.421
Market Value of Corporations (end of period)	
Debt	0.689
Equity	0.281
Debt-Equity Ratio	2.447

Table 2: Tangible Assets and Market Value

The end-of-period debt to equity ratio, b'/v, is set to 2.447, which is the average of its data counterpart for 1980-1984. The ratio of depreciation of corporate fixed capital to corporate capital is 7.2% for 1980-1984, hence I set $\delta k/k$ equal to 0.072.

[23] Note that the capital stock is reported on a beginning-of-period basis which as a ratio to output corresponds to k_t/y_t in the model. Similarly, the end-of-period value of land relative to output corresponds to $q_t\bar{l}/y_t$, the end-of-period debt relative to output corresponds to b_{t+1}/y_t and the end-of-period equity relative to output corresponds to v_t/y_t.

[24] This is crucial in the case of Japan since the non-corporate sector holds only about 30% of all corporate equity. The rest is intercorporate holdings of shares.

To find corporate capital and land holdings relative to *corporate* output, I first need to determine the value added of the corporate sector relative to total income. I use the share of corporations in total operating surplus (attributed to capital) plus total depreciation (dep.) as a proxy for the share of corporate value added; hence

$$\text{corp. share} = \frac{\text{corp. o.s.+corp. dep.}}{\text{total o.s.-labor share*(noncorp. o.s.-owner occ. housing)+total dep}}.$$

Using income account data from Table 1, the corporate share in total value added is estimated as 0.624%.

The ratio of corporate capital to *total* output is 1.217.[25] Since corporate output makes 62.4% of total output, the capital-output ratio for the corporate sector, k/y, is set to 1.951. Similarly, the value of corporate land relative to total output was 0.912 which yields a corporate land value to corporate output ratio, $q\bar{l}/y$, of 1.459.

Figure 5 plots the weekly labor hours per working age person in Japan between 1980-2002. The average for 1980-1984 is 30.3 hours. Assuming people have a total of 100 non-sleep hours in a week, the ratio of labor hours in total available time, h, is set to 0.303. Note that labor hours in Japan dropped in the 90s mainly as a result of workweek length legislation which called for the reduction of labor hours per worker from 44 to 40 hours by 1997 [Hayashi and Prescott (2002)].

[25] Note that the ratio of corporate capital to total output reported here is slightly higher than what is shown in Figure 1 in the introduction. This is due to the downward adjustment made to total output.

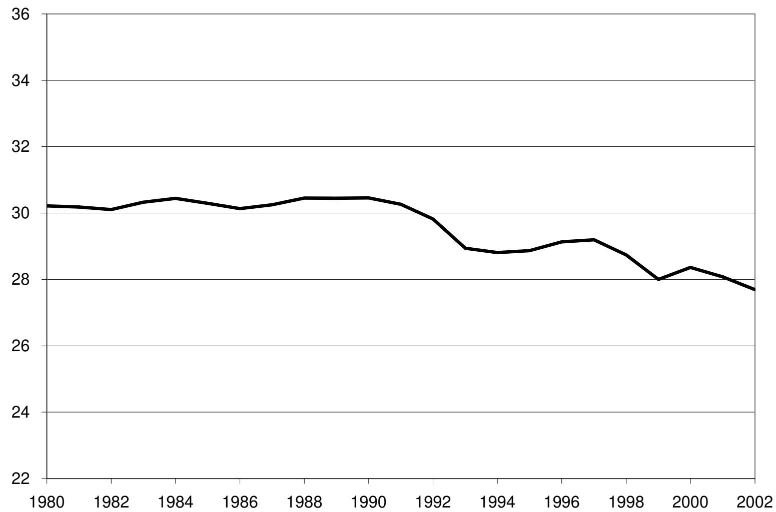

Figure 5: Weekly labor hours per working age person (15-64)

4.2 Matching Model's Balanced Growth with Data

The depreciation parameter, δ, is calibrated to match the ratio of depreciation of corporate fixed capital to corporate capital, $\delta k/k = 0.072$. Along the balanced growth path (and outside it, in this case), the end-of-period debt to equity ratio is given by[26]

$$\frac{b'}{v} = \frac{\phi}{1-\phi}\frac{1-(\tau_y - \tau_d^c)}{\left(1-\tau_d^h\right)}.$$

The fraction of assets that can be collateralized, ϕ, is calibrated to 0.600 using the above expression. The firm's first order condition evaluated along

[26]Note that in the data, debt is reported on a book value basis and only listed shares are reported as equity. This implies that the reported values for both debt and equity are below their total market value. That is why I chose to calibrate ϕ to match the debt to equity ratio, rather than match debt or equity by itself.

the balanced growth is

$$\theta_h = wNh/y.$$

I therefore calibrate the share of labor in production, θ_h, to match the labor share in the data, 0.642. This implies that the sum of the capital and land shares, $\theta_k + \theta_l$, equal to 0.358.

Evaluating the firm's first order condition with respect to capital along the balanced growth path yields the following expression:

$$\theta_k = \frac{(1-\tau_y)(k/y)}{(1-\tau_x)[1-\tau_b-\phi(\tau_y-\tau_b)]r_b+(1-\tau_x-\tau_y)\delta+\tau_k}$$

The share of land in production can similarly be expressed along the balanced growth path as

$$\theta_l = \frac{(1-\tau_y)\gamma\left(q\bar{l}/y\right)}{[1+(1-\tau_b)r_b-\gamma]-\phi(\tau_y-\tau_b)r_b+\gamma\overline{\tau_l}}.$$

These two expressions, coupled with $\theta_k + \theta_l = 0.358$, imply that the interest rate on corporate bonds, r_b, along the steady-state is 4.94%.[27] This interest rate is then used in the above balanced growth path expressions to calibrate the capital share parameter, θ_k, to 0.297 and the land share parameter, θ_l, to 0.061.

I calibrate the steady-state growth rate of TFP, $\overline{\Delta a}$, to 0.0204 using

$$\gamma = \eta^{\frac{\theta_h}{1-\theta_k}} e^{\overline{\Delta a}}.$$

[27] Note that the implied (net) real interest rate, r, is 4% since $r = (1-\tau_b)r_b$.

The share of consumption in the utility function, α, is calibrated to 0.405 using the following relationship (which comes out of evaluating the household's marginal rate of substitution between consumption and leisure along the balanced growth path):

$$\frac{1-\alpha}{\alpha} = \frac{1-\tau_h}{1+\tau_c} \frac{\theta_h}{Nc/y} \frac{1-h}{h}$$

Similarly I calibrate the discount factor, β, to 0.981 using the following balanced growth path condition:

$$(1-\tau_b)\, r_b = \frac{(\gamma/\eta)^{1-\alpha(1-\sigma)}}{\beta} - 1$$

The goods market clearing condition along the balanced growth path can be written as

$$\frac{Nc}{y} + [\gamma - (1-\delta)] \frac{k}{y} + \psi = 1.$$

This is used to calibrate the ratio of government expenditure to corporate output, ψ, to 0.279. The implied investment-output ratio for the corporate sector is then 18.8%.

The calibrate the parameter for the initial target land tax revenue, $\overline{\Omega}$, first note that, at $t = 0$ and along the balanced growth path, the land tax revenue as a share of output can be written as[28]

$$\frac{\overline{\Omega}}{y_0} = \overline{\tau_l}\left(\frac{q_0\bar{l}}{y_0}\right).$$

Since at $t = 0$, the level of TFP factor, a_0, equals 0, and the population is normalized to 1 (i.e. $N_0 = 1$), the initial target land tax revenue, $\overline{\Omega}$, is set to 0.0091 using the following expression:

$$\overline{\Omega} = \left[\left(\frac{k}{y}\right)^{\theta_k} \bar{l}^{\theta_l} h^{\theta_h}\right]^{\frac{1}{1-\theta_k}} \left(\overline{\tau_l}\frac{q\bar{l}}{y}\right)$$

Table 3 below reports the National Accounts implied from the model (which includes only the corporate sector) along the balanced growth path. In the data, the ratios of corporate debt and corporate equity relative to *corporate* output are 1.12 and 0.46 respectively. The model, however, implies debt and equity levels which are almost twice as high as their data counterparts. This is expected since the reported debt and equity levels in the data are below total market value as argued previously.

The implied government expenditure from the model is 27.9% of *corporate* output. This number is high relative to the data (which is 14.3% of *total* output), but not unreasonably high if one is to assume that most the government consumption expenditure in the data involves corporate goods. Also note that along the balanced growth path of the model, the size of the lumpsum transfers from the government to the stand-in household, T/y, is

[28] This implies that the ratio of land revenue to output is about 2%. This is slightly higher than the data since the marginal tax on land is greater than the average tax due to exemptions.

National Accounts (*relative to corp. output*)	**Model**
Expenditure	
Consumption	0.534
Government Expenditure	0.279
Investment	0.188
Total Expenditure	1
Income	
Labor Compensation	0.642
Operating Surplus	0.218
Depreciation	0.140
Total Income	1
Balance Sheet	
Capital Stock (k/y)	1.951
Value of land (v/y)	1.459
Debt (b'/y)	2.016
Equity (v/y)	0.824
Debt-Equity Ratio (b'/v)	2.447

Table 3: Summary of parameter values

about 16.4% of output.

5 Simulations and Quantitative Findings

In this section, I first briefly discuss the computation procedure and the calculation of the TFP series that is fed as innovations into the model's stochastic process. I then present the model's quantitative predictions on asset prices and macroeconomic variables using simulations from the calibrated model economy.

5.1 Computation

First I transform all model variables to ensure stationarity. Let $\widetilde{u}_t$ denote the detrended value of u_t for each variable u and define

$$\widetilde{u}_t = \begin{cases} u_t / \left[\eta^{\left(\frac{\theta_h}{1-\theta_k}\right)t} e^{a_{t-1}} \right] & \text{for } u = k \text{ and } b \\ u_t / \left[\eta^{\left(\frac{\theta_h}{1-\theta_k}\right)t} e^{a_t} \right] & \text{for } u = x,\ g,\ v,\ q,\ d,\ T \text{ and } \Omega \\ u_t / \left[\eta^{\left(\frac{-\theta_l}{1-\theta_k}\right)t} e^{a_t} \right] & \text{for } u = c \text{ and } w \\ u_t / \left[\left(\beta \eta^{-\alpha(1-\sigma)\frac{\theta_l}{1-\theta_k}} \right)^t e^{[\alpha(1-\sigma)-1]a_t} \right] & \text{for } \ u = p \\ u_t & \text{for } u = h,\ s,\ r_b,\ l \text{ and } \Delta a \end{cases}$$

Note that capital stock, k, and the level of debt, b, are detrended using TFP levels for period $t-1$. These transformations render the model stationary in Δa_t.

I then log-linearize the equilibrium conditions around the stationary model's steady-state and use the Blanchard-Kahn method [Blanchard and Kahn (1980)] to find the policy function for each variable.

5.2 Calculating TFP

I take the corporate production function in the model

$$y_t = e^{(1-\theta_k)a_t}\ k_t^{\theta_k}\ l_t^{\theta_l}\ (N_t h_t)^{\theta_h}$$

and set the share parameters for capital, land and labor to their calibrated values in section 4. I assume the quantity of land is a constant each period

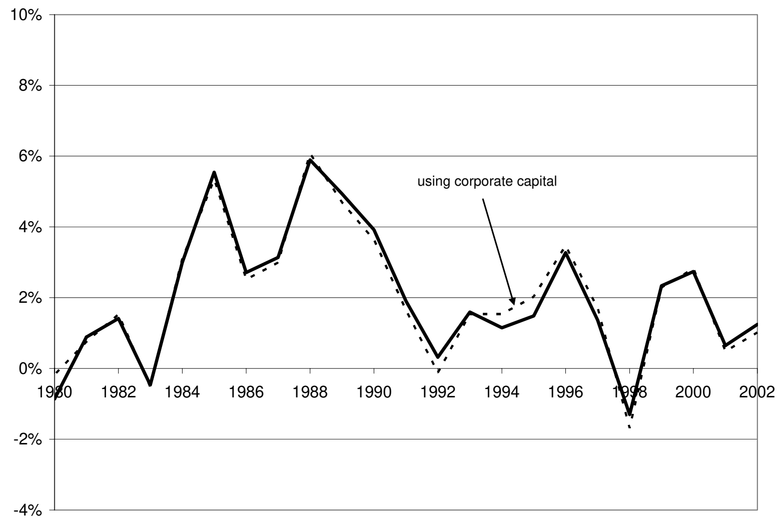

Figure 6: Change in productivity factor, Δa

(equal to 1 without loss of generality) and construct a *productivity factor* series, $\{a_t\}$, using data on real GDP, real capital stock and total labor hours.[29] I then take the first difference of this series to arrive at the *change in the productivity factor* series, $\{\Delta a_t\}$, where $\Delta a_t = a_t - a_{t-1}$ (see Figure 6).

The deviations of the change in productivity factor from the steady-state are then calculated as

$$\widehat{\Delta a_t} = \Delta a_t - \overline{\Delta a}$$

where $\overline{\Delta a}$ is the average change in the productivity factor. For 1980-2002, this average change is equal to 2.03% which is in line with the calibrated

[29] Note that using corporate capital instead of aggregate capital produces almost identical results for the change in productivity factor series as shown in Figure 6. I used the GDP deflator to deflate the capital stock series. Using the investment deflator instead also produces very similar results.

value of $\overline{\Delta a}$ found in section 4. This is also the average growth of productivity observed for the U.S. economy in the postwar period. The average for 1980-1984, however, is only 0.79%. This implies that the early 80s are probably a little below the steady-state and hence the increase in the productivity factor in the late 80s are somewhat higher than what is implied from using 2.03% for $\overline{\Delta a}$. I therefore calculate the $\widehat{\Delta a_t}$ series using $\overline{\Delta a} = 0.79\%$ to account for the bigger innovations. As shown in the next subsection, this will ensure that the model matches the macroeconomic variables, especially output, for the late 80s. Using $\overline{\Delta a} = 2.03\%$, however, does not change the main results presented in the next two subsections.[30]

I then run an AR(1) regression on the change in productivity growth series to estimate the persistence parameter for the TFP shock, ρ. I use the estimated parameter value, 0.438, in the benchmark simulation and then conduct sensitivity analysis on this parameter.

5.3 Benchmark Simulation

For the simulations, I set the model economy to be along a balanced growth path between 1980-1984 and feed the $\left\{\widehat{\Delta a_t}\right\}$ values for the years 1985-2002 calculated in the previous subsection into the model.

Figure 7 plots the predicted time series for the value of land relative to output, ql/y, the tax rate on land, τ_l, equity to output ratio, v/y, and debt to output ratio, b'/y, against their data counterparts.[31] With temporary

[30] The main issue is the persistence of the shocks; the size of the shocks is of secondary importance.

[31] In generating the time series for the ratios relative to corporate output in the data, the share of corporate value added in total output is assumed to be 62.4% for all years. This

shocks, the model generates essentially flat asset price profiles with land values rising only 1.3% relative to output at its highest level in 1988 and actually declining 0.7% between 1984-1990.

The model matches the observed patterns of macroeconomic aggregates relatively well, especially for the 80s (see Figure 8). Faced with a *temporary* increase in the growth rate of TFP, investment activity picks up temporarily which reduces the share of consumption in total output. Despite the increase in investment, the capital output ratio declines in the short-run as the growth in output is higher than the growth in the capital stock. Labor hours are also increased temporarily to take advantage of the temporary increase in productivity. In the 90s, the patterns are reversed as the growth of TFP declines. The reversal in the data is sharper mainly due to the decrease in the workweek length and the decline in the growth rate of population, neither of which are captured by my model [Hayashi and Prescott (2002)].

The predictions regarding flat asset price profiles are robust to using higher intertemporal elasticity of substitution (i.e. lower σ), and/or higher debt to equity ratio (i.e. higher ϕ) in calibrating the model. Lowering σ to 0.1 generates a maximum increase of only 2% in ql/y. Similarly, calibrating the model to a debt to equity ratio of 10 (i.e. $\phi = 0.86$) generates a maximum increase of only 1.5%.[32]

value corresponds to the corporate share averaged for 1980-84 as found in the calibration section.

[32] Note that with any of these changes, the whole model is recalibrated to match the data ratios spelled out in the calibration section.

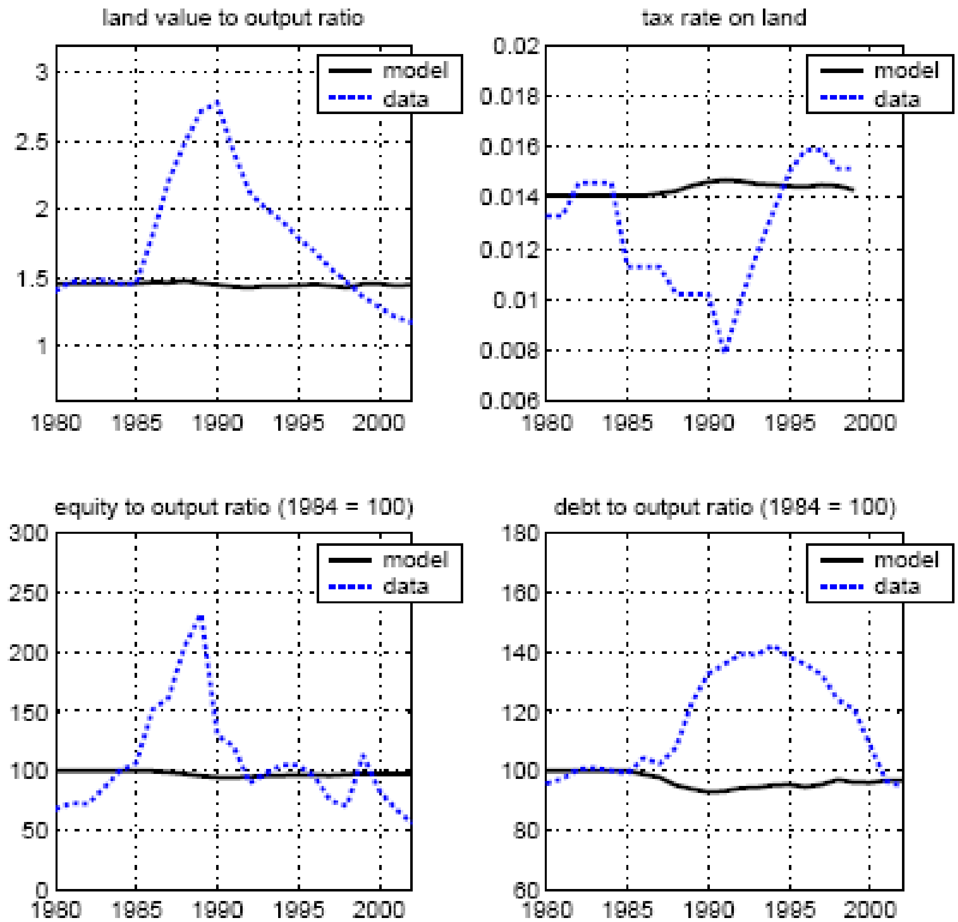

Figure 7: Benchmark Simulation: Asset Prices

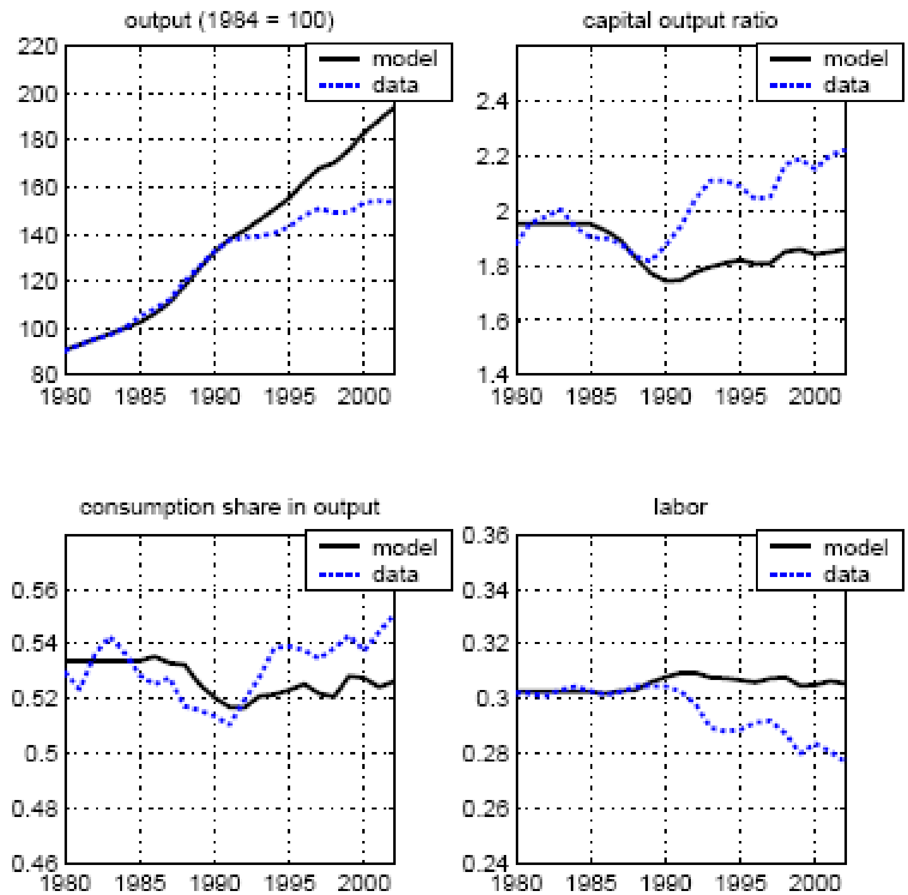

Figure 8: Benchmark Simulation: Macroeconomic Aggregates

5.4 Productivity shocks with higher persistence

The predictions on asset prices are more in line with the data, when I increase the persistence of the TFP shocks.[33] For example, with the persistence parameter, ρ, set to 0.99, the model can generate a 77.5% increase in land values and 30% increase in equity values relative to output (see Figure 9).[34]

The model's predictions on macroeconomic aggregates, however, are worsened with persistent shocks (see 10). Faced with a *persistent* increase in the growth rate of TFP, agents increase consumption and leisure, and reduce investment and labor hours in the short-run. The end result is actually a slower growing output in the short-run. These predicted patterns are at odds with the data.

As argued before, a substantial part of the movement in the land price in the model is generated due to the endogenous decline in land tax rates. An idea is to make land taxation exogenously given to the model and feed in the observed changes in the tax rate on land holdings as land tax shocks. This will generate a sizable increase in the asset prices without influencing the macroeconomic aggregates by much. This idea has two problems however: First, it is hard to argue that the decline in the effective tax rates on land in the 80s came about exogenously and not as a *result* of the increase in land

[33] To avoid unreasonable volatility in predicted land prices, I smoothed the series Δa_t by using its 3-lag moving average. This smoothing can be thought of proxying for features such as Kalman filtering or Bayesian updating on the part agents in regard to their view of TFP growth. I did not include these features in the model not to complicate the model any further.

[34] Note that in the data, the value of corporate land increased by 90% relative to corporate output. Part of this increase, however, is due to land acquisitions by the corporate sector and not due to land price increases per se. The *total* value of land increased by 70% relative to GDP as mentioned in the introduction.

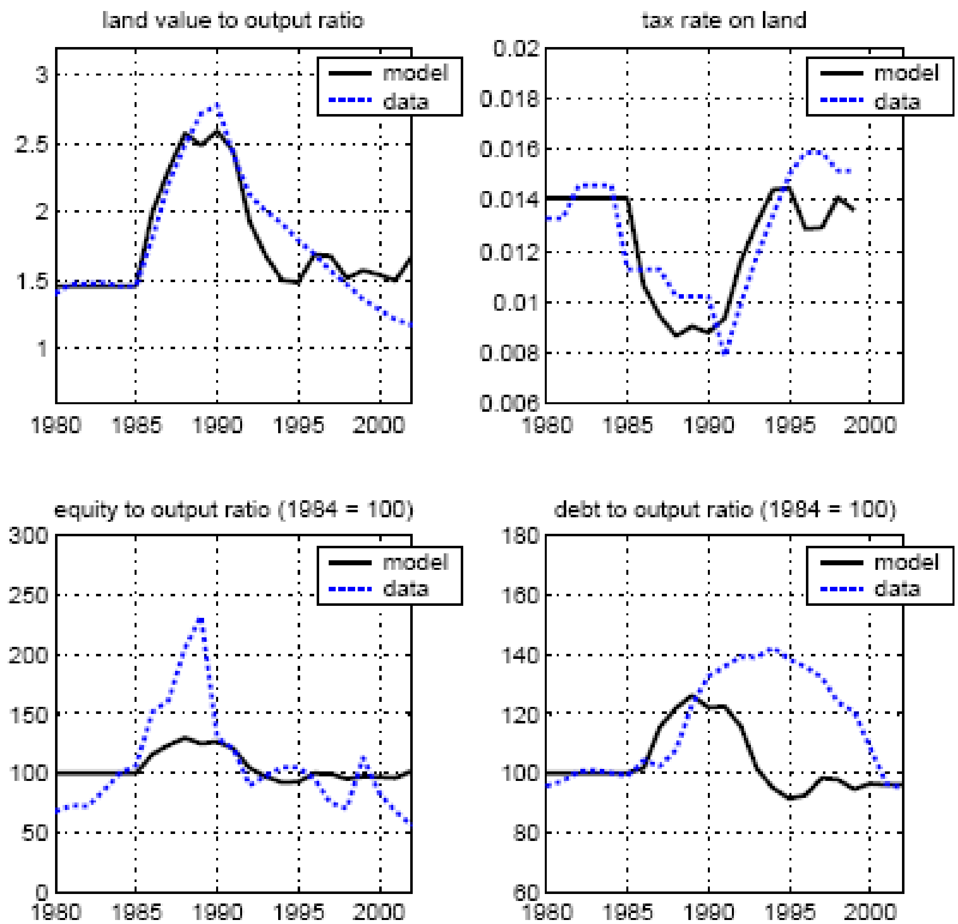

Figure 9: Simulation with Persistent Shocks: Asset Prices

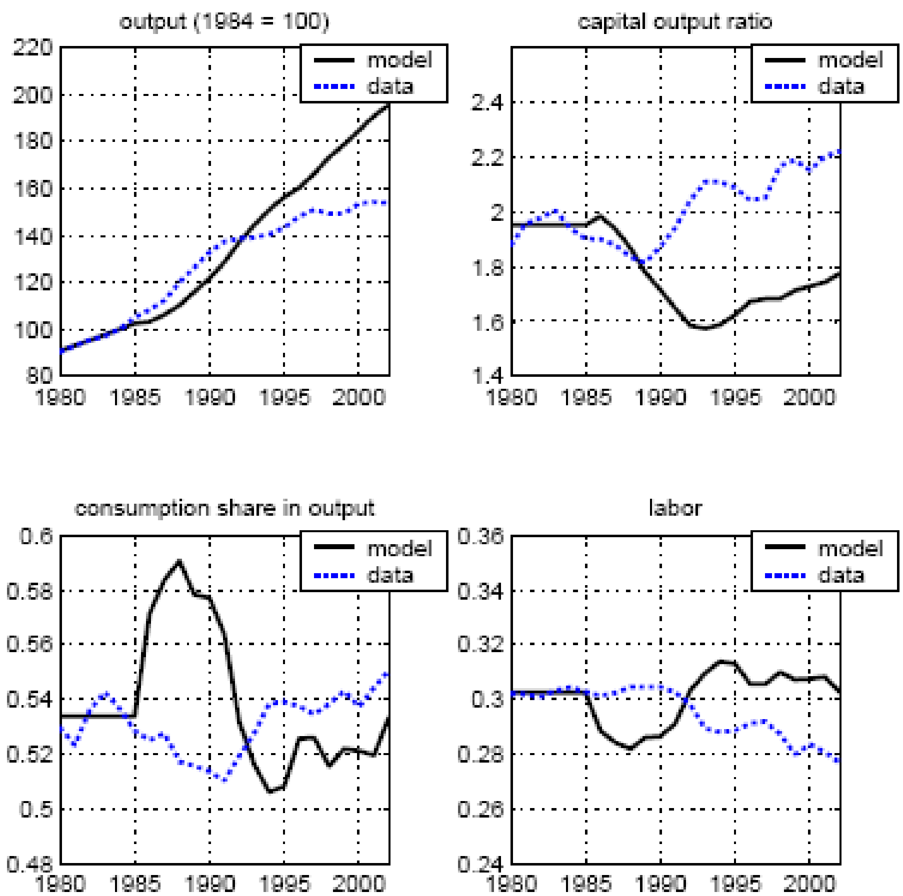

Figure 10: Simulation with Persistent Shocks: Macro Aggregates

values. In fact, there was no decline in the official tax rates on land during this period. What did decline, however, was the assessment values of land for the purpose of property taxation [Ishi (2001)]. This must have been as a result of, and not as the cause for, the increase in land prices. In other words, land taxes magnified the effect of shocks that affected land prices, but were not themselves the source of these shocks, at least for the late 80s. Second, even if we make the changes in land tax rates to be exogenously given in the model, for these to have a sizable effect on land prices, we still need to assume that agents perceive these changes as very persistent. In other words, we would still need high persistence, but this time in the stochastic process for land tax rates.

6 Conclusion

Japanese land and corporate market values increased significantly in the late 80s and then declined in the 90s. This paper uses a neo-classical growth model to address whether and if so how much of the movements in land and corporate valuation in Japan can be accounted for by the observed changes in the growth rate of TFP. The collateral use of land and land taxation policy that is countercyclical to land prices substantially magnify the effect of small shocks by reducing the required return on land. With the model calibrated to Japanese data, I find that the observed changes in fundamentals cannot simultaneously account for the movements in asset prices and macroeconomic variables. The movements in asset prices (especially land prices) can be justified if agents expected the changes in TFP growth to be very persistent. Persistent TFP growth expectations, however, have counter-predictions regarding the macroeconomic aggregates.

Future research should test other possible explanations, such as the effects of monetary policy, to explain the observed movements of asset prices in Japan. The official discount rate of the Bank of Japan was reduced from 9% to 2.5% between 1980-1989. The effects of this expansionary policy on asset prices, along with its effects on macroeconomic aggregates, can be explored within a general equilibrium model with nominal rigidities [c.f. Bernanke and Gertler (1999)].

Another possible venue for further research is to explore the effects of real estate prices on the real economy (rather than the other way around). An increase in the price of real estate can generate a sudden increase in borrowing and lending due to the use of real estate as collateral. Some of this new lending, however, may end up financing lower quality investment projects and can result in an increase in bankruptcies and the reduction of overall productivity. This interaction between real estate prices and the real economy may be especially relevant for understanding the prolonged recession in Japan in the 1990s and assessing the possible effects of the recent decline in real estate prices in the U.S..

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A Appendix

In this appendix, I briefly describe data sources and the Japanese tax system. I also provide the proofs for the propositions in section 3.

A.1 Data Sources

The primary sources for the data used in this paper are the Annual Report on National Accounts (ARNA) published by the Economic and Social Research Institute (ESRI) of the Cabinet Office of Japan and the Japan Statistical Yearbook (JSY) published by the Statistics Bureau of Japan. ARNA contains *Gross Domestic Expenditure and Income Accounts* based on the 93 SNA (The UN System of National Accounts of 1993). It also contains *Income, Outlay and Stock Accounts by Institutional Sector*.[35] I backtrack the sectoral data to 1980 using several editions of JSY. I also use JSY for data on labor status, labor hours worked and population by age.[36]

The Sectoral Accounts contain data on the Non-financial Transactions, Income Accounts, and Closing Balance Sheets for the Non-financial Corporate sector, Financial Corporate sector, General Government, and Households and Private Non-profit Institutions. I obtain data on sectoral gross fixed capital formation, consumption of fixed capital, changes in inventories, and net purchases of land from the Non-financial Transactions tables. Data on operating surplus, compensation of employees, taxes on production and

[35] Recent data contained in ARNA can be accessed from ESRI's website at http://www.esri.cao.go.jp/index-e.html.

[36] Recent JSY data can be found in Statistics Bureau's website at http://www.stat.go.jp/english/index.htm.

imports and subsidies are from the sectoral Income Accounts. The year-end values for tangible assets and financial assets and liabilities of each sector are obtained from the Closing Balance Sheet Accounts. To arrive at net debt of corporations, I subtract nonequity financial assets from financial liabilities. Net equity of corporations is found similarly whereby equity assets are netted out from equity outstanding. The changes in the resulting net equity numbers align with the changes in the Topix and the Nikkei indexes fairly well except for the early 80s.[37] I take the 1990 level of the net equity calculated from the National Accounts as the benchmark and use the change in the Topix index to construct a new net equity series for the years 1980-2002. I use this in my calibration and the plots in the results section.

A.2 The Japanese Tax System

In this subsection, I briefly discuss the Japanese tax system related to land and corporate valuation as suggested by the model in section 2.[38] Special emphasis is placed on the tax reforms that took place during 1987-88 regarding corporate income taxation and taxation of household savings income and also the tax reforms regarding land taxation in 1991.

[37] The equity numbers from the National Accounts suggest a four-fold increase in equity values between 1984-1989 rather than three-fold as suggested by the Topix and the Nikkei indexes.

[38] For a detailed survey of the Japanese tax system and its evolution through the years, see Ishi (1989, 1993, 2001). This section is mainly derived from those sources.

A.2.1 Corporate Property Taxation

In Japan, taxes on corporate property (structure and equipment capital and land) are mainly imposed at the municipality level. The three major tax items on property holdings of corporations are the *property tax*, *city planning tax*, and the *special land-holdings tax.* The property tax is imposed on all tangible assets at a standard rate of 1.4%. The city planning tax is levied on land and buildings at a rate of 0.3%. The special land-holding tax is levied on land holdings at a rate of 1.4% and the land portion of the property tax is deductible for calculations of taxable value. All these taxes suggest that the statutory tax rates on corporate land and capital are 3.1% and 1.5% respectively.

The effective tax rate on land is much lower, however, due to the *under-assessment* of land values for tax purposes. In Japan, an official land valuation (*kouji kakaku*) is published every year by the National Land Agency to serve as a tax base for land in different regions. In turn, local governments assess land values for taxation purposes as a ratio of this benchmark price every three years. The local government assessments are significantly lower than the official values and has gone even further down in the 80s. The national average for the ratio of assessment to official values dropped from 67.4% in 1982 to 36.3% in 1991 [See Ishi (2001)].[39] Given that the official land values were already around 70% of their market values, the effective

[39] The effective tax rates on residential and agricultural land were much lower than corporate land since the tax base for residential land was reduced by 1/2 to 1/4 of its assessment value as a special relief. Agricultural land in urban areas were assessed as residential land, however their tax was exempted if the owners continued farming for 20 years. The 1991 tax reform got rid of this exemption for agricultural land.

marginal tax rate on corporate land was about 1.4% in early 80s.[40] This ratio dropped to 0.8% by 1991 mainly due to the fall in local government assessments (see Figure 4 in the introduction). In the tax reform of 1991, the assessment ratios were raised to 70% of official values and also a new tax on land holdings, the *Land Value Tax*, was introduced at the national level starting from 1992. This new tax was levied at a rate of 0.3% (0.2% in 1992) on land holdings of corporations and individuals. Later it was reduced to a rate of 0.15% in 1996-97 as a special relief and was suspended altogether by 1998.

Ishi (2001) reports that the ratio of assessments to official land values in the whole of Japan was 67.4% in 1982, 52.1% in 1985, 47.2% in 1988, and 36.3% in 1991.[41] I use the statutory tax rates, an official land price to market price of 70% for all periods and these reported assessment to official value ratios to arrive at the effective marginal tax rate on land holdings. I have also assumed that the assessment ratio gradually increased back to 70% by 1996.

A.2.2 Corporate Income Taxation

Corporate income is taxed on all levels of government (national, prefectural and municipal) in Japan. Before 1990, the national *corporate tax* entailed a two-tier system where separate tax rates applied to corporate retained earnings and income paid out as dividends. The lower tax burden on

[40] Note that the *average* tax rate on land and capital holdings were even lower due to exemptions.

[41] In the big cities, the assessment ratios were even lower with only 21.9% in Tokyo area, and 14.6% in Osaka-city in 1991.

dividends was intended to encourage dividend payments and higher rates of equity financing, however was deemed ineffective and was phased out during 1989-90. Within the context of the 1988 tax reform, the tax rate on retentions was lowered from 42% to 37.5% and the tax rate on dividends was increased from 32% to 37.5% by 1990.

The local taxes on corporate income are the prefectural and the municipal *inhabitant's taxes* and the prefectural *enterprise tax*. The inhabitant's taxes on corporate income are levied as a surtax on the national corporate tax, whereby a standard rate of 5% is levied on national corporate tax at the prefectural level and another 12.3% is levied at the municipal level neither of which are deductible from the national corporate tax. The enterprise tax, however, is deductible and it was levied at a rate of 12% on all corporate income until 1999 when the rate was lowered to 9.6%.[42] With all national and local taxes in mind, the effective tax rates on corporate retentions and dividends can be calculated as

$$\tau = (1 - \tau_e) \left[\tau_n \left(1 + \tau_i \right) \right] + \tau_e$$

where τ_e is the enterprise tax, τ_n is the national corporate tax (on retentions or dividends), and τ_i is the sum of prefectural and municipal inhabitant's surtaxes. Figure 11 plots this effective marginal tax rate on corporate income retained and paid as dividends.

The effective corporate income tax rate was around 55% for retained

[42] Actually not the current year's, but the previous year's enterprise tax payments are deductible. The difference is negligible, so I treat the current year as deductible in the tax rate calculations.

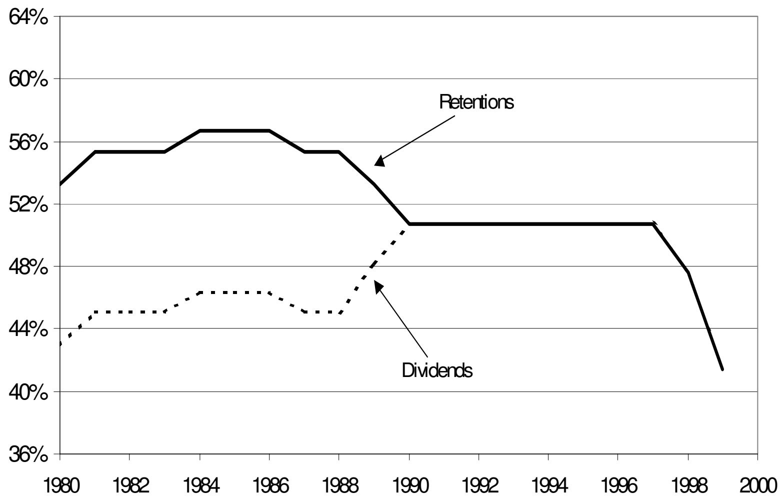

Figure 11: Effective marginal tax rates on corporate income

profits and 45% for dividends before the 1988 reform. With the reform, these rates have converged to 50% and stayed there until 1998-99 when major reductions in the national corporate tax and enterprise tax have reduced the effective corporate income tax rate to 41.5%; close to its counterparts in the U.S. and Europe.

A.2.3 Dividend and Interest Income Taxation

In Japan, individual income from investments and savings are treated preferentially, and taxed separately from other household income at special rates. Prior to the tax reforms introduced in 1988, most of the income earned from interest was tax-exempt. The *Maruyu* system (tax-exempt small amount savings) which included deposits at banks, securities companies and other private institutions allowed a person to save up to 3 million yen tax-free.

In addition to this, there were exemptions from other interest income from postal savings, national and local bonds, savings for the formation of employee assets and postal installment savings for housing. With these exemptions, a couple could save up to the yen equivalent of $180,000 without paying any taxes on their interest. In effect, around 70% of interest income was completely tax exempt.

The amount of interest income that exceeded the limits was either taxed at a flat rate of 35% at source, or at 20% at source with the non-taxed portion combined with other incomes on the individual tax return; this was at the choice of the taxpayer. The individual income tax rates are highly progressive in Japan and ranged from 10 to 75% with 15 brackets before 1984, but most high income groups avoided the high marginal taxes on their savings income by the separate taxation at source. Assuming 60% of individuals had a marginal tax on interest income of 0%, and the rest had a marginal tax rate of 48% (including local taxation), the aggregate marginal tax rate was around 19% on interest income before 1988. With the 1988 tax reform, a flat 20% tax at source on all interest income was introduced (15% in national individual *income tax* and 5% in prefectural *inhabitant's tax*).

The taxes on individual income from corporate dividends are similar to interest income taxation. Dividend income does not share the generous exemptions of the Maruyu system, but it may be taxed at a flat rate of 35% at source, or at 20% at source with the non-taxed portion combined with other incomes on the individual tax return as in the interest income. For the local inhabitant's taxes on individuals, dividend income is treated as any other income and included in comprehensive tax base except for exemptions for small dividend income. The inhabitant's taxes are progressive taxes. On the prefectural level, rates range from 2% to 4% with 3 brackets. On the municipal level, the tax schedule had 13 brackets ranging from 2.5% to 14% in 1985, 7 brackets ranging from 3% to 12% in 1987, 4 brackets ranging from 3-12% in 1992 and only 3 brackets with 3%, 8%, and 10% rates in 2000. There's a special tax credit on the national level applied to dividend income whereby 10% of dividend income is deductible from individual taxable income. Given these considerations, the effective marginal tax rate on dividend income can be calculated as

$$\tau = 0.35 + \tau_i - (0.1 * \tau_n)$$

where τ_n is the national income tax on individuals and τ_i is the sum of prefectural and municipal inhabitant's taxes on individual income. I have assumed that all shareholders choose to be taxed at the separate rate of 35% at source for the national tax and deduct 10% of dividend income from their comprehensive taxable income. This is not unreasonable given that national individual income taxes are high and progressive ranging from 10.5% to 70% in 1985.[43] Considering a 3% prefectural, 10% municipal and 30% national tax rate on individual income, the effective marginal tax rate on individual dividend income is 45%.

[43] The top bracket for individual national income was reduced to 60% in 1987, and to 50% in 1989.

A.3 Proofs of Propositions

A.3.1 Proposition 1

The proof follows from the first order conditions of the households and and corporations with respect to debt holdings. From the households, we have

$$E_t \left\{p_{t+1} \left[1 + (1 - \tau_b) \, r_{b,t}\right]\right\} + \mu_{1,t} = p_t$$

where $\mu_{1,t}$ is the multiplier on the nonnegativity constraint of debt. From the corporations, we get

$$E_t \left\{p_{t+1} \left[1 + (1 - \tau_y) \, r_{b,t}\right]\right\} - \mu_{2,t} + \mu_{3,t} = p_t$$

where $\mu_{2,t}$ is the multiplier on the nonnegativity constraint of debt, and $\mu_{3,t}$ is the multiplier on the collateral constraint of debt. The two conditions above imply

$$E_t \left[p_{t+1} \left(\tau_y - \tau_b\right) r_{b,t}\right] = \mu_{3,t} - \mu_{2,t} - \mu_{1,t}$$

Note that all the multipliers are nonnegative, and when the collateral constraint binds, the nonnegativity constraints do not (and vice versa). When $\tau_y > \tau_b$, the left side of the above expression is strictly positive. This can only happen when $\mu_{3,t}$, the multiplier on the collateral constraint is strictly positive and the nonnegativity constraints do not bind, i.e. $\mu_{1,t} = \mu_{2,t} = 0$. On the other hand, when $\tau_y > \tau_b$, the left side is strictly negative. This can only happen when the nonnegativity constraints bind, i.e. $\mu_{1,t}$ and $\mu_{2,t} > 0$, and the collateral constraint does not bind, i.e. $\mu_{3,t} = 0$. When $\tau_y = \tau_b$, the left side is zero; hence all multipliers are zero which is consistent with any debt value between 0 and $\phi\left[(1-\tau_x)\,k_{t+1}+q_t l_{t+1}\right]$.■

A.3.2 Proposition 2

The result follows from the first order condition of corporations with respect to land holdings and the collateral constraint. When $\tau_y > \tau_b$, the collateral constraint binds and the first order condition of corporations with respect to l_{t+1} can be written as

$$E_t\left[\frac{p_{t+1}}{p_t}\left\{(1-\tau_y)\,\theta_l\frac{y_{t+1}}{l_{t+1}}+q_{t+1}-\left[1+(1-\tau_y)\,r_{b,t}\right]\phi q_t-\frac{\Omega_{t+1}}{\bar{l}}\right\}\right]=(1-\phi)\,q_t.$$

First note that

$$\frac{\Omega_{t+1}}{\bar{l}}=\tau_l\left(\Omega_{t+1},q_{t+1}\right)q_{t+1}$$

Along the balanced growth path,

$$\frac{p_{t+1}}{p_t}=\beta\left(\gamma/\eta\right)^{\alpha(1-\sigma)-1}\ \text{ and } r_b=\frac{\frac{p_t}{p_{t+1}}-1}{(1-\tau_b)}.$$

Also

$$\tau_l\left(\Omega_{t+1},q_{t+1}\right)=\overline{\tau_l}\text{ and } l_{t+1}=\bar{l}.$$

Replacing the above expressions into the first order condition with respect to land (after some algebra) yields the value of land relative to output in balanced growth.■

A.3.3 Proposition 3

The proof follows from the first order condition of the stand-in household with respect to firm shares and the first order conditions of the corporations with respect to capital, land, and labor. The household's problem in equilibrium implies

$$E_t\left\{p_{t+1}\left[\left(1-\tau_d^h\right)d_{t+1}+v_{t+1}\right]\right\}=p_t v_t.$$

Imposing the binding collateral constraint, the corporations' first order conditions with respect to capital, land and labor are given by

$$E_t\left[p_{t+1}\left\{\begin{array}{c}(1-\tau_y)\,\theta_k\frac{y_{t+1}}{k_{t+1}}+(1-\tau_x)(1-\delta)\\ +\tau_y\delta-\tau_k-[1+(1-\tau_y)\,r_{b,t}]\,\phi\,(1-\tau_x)\end{array}\right\}\right]=p_t\,(1-\phi)(1-\tau_x)$$

$$E_t\left[p_{t+1}\left\{\begin{array}{c}(1-\tau_y)\,\theta_l\frac{y_{t+1}}{l_{t+1}}+q_{t+1}\\ -[1+(1-\tau_y)\,r_{b,t}]\,\phi q_t-\frac{\Omega_{t+1}}{\bar{l}}\end{array}\right\}\right]=p_t\,(1-\phi)\,q_t$$

$$w_t N_t h_t=\theta_h y_t$$

respectively. These conditions coupled with the collateral constraint and the definition of dividends imply (after some algebra)

$$E_t\left[p_{t+1}\left\{\left(1-\tau_d^h\right)d_{t+1}+\frac{\left(1-\tau_d^h\right)}{\left[1-\left(\tau_y-\tau_d^c\right)\right]}\left[(1-\tau_x)\,k_{t+2}+q_{t+1}l_{t+2}-b_{t+2}\right]\right\}\right]$$
$$=p_t\frac{\left(1-\tau_d^h\right)}{\left[1-\left(\tau_y-\tau_d^c\right)\right]}\left[(1-\tau_x)\,k_{t+1}+q_t l_{t+1}-b_{t+1}\right]$$

This is consistent with the equilibrium condition of the stand-in household (and the transversality condition) if and only if

$$v_t = \frac{\left(1 - \tau_d^h\right)}{\left[1 - \left(\tau_y - \tau_d^c\right)\right]} \left[\left(1 - \tau_x\right) k_{t+1} + q_t l_{t+1} - b_{t+1}\right].$$

Using the binding collateral constraint for debt and rearranging the tax terms, the value of equity can be written as

$$v_t = \left[1 - \frac{\tau_d^h + \tau_d^c - \tau_y}{1 + \tau_d^c - \tau_y}\right] (1 - \phi) \left[\left(1 - \tau_x\right) k_{t+1} + q_t l_{t+1}\right]$$

which completes the proof.■