Real Estate Prices, Borrowing Constraints and Business Cycles

A Study of the Japanese Economy

Suparna Chakraborty*

March 2005

---

*Dept. of Economics, University of Minnesota & Research Dept., Federal Reserve Bank of Minneapolis
E-mail: suparna@econ.umn.edu. I thank V.V.Chari, Michele Boldrin, Nobuhiro Kiyotaki, John Moore, Fumio Hayashi and seminar participants at Fall 2004 Midwest Economic Theory and Trade conference, St. Louis, University of Tokyo and Bank of Japan, Board of Governors of Federal Reserve System, D.C., Bank of Canada, Williams College, Indiana University, Barnard, Columbia University, Ohio Wesleyan University, Zicklin School of Business, Baruch, CUNY and Macroeconomics Workshop at University of Minnesota for their helpful comments.

Abstract

This paper investigates the causes of business cycle fluctuations that Japan experienced over the period 1980 to 2000. To this end, I build a dynamic general equilibrium model with endogenous borrowing constraints where business cycle fluctuations are the result of TFP fluctuations and investment frictions. I identify land tax changes since 1984 as a possible source of investment frictions, the idea being that given a strong preference for debt-financing and widespread use of land as collateral in Japan, land tax changes will cause fluctuations in land price that can potentially affect output and investment by affecting borrowing capacity of firms. Calibrating the model using Japanese data and feeding in observed TFP and land taxes one by one and in unison, I find that TFP and land tax fluctuations can significantly account for observed fluctuations in output, but cannot account for land price fluctuations unless agents expect land tax changes to be permanent. I further identify redistribution of land holding between commercial and residential uses in response to land tax and TFP changes as an important channel through which the effect of these external fluctuations on output gets amplified. Observed data of land use in Japan provides evidence of such redistribution.

Key words: Japanese economy, Business cycle fluctuations, land price fluctuations, borrowing constraints, debt-financing, collateral, redistribution, financial accelerator, expectations, amplification

JEL classification codes: E32, O11, O41, O47, O53

1 Introduction

The aim of this paper is to build a standard growth model with efficiency and investment frictions to numerically account for the business cycle fluctuations witnessed in Japan over the period 1984 to 2000.

This paper builds on my previous paper[1] that shows that to have a model that significantly accounts for business cycle fluctuations, we need to incorporate efficiency and investment frictions. The efficiency friction that I model is fluctuations in Solow residual. As for investment frictions, I model fluctuations in land prices as a potential source of investment friction. I further use efficiency and land tax fluctuations as a catalyst for land price fluctuations. The idea is that given the preference for debt financing by Japanese firms and widespread use of land as collateral, fluctuations in land price significantly amplify the effect of external fluctuations on output. This paper seeks a quantitative answer to the specific question " To what extent can fluctuations in TFP and land taxes account for business cycle fluctuations in Japan given the presence of endogenous borrowing constraints in the economy". Using a dynamic general equilibrium model with time varying efficiency and land taxes, I find that fluctuations in TFP and land taxes can significantly account for fluctuations in output. Land taxes alone successfully account for 40% of the fluctuations. As for land price fluctuations, TFP and land tax fluctuations cannot significantly account for them unless agents expect these external changes to be permanent.

This paper is based on a vast array of literature on endogenous borrowing constraints. The seminal papers in this area are by Bernanke and Gertler (1989) and Kiyotaki and Moore (1995) who pointed out how the dynamic interaction between endogenous credit limits and asset prices turn out to be a powerful transmission mechanism by which effect of shocks persist, amplify and spill over to the real economy. As

[1] "Business Cycle Accounting: Application to Japanese data for the period 1984 to 2000" University of Minnesota Mimeo 2004

for the reasons of Japanese economic fluctuations, there are two diametrically opposing strands of literature. Authors like Kashyap and Hoshi (2003) have held low profitability of the banking sector and non-performing loans responsible for the economic slowdown. Other authors like Prescott and Hayashi (2004) on the other hand, blame the economic fluctuations on fluctuations of Solow residual and attribute no role to investment frictions.

I develop a standard stochastic growth model with both efficiency and investment frictions where efficiency frictions are modeled as fluctuations in Solow residuals. Investment frictions on the other hand result from land price fluctuations whose effect on output gets amplified in the presence of endogenous borrowing constraints that entrepreneurs in this model need to satisfy to get funds for investment. I use land as an input for production as well as for residential purposes. Land is also used as a collateral to secure loans. As a catalyst for land price fluctuations, I look at land tax fluctuations, which was suggested by Alpanda (2004) who found that changes in land-holding taxes can significantly account for the increase of land value relative to GDP in the eighties and the fall in the early nineties but only if the changes were expected to be highly persistent. There are also other views about the boom and bust of land prices. Ito (1992) and Kobayashi (2004) have done studies of various possible causes of the boom and bust of land and asset prices in Japan. These authors have primarily stressed the role played by people's expectations about persistence of land prices to explain the boom and bust of land prices in the last two decades. In my experiments, I further test if expectations play a significant role in accounting for fluctuations in land prices. A key feature of the Japanese tax system that drives the model is that the government allows firms to deduct interest payment on debt from taxable corporate income thus creating a tax shelter for firms. This incentive encourages debt financing, as internally generated funds cannot be claimed as deductible from corporate income tax.

The arguments of this paper assume that collateral constraints are important for the Japanese economy. The empirical question of whether collateral constraints are important in the Japanese corporate sector has been studied by many authors including Kashyap, Hubbard and Whited (1993), Bayoumi (2000), Ogawa et. al

(1994). Bayoumi uses a VAR to investigate four possible explanations of the extended slump in Japanese economic activity over the 1990s: the absence of bold and consistent fiscal stimulus, the limited room for expansionary monetary policy due to liquidity trap, over investment and debt overhang and disruption of fiscal intermediation. He finds that "the major explanation is disruption in financial intermediation, largely operating through the impact of changes in domestic asset prices on bank lending".

I calibrate the model to match the moments from Japanese data during 1980-1984. Working through the dynamics of the model, I find that fluctuations in TFP and land taxes can significantly account for fluctuations in GDP per capita and the effect is greatly amplified in presence of endogenous borrowing constraints. Fluctuations in land taxes alone account for 30% of the increase and 50% of the subsequent drop in real GDP per capita. However, fluctuations in land taxes and TFP cannot significantly account for fluctuations in land price if agents do not expect them to be permanent. This finding gets us to the questions, if land prices do not change significantly, what causes the model to replicate the type of business cycle fluctuations that Japan experienced? My answer: redistribution of land holding between commercial and residential uses in response to changes in TFP and land taxes.

How does the redistribution mechanism work? Entrepreneurs value land as an input as well as collateral asset. Also the statutory tax rate on land holding of entrepreneurs is three times the tax rate on land holding of workers, so the entrepreneurs' decision on how much land to hold is very sensitive to fluctuations in land taxes. Hence any change in the land taxes leads to a redistribution of land between workers and entrepreneurs. Since in this model, only entrepreneurial land is used for production, any fluctuation in land holding of entrepreneur affects output. Given that entrepreneurs derive their income from selling the output produced, fluctuations in output have an impact on entrepreneurs' investment in land and capital for future. Given that when borrowing constraints are endogenous, the borrowing limit is a fraction of the entrepreneurial wealth which comprises of capital and land holding of the entrepreneur, fluctuations in entrepreneurial investment has a direct impact on how much the entrepreneur can borrow which then affects future production. So, any change in land taxation policy, working through redistribution of land amplifies the economy's response to changes in land taxes.

The paper is organized as follows. In Section 2, I provide some facts about the Japanese economy before and during the downturn in 1990s. In Section 3, I explain the model- a dynamic general equilibrium model with perfect competition and borrowing constraint. In Section 4, I state the model propositions. Section 5 describes the calibration and solution procedure. Section 6 describes the results. In Section 7, I present some sensitivity analysis of changing expectations about persistence of shocks. Further, I show numerically the amount of amplification resulting from endogenous borrowing constraints. Section 8 provides a conclusion.

2 Overview of the Japanese economy (1980 to 2000)

2.1 Land prices in Japan

Land is a very valuable asset in Japan. It is valued highly both by the corporate sector and the household sector. Not only is land used for production and real estate investment, the corporate sector in Japan puts up land as collateral when borrowing from banks for investment funding. During the 1980s, the government of Japan started the process of liberalization of the economy and allowed foreign investors to invest in Japanese firms. As direct foreign lending became a major form of financing for the big firms, the domestic lenders like banks and postal savings institutions were left with a large supply of funds. In order to invest the excess funds, banks started lending to the small firms, which typically offered land as collateral. During this period, the government also encouraged real estate investment and resorted to reduce taxes on land in an effort to motivate people to invest in real estate. All these factors led to a sharp rise in price of land. Between 1980 and 1990, price of land in Japan increased by 89% with respect to a long-term trend as figure 1 demonstrates.

Worried by this dramatic increase the government undertook a series of measures to control for the prices. Some of the more noticeable ones implemented by 1990 were a policy to restrict bank's lending for real estate purposes and a significant increase in taxes on land holding. By 1991, land prices started falling, and by 2000, land prices had fallen below what it was in 1980.

2.2 Share of land held by the corporate sector in Japan

I assume that total land holding in the economy is one. Traditionally, Japanese firms own substantial land holding. As depicted in figure 2, the average share of land held by corporate sector during the period 1980 to 1984 stood at 27%. During the boom period of late eighties, share of land held by the corporate sector increased by 13.4%. However, during the lost decade, share of land held by the corporate sector fell by 15.2%. Corporate sector land holding has comprised a significant portion of total collateral offered to banks to secure loans.

The period of 1984 to 2000 was also marked by significant fluctuations in the real economy.

2.3 Per capita output

Japanese economy had stabilized after the oil price shock and was growing at a rate of 2.15%. However, a host of measures enacted in later eighties resulted in another economic boom. As is evident from figure 3, Japanese economy performed very well during 1984 to about 1991, the average growth rate of per capita GDP was 1.39% above trend. The boom was short-lived and economy started stagnating since 1991. The average growth rate of per capita GDP fell to 1% below trend level during 1991 to 2000.

2.4 Capital-output ratio

Figure 4 plots the capital output ratio over the period 1980 to 2000. The average capital output ratio stood at 2.42 from 1980 to 1991. However, since 1991 significant capital deepening has occurred. By 2000, capital output ratio increased to 3.1.

In this paper, I use a model with possible external sources of frictions to replicate the above facts. I concentrate on two possible frictions: TFP fluctuations and changes in land taxation policy over the late eighties and early nineties.

2.5 Fluctuations in TFP

I begin by estimating Solow residual from the data. Figure 5 depicts TFP after taking out along term trend of 2.15%. Between 1980 and 1991, TFP grew over and above the trend growth rate. However the trend changed after 1991 and by 2000, TFP had fallen below its 1980 level.

2.6 Land tax system in Japan

The land tax system in Japan is a complicated one[2]. The standard statutory tax rate in Japan is 3.1%, which with a maximum of 3.8%. The agricultural land holdings and the residential land holdings are charged a lower statutory tax rate about 1/3rd of the corporate sector tax rate. However, the tax is not assessed on the market value of land, rather on a certain percentage of the official value of land. In Japan, the Land Tax Agency has the job of determining the official value of land. They usually look at past three-year averages to arrive at the official land value. Typically, the official land value is 70% to 80% of the market value of land. The government then decides on an assessment value of land for taxation purposes. The assessment

[2] The source is the book "The Japanese Tax System" Hiromitsu Ishi. Details of the tax system are available in Appendix 2

value of land is a certain fraction of the official value of land. In 1980, it was about 70% of the official land value but by 1990, it had declined to about 36.3% of the official land value. For analyzing the effect of land taxes, it is therefore important to look at the effective land tax rate instead of the statutory tax rate.

Effective land tax rate = (Statutory tax rate* Assessment ratio*Official land value)/Market Value

Figure 6 shows us the effective land tax rate of the corporate sector from 1972 till 1997. I have assumed that the tax rates did not change thereafter. The effective land tax rate has been pretty stable from 1972 to about 1984. However, since 1985, it started to decline and was falling till about 1990. In the meantime, in 1989, in an effort to increase the land taxes, legislation was enacted to increase the assessment ratio. The policy was implemented in 1990 and since then land holding taxes have been on the rise.

3 The model

I use a standard stochastic growth model with time varying productivity and land taxes. In my model borrowers face a credit constraint. I consider exogenous as well as endogenous credit constraints and compute the numerical results in each case. A comparison of these results shows quantitatively the extent of amplification caused by endogenous credit constraints.

Description of the economy

The model economy every period consists of a measure N_t of agents, N_t^w of them are workers and the remaining $N_t^e = N_t - N_t^w$ are entrepreneurs. I assume that a person is born either a worker or an entrepreneur and the fraction of workers to entrepreneurs is constant over time. This is not a very unrealistic assumption given the fact that in Japan, family businesses (*keiretsu*) dominate and it is relatively more difficult for potential entrants to become entrepreneurs if they are not a part of a well-established business family. I assume that population grows at a constant rate of η. The economy is endowed with 1 unit of land resource held by workers and entrepreneurs. Workers are endowed with 1 unit of labor and entrepreneurs are also endowed with 1 unit of labor. The labor of the entrepreneur is distinct from the labor of the workers. We can think of entrepreneurs to have managerial or administrative skills as distinct from workers who may provide the physical labor. There is one good being produced and consumed. The production technology for producing the good is owned by the entrepreneurs. Production requires capital, labor of workers, labor of entrepreneurs as well as land as input into the production process. The production technology is given by $y_t \leq e^{z_t} F\left(k_t, h_t^{wd}, h_t^e, l_t^e\right)$ where z_t is the productivity parameter. There is a government that sets the tax rates, spends on final goods and disburses transfers to the consumers. I shall assume that government expenditure is wasteful and does not increase utility of the population. Government balances budget every period. In working out the dynamics of the model, I assume that government spending is a constant fraction of output. Further, the share of each group of consumers in total transfers does not change over time. For notational convenience, I am using all capital letters to indicate aggregate variables and small letters to indicate per capita variables.

Representative worker's problem

The representative worker begins every period t with a_t units of savings and l_t^w units of land held from the previous period t-1. He is also endowed with 1 unit of labor. During the period t, he has to decide the fraction of time h_t^w he wants to work at the given wage rate w_t and amount of final good c_t^w he wants to consume to maximize the present discounted value of his lifetime utility. If he supplies h_t^w units of labor, he earns after tax wage income, $w_t h_t^w \left(1-\tau_h\right)$. He earns after tax interest income $\left(1+r_t(1-\tau_b)\right)a_t$ on his savings from the last period, t-1. The worker also receives transfers T_t^w every period from the government. The worker spends part of his income for buying consumption good. I further assume that the worker values land for residential purposes so every period he also invests in land to be used the next period. I denote worker's investment in land by $q_t\left(l_{t+1}^w - l_t^w\right)$ where the market price of land in period t is denoted by q_t. In addition, every period the government also charges the worker some tax on the value of his land holdings $q_t l_t^w$. The amount of tax due on land holding of the worker is $q_t l_t^w \tau_{lt}^w$, where τ_{lt}^w is the effective tax rate on land holding. Any remaining income is saved for future.

Thus the representative consumer's problem can be stated as:

$$\underset{c_t^w, h_t^w, l_{t+1}^w}{Max} \; E_0 \sum_{t=0}^{\infty} \beta^t u^w (c_t^w, 1-h^w{}_t, l_t^w)$$
$$subject\ to:$$
$$1.\ c_t + q_t(l_{t+1}^w - l_t^w) + q_t l_t^w \tau_{lt}^w + a_{t+1} \le w_t h^w{}_t (1-\tau_h) + (1 + r_t(1-\tau_b)) a_t + T_w^t \forall t$$
$$2.\ c_t \ge 0;\ a_{t+1} \ge 0;\ 0 \le h^w{}_t \le 1;\ l^w{}_{t+1} \ge 0;\ \forall t$$

Representative Entrepreneur's problem

The representative entrepreneur begins every period t with l_t^e units of land, k_t units of capital stock and b_t units of borrowed funds from the previous period t-1. He also owns the production technology and is endowed with 1 unit of labor. In period t, the entrepreneur decides what fraction of time h_t^e he would work and how many units c_t^e of output he would consume to maximize present discounted value of lifetime utility. He also decides how much labor h_t^{wd} to hire for production. In addition, he supplies l_t^e units of land and k_t units of capital for production. The production technology uses land, capital, labor of worker and labor of entrepreneur to produce output, y_t.

With the income received from sale of output, the entrepreneur pays the workers labor income $w_t h_t^{wd}$. His repayment on loans with interest is $(1+r_t)b_t$. He also has to pay a corporate tax on taxable corporate income. He can claim the wage income paid to workers, the depreciation of capital stock and the interest part of repayment of funds as deductible. We shall assume that the depreciation rate of capital stock is a constant, δ. So, the corporate income tax paid is $\tau_y(y_t - w_t h_t^w - r_t b_t - \delta k_t)$. The entrepreneur receives transfers T_t^e every period from the government. With the remaining income, the entrepreneur finances consumption; invests in land, $q_t\left(l_{t+1}^e - l_t^e\right)$ and invests in capital stock, x_t for future. Just like the workers, the entrepreneur also has to pay a tax on land holding, $q_t l_t^e \tau_{lt}^e$, the tax rate τ_{lt}^e being greater than τ_{lt}^w. In this model, the fact that the entrepreneur can claim interest payment as a deductible from taxable corporate income provides an incentive to the entrepreneur to finance production through borrowed funds. So every period the entrepreneur borrows funds b_{t+1} for future investment. However, he cannot borrow unlimited funds. The entrepreneur faces a limit to how much he can borrow. In the model with exogenous borrowing constraint, the borrowing limit B_{t+1} is independent of the wealth holding of the entrepreneur. As opposed to this, in a model with endogenous borrowing constraint, borrowing limit B_{t+1} is a certain fraction, ϕ of the value of his wealth holding, $\left(k_{t+1}+q_t l^e_{t+1}\right)$.

Thus the representative entrepreneur's problem can be stated as:

$$
\begin{aligned}
& Max_{\, c_t^e, x_t, l_{t+1}^e, h_t^e, h_t^{wd}} \; E_0 \sum_{t=0}^{\infty} \beta^t u^e(c^e{}_t, 1-h^e{}_t) \\
& subject\ to: \\
& 1.\, c^e{}_t + x_t + q_t(l^e_{t+1} - l^e_t) + w_t h^{wd}{}_t + q_t l^e_t \tau^e_{lt} + (1+r_t(1-\tau_b))b_t \\
& \le y_t - \tau_y(y_t - w_t h^{wd}{}_t - \delta k_t - r_t b_t) + b_{t+1} + T^e_t \;\forall t \\
& 2.\, x_t \le k_{t+1} - (1-\delta)k_t \;\forall t \\
& 3.\, y_t \le e^{z_t} F\left(k_t, h^{wd}_t, h^e_t, l^e_t\right) \forall t \\
& 4.\, b_{t+1} \le B_{t+1} \quad \forall t \\
& 5.\, c^e_t \ge 0;\, b_{t+1} \ge 0;\, 0 \le h^e{}_t \le 1;\, l^e{}_{t+1} \ge 0;\, k_{t+1} \ge 0;\, \forall t
\end{aligned}
$$

I assume that government balances its budget every period, so that

$$G_t + T_t \le N^w_t\left(\tau_h w_t h^w_t + \tau_b r_t a_t + \tau^w_{lt} q_t l^w_t\right) + N^e_t\left(\tau_y(y_t - w_t h^w_t - \delta k_t - r_t b_t) + \tau^e_{lt} q_t l^e_t\right) \forall t$$

where G_t is aggregate government expenditure and T_t is aggregate transfer. I shall further assume that government expenditure on goods is wasted every period and does not enter representative agent's utility function.

Every period the resource constraints are satisfied so that labor, goods and land and savings market clears:

$$N_t^e h_t^{wd} \le N_t^w h_t^w$$

$$N_t^e l_t^e + N_t^w l_t^w \le 1$$

$$N_t^e b_t \le N_t^w a_t$$

$$N_t^e c_t^e + N_t^w c_t^w + N_t^e (k_{t+1} - (1-\delta)k_t) + G_t \le N_t^e y_t$$

$$N_t^e T_t^e + N_t^w T_t^w \le T_t$$

Notice that if there are no wedges, i.e. we set the time varying TFP to a constant value and assume no time varying taxes on land holding then the economy would be on a balanced growth path. I assume that on a balanced growth path output and investment per capita grow at a constant rate g_z. However, if there were shocks to either the TFP, or tax on land holding, then the output would diverge from the balanced growth path output.

Definition of recursive equilibrium in this model[3]

I denote the vector of state variables of representative worker is denoted by $s^w = \left(s, l^w, S, \tau\right) \in R_+^9$ and representative entrepreneur by $s^e = \left(s, l^e, k, S, \tau\right) \in R_+^{10}$, where $S \in R_+^4$ be the vector of aggregate state variables. For a detailed description of the states, please refer to Appendix 2.

A Recursive Competitive equilibrium for this model comprises of value function of worker, $v^w(s^w)$ and value function of entrepreneur, $v^e(s^e)$; price functions $w(S), r(S), q(S)$; policy functions denoting worker's consumption, labor supply, $c^w(s^w), h^w(s^w)$; policy functions denoting entrepreneur's

---

[3] Details of the state space are specified in Appendix 2

consumption, labor demand, entrepreneur's labor supply and output, $c^e(s^e), h^e(s^e), h^{wd}(s^e), y(s^e)$; laws of motion of entrepreneur's borrowing, entrepreneur's stock of land and capital, $b(s^e), l^e(s^e), k(s^e)$; laws of motion of worker's saving and stock of land, $a(s^w), l^w(s^w)$ and aggregates: $K(S), L^w(S), L^e(S), S(S), B(S)$ such that:

Given price functions and predetermined state variables, policy functions and laws of motion solve the

(a) Representative worker's problem:

$$
\begin{aligned}
& v^w(s^w) = \max_{c^w, h^w, l'^w, a'} u^w(c^w, l^w, 1-h^w) + \beta E v^w(s'^w) \\
& s.t. \\
& c^w + q\left(l'^w - l^w\right) + \tau_l^w q l^w + a' \leq w h^w (1-\tau_h) + \left(1 + r(1-\tau_b)\right) a + T^w \\
& non\, negativity\ \ satisfied
\end{aligned}
$$

(b) Representative entrepreneur's problem:

$$
\begin{aligned}
& v^e(s^e) = \max_{c^e, h^{wd}, h^e, l'^e, b'} u^e(c^e, 1-h^e) + \beta E v^e(s'^e) \\
& s.t. \\
& c^e + k' - (1-\delta)k + q\left(l'^e - l^e\right) + \tau_l^e q l^e + w h^{wd} + (1+r)b \leq y - \tau_y\left(y - w h^{wd} - rb - \delta k\right) + b' + T^e \\
& b' \leq B' \\
& y \leq e^z F(k, l^e, h^e, h^{wd}) \\
& non\, negativity\ \ satisfied
\end{aligned}
$$

(c) Resource constraints satisfied

(d) Government budget is balanced

4 Model propositions

There exists no analytical solution to the model. However, we can derive some propositions along the balanced growth path.

Proposition 1 *On a balanced growth path, an increase in value of land holding tax on corporations decrease the value of land held by corporations relative to GDP and vice versa.*

Value of land held by corporations with respect to GDP is given by:

$$\frac{ql^e}{y} = \frac{\theta_l}{\frac{1}{\beta\eta}\left[(1-\phi) - \frac{\phi\beta}{(1+g_z)}\left(1+(1-\tau_y)r\right)\right] - 1 + \tau_l^e}$$

-in a model with endogenous borrowing constraint;

$$\frac{ql^e}{y} = \frac{\theta_l * (1-\tau_y)}{\frac{1}{\beta\eta} - 1 + \tau_l^e}$$

-in a model with exogenous borrowing constraint.

The formula can be derived from the Necessary first order conditions[4]. The formula shows a negative relation between share of corporate land in output and land holding tax.

Proposition 2 *Borrowing Constraint binds with equality if and only if the tax rate on earned income of workers is strictly less than the corporate income tax rate*[5].

Intuition: In Japan, government has tried to encourage savings by households and debt financing by corporations. It has allowed the corporations to claim the interest paid on borrowings as a deductible from

---

[4] See Appendix 1 for the derivation of the formula

[5] Proof of the proposition provided in Appendix 1

their corporate income tax base. No such deduction is allowed for equity financing. This tax shelter promoted debt financing over equity financing as a cheaper alternative as long as the tax paid on interest income by the lenders, in our model the workers, is less than the corporate income tax rate. This is true in Japan where the corporate income tax rate borders around 49.5% but the tax on interest income is around 35% as explained in the previous section.

Proposition 3 *In a model with endogenous borrowing constraint, on a balanced growth path, an increase in value of land holding tax on corporations decrease borrowings of corporations relative to GDP and vice versa.*

Borrowing of corporations with respect to GDP is given by:

$$\frac{b}{y} = \phi\left(\frac{k}{y} + \frac{ql^e}{y}\right)$$

where

$$\frac{k}{y} = \frac{\theta_k}{\dfrac{1-\tau_y}{\dfrac{\beta}{(1+g_z)}}\left[(1-\phi)\left(1-\dfrac{\beta}{(1+g_z)}\right)\right] + \delta + \phi r}$$

$$\frac{ql^e}{y} = \frac{\theta_l}{\dfrac{1}{\beta\eta}\left[(1-\phi) - \dfrac{\phi\beta}{(1+g_z)}\Big(1+(1-\tau_y)r\Big)\right] - 1 + \tau_l^e}$$

The formula can be derived from the Necessary first order conditions and Proposition 2. As we can see from the formula, tax on land holdings affect the value of land held by corporate sector relative to output inversely. It does not affect the capital output ratio. Proposition 2 shows that on a balanced growth path borrowing constraint hold with equality. So, borrowing to output ratio is a constant fraction of the sum of capital output ratio and value of land holding in the corporate sector to output ratio. Hence, any decline in value of corporate land holding to output as a result of increases in land holding tax results in a decline in borrowing to output ratio.

5 Solution procedure and calibration

5.1 Solution procedure

In proposition 2, I show that the borrowing constraint holds with equality in the steady state. I assume that the same is true in the neighborhood of the steady state and use the Method of Log Linearization around steady state suggested by King, Plosser and Rebelo (1988) to solve the non-linear model. The computational tool used is the Blanchard-Kahn Algorithm. I have assumed population growth in my model, so I have to adjust the problem of the representative worker and representative entrepreneur accordingly. Notice that in the model, in the absence of distortionary wedges, the economy would be on a balanced growth path with output per capita, consumption per capita, investment per capita all growing at the rate g_z, land price q_t would rise at the rate $(1+g_z)\eta$, land held by both workers and entrepreneurs would fall at the rate η and labor would be constant over time. Further, in case of exogenous borrowing constraints, we need exogenous borrowing constraint to grow at the rate $(1+g_z)\eta$ on a balanced growth path. So, to solve for a steady state for the model, I need to discount all variables on the balanced growth path by their growth rate on the balanced growth path. The first step is to calibrate the model to estimate the parameters. I calibrate the model to match the moments from the Japanese data taking averages over 1980 to 1984. The next step is to find the steady state values of the variables around which we will log-linearize the model. I shall choose the initial condition for the variables such that in the starting year, one that I choose to be 1980, the economy would be on a balanced growth path, at its observed initial value for consumption, investment, government consumption, output and land value. I can then log-linearize the model around the steady state and numerically compute the results[6].

[6] The details are available in appendix 1.

5.2 Calibration

To calibrate the model, I shall first have to specify the functional form used for utility function of worker and entrepreneur and the production function.

Let

$$u^w(c_t^w, 1-h_t^w, l_t^w) = \log c_t^w + \alpha_1 \log(1-h_t^w) + \alpha_2 \log l_t^w$$

$$u^e(c_t^e, 1-h_t^e) = \log c_t^e + \alpha_1 \log(1-h_t^e)$$

$$e^{z_t} F\left(k_t, h_t^{wd}, h_t^e, l_t^e\right) = e^{z_t} k_t^{\theta_k} h_t^{wd\theta_h} l_t^{e\theta_l} h_t^{e(1-\theta_h-\theta_l-\theta_k)}$$

In a model with exogenous borrowing constraints, I assume:

$$B_{t+1} = E_t\left(\overline{B} e^{z_{t+1}}\right)$$

I further assume that TFP and land taxes follow a stochastic AR1 process.

$$z_t - \overline{z} = \rho_z\left(z_{t-1} - \overline{z}\right) + \varepsilon_{zt}$$

$$\tau_{lt}^w - \overline{\tau_l^w} = \rho_l^w\left(\tau_{lt-1}^w - \overline{\tau_l^w}\right) + \varepsilon_{lt}^w$$

$$\tau_{lt}^e - \overline{\tau_l^e} = \rho_l^e\left(\tau_{lt-1}^e - \overline{\tau_l^e}\right) + \varepsilon_{lt}^e$$

The main source of my data is the Hayashi and Prescott (2002) data set and Japan Statistical Yearbook. For data on land values, I have used Alpanda (2004) dataset, which is derived from the Japan Statistical Yearbooks.

5.3 Interpretations of data used:

The aggregate consumption in my model is the sum of the aggregate consumption of the workers and the entrepreneurs. To match the model to the national income accounts, I have added net exports to consumption to arrive at aggregate consumption. I have also subtracted Net Indirect Business Taxes from consumption. Therefore Aggregate consumption, $N_t^w c_t^w + N_t^e c_t^e$ = Private consumption + Net Exports-Net Indirect Business Taxes;

I have added government investment to data on private sector investment to get aggregate investment. Investment is the sum of Gross Fixed Capital formation and Net change in inventories. Therefore, Aggregate Investment, X_t = Private Investment + Government Investment;

Output, Y_t = Aggregate Consumption + Aggregate Investment + Government Consumption. This data is identical to GDP minus Net Indirect Business Taxes.

To get the aggregate value of land held by the entrepreneurs, I have added the aggregate value of land held by the corporate sector and the aggregate value of land held by the agricultural sector. We have data for the aggregate land under cultivation from Japan Statistical Yearbook. However, there is an issue if the use of agricultural land is for agricultural purposes only or the farmers use part of it for residential purposes. Here I assume that half of the agricultural land is for cultivation and the other half is used for residential purposes. The data on aggregate value of land holding provides the aggregate value of land holding in the corporate sector and the aggregate value of land holding in the non corporate sector which includes agricultural land. Therefore we need to adjust the data on corporate land holding to also account for the agricultural land to get aggregate value of land held by entrepreneurs;

Aggregate Capital Stock held by entrepreneurs, K_t = Aggregate capital stock in the economy, which includes private as well as government capital. I assume that government capital is used for production purposes.

Ratio of entrepreneurs to working population, $\frac{N_t^e}{N_t}$: I take the ratio to be 12% in accordance with the population census of Statistical Bureau. My measure of entrepreneurs is the self-employed and the total working population consists of all adults aged 20 to 69. I shall calibrate the model so to match the data for the Japanese economy for 1980-1984 averages.

Share of transfer going to the worker: There is no data for this parameter. One of the reasons that I use transfers in my model is to avoid any income effect of change in taxes on hours worked in comparison of steady states. The share parameter value that ensures this is .86.

The model is calibrated to match the moments of the data as stated under the National Income Accounting and Balance Sheet concepts. To get the long run population growth rate η, I take the averages for 1980-1984 of the working population. I define working population as population aged 20 to 69. The average growth rate of working population is .81%. I consider the long run growth rate of the per capita variables $(1+g_z)$ to be 1.215%, which is the average growth rate of GDP per working population for 1980 to 1984.

We also need to state the tax parameters used for calibration. The tax on labor income τ_h is 33%. The tax on interest income earned by workers τ_b is 35%. The corporate income tax rate τ_y is assumed to be 49.5%. I hold these taxes constant for the entire period 1980 to 1984. The average tax rate on land holding on corporate sector τ_l^e is 1.67% and about .56% for the non-corporate sector land tax rate τ_l^w during 1980-1984. Let us summarize the NIA concepts for Japan for 1980-1984 averages

Table 1 National income accounting

National Income Concepts (with respect to output)	NIA Data	Model Adjustments National Income Concepts (with respect to output adjusted for Net IBT)
Product Side of National Accounts		
Consumption	.691	.679 (Private Consumption +Net Exports -Net IBT)
• Private	.592	.58
• Government	.099	.099
Investment	.299	.32 (Private + Government Investment)
• Private	.241	.32
• Government	.057	0
Net Exports	.010	0
Total	1	1
Income side of national accounts		
Compensation of employees	.55	.59
Operating Surplus	.25	.27
Depreciation of Capital	.13	.14
Indirect Business Taxes net of subsidies	.06	0
Total	.99	1

Next, we need to summarize the Balance sheet concept that has been used for calibration. I am using four stock variables: value of capital at the beginning of the year, value of land held by the corporate sector, value of land held by the non-corporate sector (which includes government) and value of aggregate loans.

Table 2 Balance sheet

Balance Sheet Concepts (with respect to output)	NIA Data	Model Adjustments (with respect to output adjusted for Net IBT)
	Output adjusted for Net IBT	Output adjusted for Net IBT
Capital	2.446	2.446
Private	2.146	2.446 (private + government)
Government	.3	0
Land value	3.63	3.63
Corporate	.91	.933(adjusted for agricultural land used for production)
Non corporate (including government)	2.72	2.694(adjusted for agricultural land used for residential purposes)
Borrowing	2.2	2.2

I further assume interest rate to be 4.8% from Hayashi-Prescott data set. Using the above data and the steady state equations we can estimate the parameter values. Given the capital-output ratio and the investment-output ratio, we get delta to be .1002. It is slightly lower than the data because w cannot match all three (capital-output ratio, investment-output ratio and depreciation) from the Necessary first order condition. We need to take estimates of two from the data and estimate the third from the model. The measure of land value in corporate sector to output and borrowing to output ratio gives us the collateral constraint parameter ϕ equal to .66. Interest rate data gives us β of .99. I shall assume that the share of workers in total output is given by compensation of employees to output ratio and is equal to .59. We derive the preference parameters and shares of capital, land and entrepreneur from the first order conditions. Summarizing all our parameters estimated by matching the moments of the data, we get[7]:

Table 3 Calibration

α_1	α_2	β	δ	θ_k	θ_l	θ_h	ϕ
1.96	.0471	.99	.1	.37	.03	.59	.66

Stochastic process

Before I can solve the model, I need to state the evolution of TFP and Land Holding Taxes in my model. I assume that TFP and Land Holding Tax on the workers and entrepreneurs follow an AR1 process such that:

$$z_t - \overline{z} = \rho_z \left(z_{t-1} - \overline{z} \right) + \varepsilon_{zt}$$

$$\tau_{lt}^w - \overline{\tau_l^w} = \rho_l^w \left(\tau_{lt-1}^w - \overline{\tau_l^w} \right) + \varepsilon_{lt}^w$$

$$\tau_{lt}^e - \overline{\tau_l^e} = \rho_l^e \left(\tau_{lt-1}^e - \overline{\tau_l^e} \right) + \varepsilon_{lt}^e$$

We use SUR estimation procedure to estimate the parameters of the stochastic process,

$$\rho_z = .51; \rho_l^w = \rho_l^e = .91$$

[7] The details are worked out in Appendix 1

6 Results

The purpose of this paper is to quantitatively account for fluctuations in per capita output and land prices using fluctuations in TFP and land taxes. To this end, I have calibrated the model to match the moments from data for the period 1980 to 1984 and solved the model for the decision variables. In this section, I feed the TFP and land tax wedges one by one and in unison in the model to assess the fraction of economic fluctuations accounted for by these wedges.

Before stating the results, it may be worthwhile to compare the steady state results of land-holding tax and TFP shock in a model without borrowing constraint with a model where borrowing constraint binds to see the amplification effect of a borrowing constraint. I shall compare the steady state values of output per working population, y, share of land held by corporate sector, l^e and land prices q. We have two sources of shocks in the model, the TFP and the Land Holding Tax on workers and entrepreneurs. Data tells us that between 1980 and 1991, land-holding taxes on the corporate sector fell from 1.67% to .9%. Land holding taxes on the non-corporate sector, which was about 1/3rd of the tax levied on the corporate sector, fell from .56% to .3%. Given the data and calibrated parameters we can estimate sequence of TFP shocks from the production function. I set the TFP at 1980 to be one. Between 1980 and 1991, TFP fell from 1 to 1.005.

6.1 Amplification effect of shocks (steady state comparison)

Table 4 Land tax shock

	y	l^e	q
Endogenous Borrowing Constraint	1.01% increase	29.27% increase	84.12% increase
Exogenous Borrowing Constraint	.34% increase	5.66% increase	67.6% increase

In a model with exogenous borrowing constraints, a fall in land holding tax has very small impact on output. The effect on land holding is comparatively more but the most impact is definitely on land prices. If we compare this with a model where we have endogenous borrowing constraint, the amplification effect is striking. Output increase is three times as much and land holding by corporate sector increases four times. The land price increase is also amplified.

However, if we have a TFP shock, the amplification effect is not there.

Table 5 TFP shock

	y	l^e	q
Endogenous Borrowing Constraint	.8% increase	0%	.8% increase
Exogenous Borrowing Constraint	.83% increase	0%	.83% increase

The result shows no amplification of TFP shock. In fact at a first glance, the result seems counter-intuitive as we get some amplification, albeit very small, in a model with exogenous constraint. This is however not very surprising given that the borrowing limit in a model with exogenous borrowing constraint depends on productivity shock.

The above result leads us to conclude that the amplification effect is significant in case of a shock land tax. This leads us to believe that any shock to the land holding tax would have had an amplified effect on real variables in an economy where borrowing constraints are binding. So, the performance of the real economy could be the result of changes in land tax policy that had an amplified effect on the real economy through land prices. We also identify two transmission mechanisms through which the amplification works-the change in price of land, also called financial accelerator mechanism and the redistribution of land holding for commercial and residential investment, that I term redistribution mechanism.

6.2 Result of feeding wedges in the model

This section quantitatively estimates to what extent land taxes and TFP can account for land prices and the real economic aggregates.

6.2.1 Accounting for economic aggregates feeding TFP and land tax fluctuations in the model

We begin the analysis by allowing both land taxes and TFP to fluctuate.

Figure 7 shows the estimated per capita output as a result of feeding TFP and land taxes in the model. Data reflects an increase in per capita GDP by 9.3% between 1980 and 1991 followed by a 15.5% drop by 2000 with respect to the long-term trend. Model result shows 14.7% increase in detrended output per capita between 1980 and 1991 followed by a 27% fall by 2000. So, the model overestimates the fluctuation in output per working population. The question that remains is how well can the model account for fluctuations in land price now that we allow both TFP and land taxes to fluctuate? The answer is not very promising. As figure 8 shows, we find that between 1980 and 1991, land prices had increased by 101% only to again fall by 51% till 2000. However, the model result shows an increase of 1.7% and a fall of 4.3%, which is insignificant, compared to fluctuations in the data.

With respect to other economic aggregates, the model can estimate the capital-output ratio till 1991 pretty well and though it shows some capital deepening after 1991 but it falls short of the extent to which capital-output ratio changed in the data, as depicted by figure 9. The model overestimates the fluctuations in land held by corporate sector shown in figure 10.

We next analyze the results by feeding the wedges one by one in the model.

6.2.2 Accounting for economic aggregates feeding only land tax fluctuations in the model

Figure 11 shows the estimation of output per capita of inserting only land tax wedge, holding TFP constant at 1980 level. In data, output per working population increases by 9.3% from 1980 to 1991 and fall by 15.5% by 2000. Feeding land tax wedges alone in the model, per capita output increases by 2.8% and falls by 7.8% by 2000. The performance is not so good in accounting for change in prices. In data, land price, after adjusting for the long-term trend, increases by 101% from 1980 to 1990. It starts falling in 1991 and by 2000 decreases by 51%. In model, as shown in figure 12, with land tax wedges alone, land prices increase by 1.4% by 1991 and falls by 3.6% with respect to the long-term trend.

To understand the impact of fluctuations in land holding tax on the real economy, I also look at other real economic aggregates. I concentrate on the capital-output ratio and share of land holding of the corporate sector. This is depicted by figure 13. The models perform well in estimating the capital-output ratio till 1991 when capital-output ratio was pretty constant. However, the models with only land tax wedge fail to capture much of the subsequent capital deepening, though they show an increasing trend in capital-output ratio. The models perform well in estimating share of land held by corporate sector, which is what figure 14 show.

In the previous analysis, the results clearly show that land tax fluctuations in Japan had significant impact on the real economic variables, though the models fall short in explaining any significant fluctuations in land prices. The dynamics also point out that the amplification is the result of redistribution of land between workers and entrepreneurs and not the result of financial accelerator at work as land prices hardly change.

In the above analysis, I held TFP constant at 1980 level but that is not true in the data where TFP fluctuates over time. In the next subsection, I show how well a model with endogenous borrowing constraint can account for fluctuations in real economic variables and land prices given fluctuations in Land Taxes as well as TFP.

6.2.3 Accounting for economic aggregates feeding only TFP fluctuations in the model

Figure 15 shows the estimation of output per capita of inserting only TFP wedge, holding land tax constant at 1980 level. In data, output per working population increases by 9.3% from 1980 to 1991 and fall by 15.5% by 2000. Feeding TFP wedges alone in the model, per capita output increases by 12.3% and falls by 22.8% by 2000. The performance is not so good in accounting for change in prices. In data, land price, after adjusting for the long-term trend, increases by 101% from 1980 to 1990. It starts falling in 1991 and by 2000 decreases by 51%. In model, as shown in figure 16, with land tax wedges alone, land prices increase by 1.1% by 1991 and falls by 2.5% with respect to the long-term trend. The model does not estimate capital output ratio very well as shown in figure 17, the performance is better in estimating share of land held by corporate sector. This is what figure 18 depicts.

6.2.4 Summary of results

The results point in two main directions. TFP and land tax fluctuations can well replicate the performance of real economic aggregates, though they do not perform well in replication land price fluctuations. Results further suggest the redistribution of land holding between corporate and non corporate sector in response to external fluctuations are a major channel through which impact of external fluctuations on real economic aggregates get amplified.

In the next section, I perform some sensitivity tests to see the robustness of my model.

7 Sensitivity analysis

I perform sensitivity tests in two directions: how well do the fluctuations in TFP and land taxes account for the fluctuations in per capita output and land prices when agents' expect the external changes to be permanent? Further, can we really observe significant amplification when borrowing constraints are endogenous as opposed to exogenous as theory suggests?

7.1 Experiment 1: Results assuming presence of unit roots

In the previous section, I presented results assuming that shocks follow a stochastic process where I estimated the persistence parameter from data. We found that even though TFP and land tax fluctuations performed reasonably well in accounting for real economic aggregates, they failed to significantly account for changes in land prices. Would the results change if the agents perceive the shocks to be more persistent? In this section, I check the results assuming the shocks are permanent. I further provide the results when borrowing constraints are exogenous to numerically show the extent to which effects of external fluctuations on economic aggregates get amplified in presence of endogenous borrowing constraints.

7.1.1 Test for presence of unit roots in stochastic process

Can we rule out the presence of unit roots in TFP and land tax data? To motivate use of unit root, I provide below the results of Augmented Dickey-Fuller test on stochastic process for TFP and land-holding taxes.

Table 6 Presence of unit root in time series for TFP

Null Hypothesis: z has a unit root				
Exogenous: Constant, Linear Trend				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.188	0.8668
Test critical values	10% level		-3.39	
*MacKinnon (1996) one-sided p-values.				

Table 7 Presence of unit root in time series for land taxes

Null Hypothesis: TAUL has a unit root				
Exogenous: Constant, Linear Trend				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.26	0.4207
Test critical values	10% level		-3.39	
*MacKinnon (1996) one-sided p-values.				

The above results indicate that we cannot reject the null hypothesis of presence of unit roots in our stochastic processes. In the following section, I shall therefore provide results assuming unit roots. Given that I allow for the presence of unit roots in the stochastic processes, I need to perform a test for co integration of TFP and Land holding tax. I use the Johansen Cointegration test.

Table 8 Cointegration test for cointegration of TFP and land taxes

Unrestricted Cointegration Rank Test				
Hypothesized		Trace	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None	0.575783	24.39203	25.32	30.45
At most 1	0.347068	8.099361	12.25	16.26
*(**) denotes rejection of the hypothesis at the 5%(1%) level				
Trace test indicates no co integration at both 5% and 1% levels				

7.1.2 Result allowing only land tax fluctuations assuming unit root

Given agents' expect changes to be permanent, model with an endogenous borrowing constraint significantly over estimates the impact of a land tax shock as is evident from figure 19. This result is not very unexpected given financial accelerator at work as when agents believe land tax changes to be permanent, there is significant impact of land tax changes on land price. Figure 20 shows the estimation of land prices by inserting only land tax wedge, holding TFP constant at 1980 level. If economic agents expect changes in land tax to be permanent, then the model performs much better in accounting for fluctuations in land value. We have observed in data land price, after adjusting for the long-term trend, increases by 101% from 1980 to 1990. It starts falling in 1991 and by 2000 decreases by 51%. A model with endogenous borrowing constraint shows a 22.3% increase in land prices and a subsequent fall by 42.9%.

However, we are also interested in performance of other aggregates. As figure 21 suggests, the model also performs well in accounting for the capital output ratio. Is there evidence of redistribution of land holding in this case? We find similar pattern of over estimation of land tax shock when we look at share of corporate landholding as figure 22 depicts, however overestimation is not as much as in case of output.

7.1.3 Result allowing only TFP fluctuations assuming unit root

As observed in the pervious case, the impact of TFP shock is much amplified when agents expect these changes to be permanent. The impact of TFP shock on per capita output is much amplified as shown in figure 23. As far as the question of estimation of land price is concerned, as figure 24 depicts, observed in data land price, after adjusting for the long-term trend, increases by 101% from 1980 to 1990. It starts falling in 1991 and by 2000 decreases by 51%. In the model, the increase in land price is 6.1% and the fall is by 11.2%. The model also estimates well the trend in capital output ratio (figure 25) and share of land owned by corporate sector (figure 26).

7.2 Experiment 2: Amplification due to endogenous borrowing constraints

The theory of endogenous borrowing constraints as suggested by Bernanke and Gertler (1989) and Kiyotaki and Moore (1995) hinges on the result that effect of external shocks on the economy are greatly amplified in the presence of endogenous borrowing constraints. Intuitively, when borrowing limit is a function of agents' wealth, any fluctuation in wealth affects borrowing capacity, which impedes future production and investment. This is not the case when borrowing limit is not dependant on agents' wealth.

Can we numerically prove this assertion?

Here I provide results of feeding fluctuations in land tax in two types of models: one with endogenous borrowing constraints, where borrowing limit is a function of agents' wealth holding; the second one with exogenous borrowing constraint, where borrowing limit does not depend on individual wealth holdings.

7.2.1 Result allowing only land tax fluctuations

As figure 27 depicts, with respect to long term trend, per capita output increases by 1.62% from 1980 to 1991 and falls by 4.5% by 2000 in a model with exogenous borrowing constraint, as opposed to an increase of 2.8% from 1980 to 1991 and a fall by 7.8% by 2000 when borrowing constraints are endogenously determined. As far as land price is concerned, we cannot discern much of amplification as we see in figure 28. This is due to the fact that when agents' do not expect external changes to be permanent, land taxes hardly have any impact on land price, so there is no observed variation even when we have endogenous borrowing constraint.

Does that mean the amplification is greater if agents' expect external changes to be permanent?

7.2.2 Result allowing only land tax fluctuations assuming unit root

When we assume unit root for the stochastic process of land taxes, in a model with endogenous borrowing constraint, per capita output increases by 25% between 1980 and 1991 and falls by 48% from 1991 to 2000. This can be compared to an increase by 2% by 1991 and a fall by 6% by 2000 as generated in a model where borrowing constraint is exogenous as figure 29 highlights. In this case, we even see amplification of the impact of land taxes on land prices. %. A model with endogenous borrowing constraint shows a 22.3% increase in land prices and a subsequent fall by 42.9%. A model with exogenous borrowing constraint shows a .62% increase in land prices and a subsequent fall by 15.9%. This is depicted in figure 30.

8 Conclusion

The aim of this paper was to build a standard growth model with efficiency and investment frictions to numerically account for the business cycle fluctuations witnessed in Japan over the period 1984 to 2000. I used a standard growth model with time-varying TFP and land taxes to model the efficiency and investment frictions in Japanese economy. The key idea of using land taxes as a catalyst of investment friction was that given penchant for debt financing of investment and widespread use of land as collateral, any external fluctuation that affects value of land can have a significant impact on the real value, by affecting borrowing capacity of firms.

Calibrating the model to match the moments of Japanese data for the period 1980 to 1984 and then feeding in the frictions one at a time and in unison, I find that changes in land taxation alone can explain about 40% of the fluctuations in real economic aggregates. However, it fails to significantly account for fluctuations in land prices. Fluctuations in TFP alone can very well account for per capita output but not land prices. The model overestimates the fluctuations in real economic aggregates if we allow both TFP and land holding taxes to fluctuate, but the model' s performance in accounting for changes in land prices does not improve. The model suggests that redistribution of land holding between corporate and household secotr play an important role in channeling the external fluctuations to have an amplified impact on real economic aggregates. I further find that the performance of the model is very sensitive to agent's expectations about persistence of shocks. If agents expect the changes in TFP and land holding taxes to be permanent, given fluctuations in TFP and land holding taxes, the model can account for half of the initial increase in land prices and almost the entire decline in land prices in the nineties. The drawback is that the model significantly overestimates the fluctuations in real economic aggregates. Unit root tests show that it is not unreasonable to assume persistence, as we cannot rule out presence of unit roots in stochastic process for land taxes and TFP. This paper also studies quantitatively the amplification effect of an endogenous credit constraint. The quantitative results of impact of changes in land taxation support the theory that in presence of endogenous constraint, effect of a shock on real economic aggregates gets amplified.

Given our analysis, we may conclude that the "Lost Decade" of economic growth in Japan was not a big puzzle. A standard growth model with time varying TFP and land taxes, as used in this paper, can significantly account for fluctuations in real economy. The bigger puzzle that remains yet unexplained is the boom and bust of land prices.

It would be interesting for future research to concentrate on causes that can account for the huge fluctuations in land prices, is it due to economic fundamentals, or is it just a bubble? If we can well account for land price fluctuations, then we hope that the penchant for debt financing and wide spread use of land as collateral in Japan will be able to significantly account for the 'Lost Decade'.

Performance of Japanese economy over the period 1980 to 2000

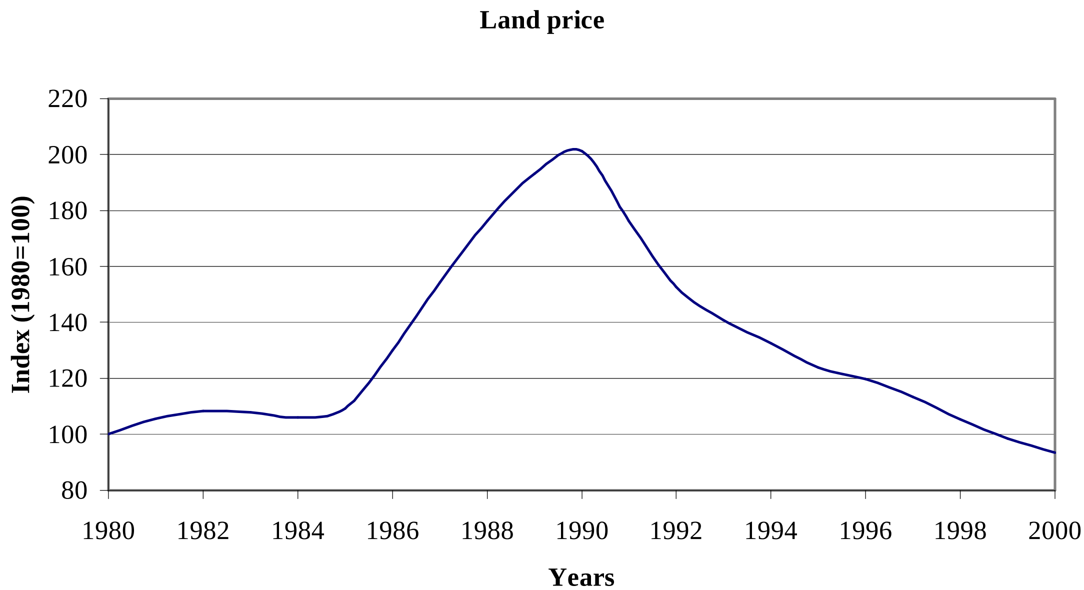

Figure 1 Land price with respect to a long-term trend

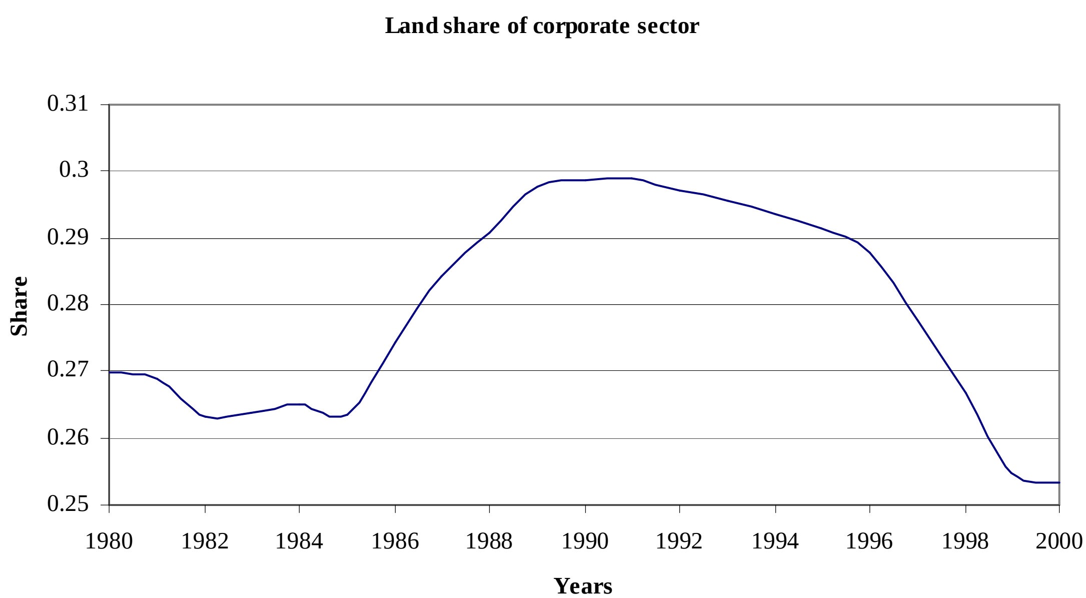

Figure 2 Share of total land area owned by the corporate sector

Performance of Japanese economy over the period 1980 to 2000

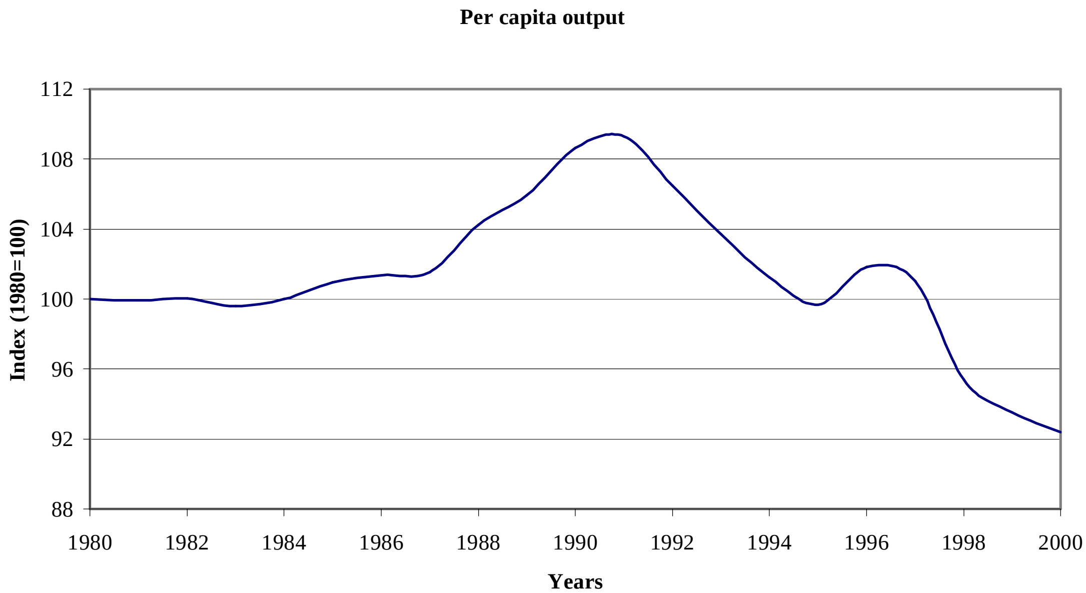

Figure 3 Per capita output with respect to a long-term trend

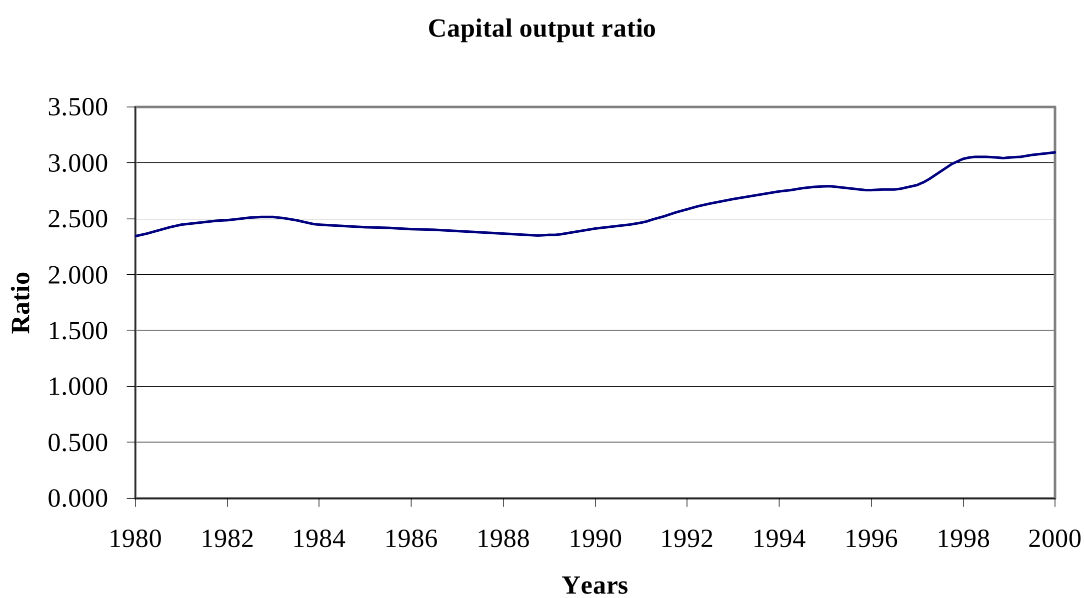

Figure 4 Capital output ratio

External sources of fluctuations

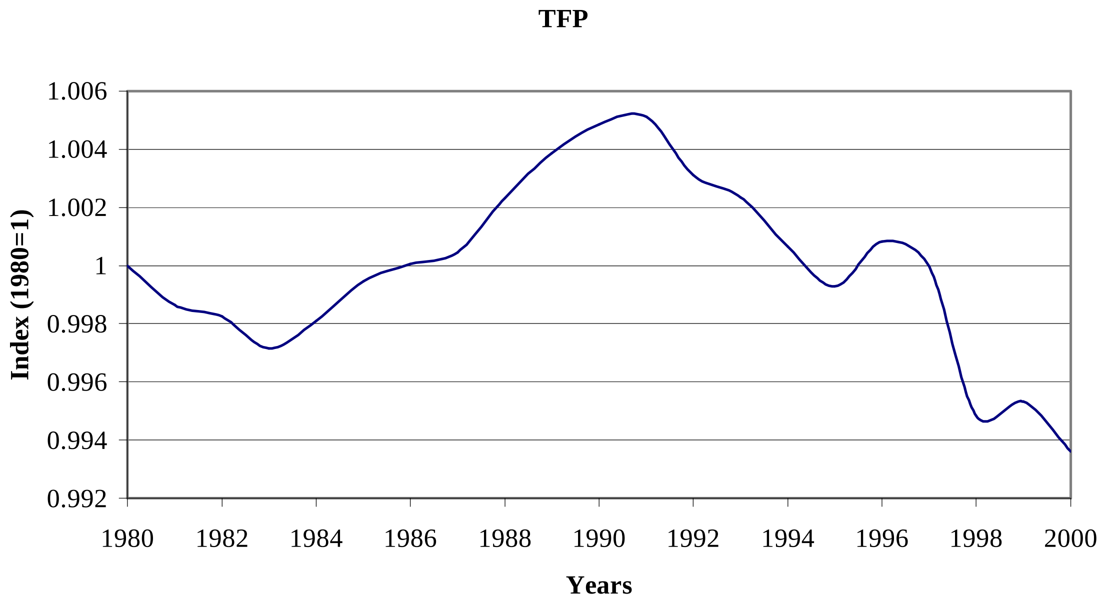

Figure 5 Fluctuations in total factor productivity (TFP)

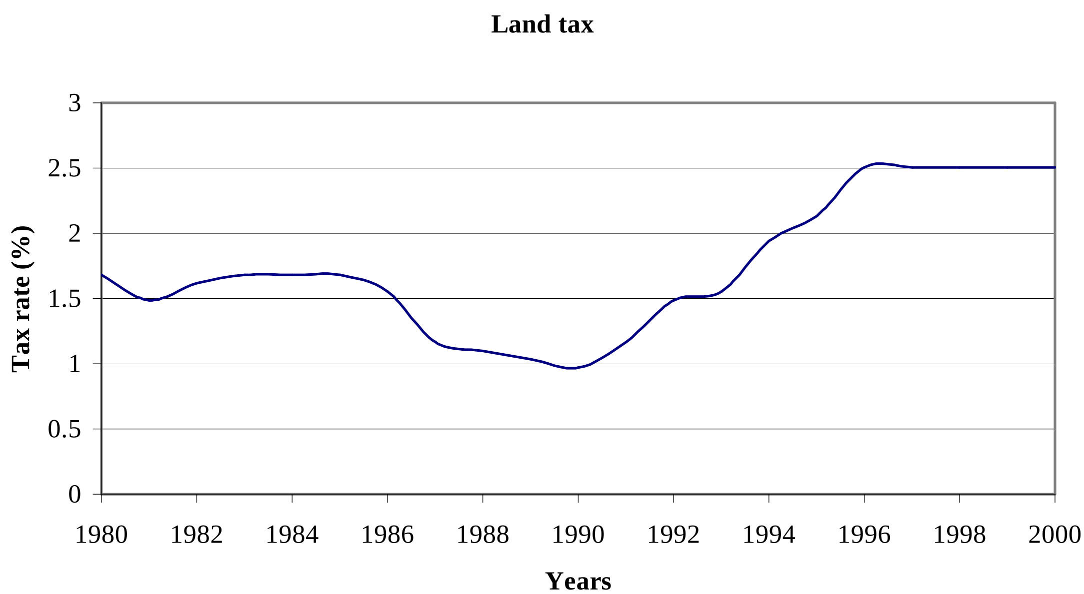

Figure 6 Effective land holding tax rate on land held by corporate sector

Feeding in TFP and land tax fluctuations jointly in the model

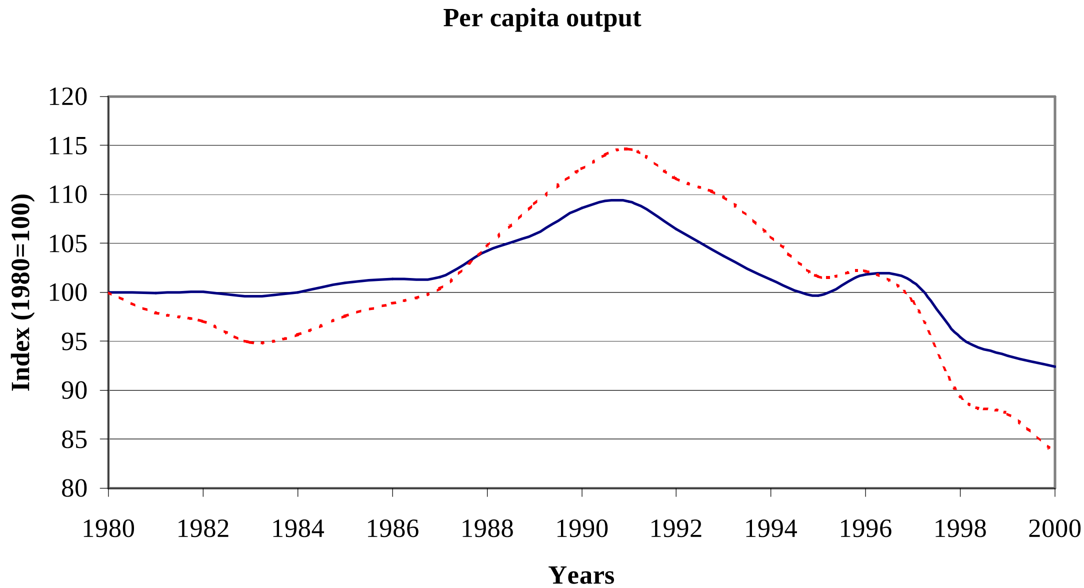

Figure 7 Per capita output with respect to long-term trend allowing for TFP & land tax fluctuations (---- data; -----model)

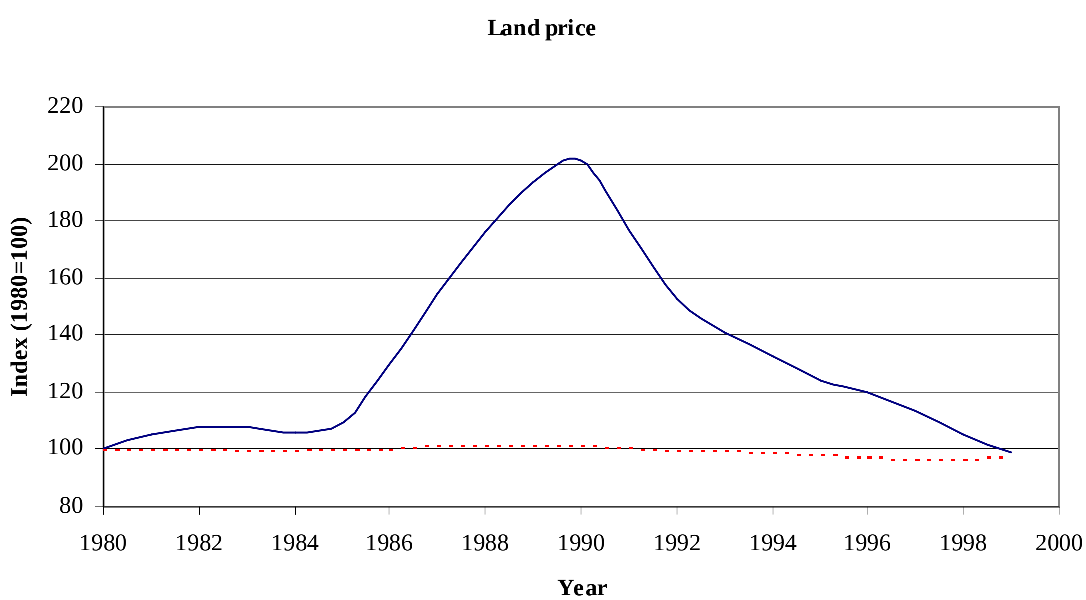

Figure 8 Land price with respect to long-term trend allowing for TFP & land tax fluctuations (---- data; -----model)

Feeding in TFP and land tax fluctuations jointly in the model

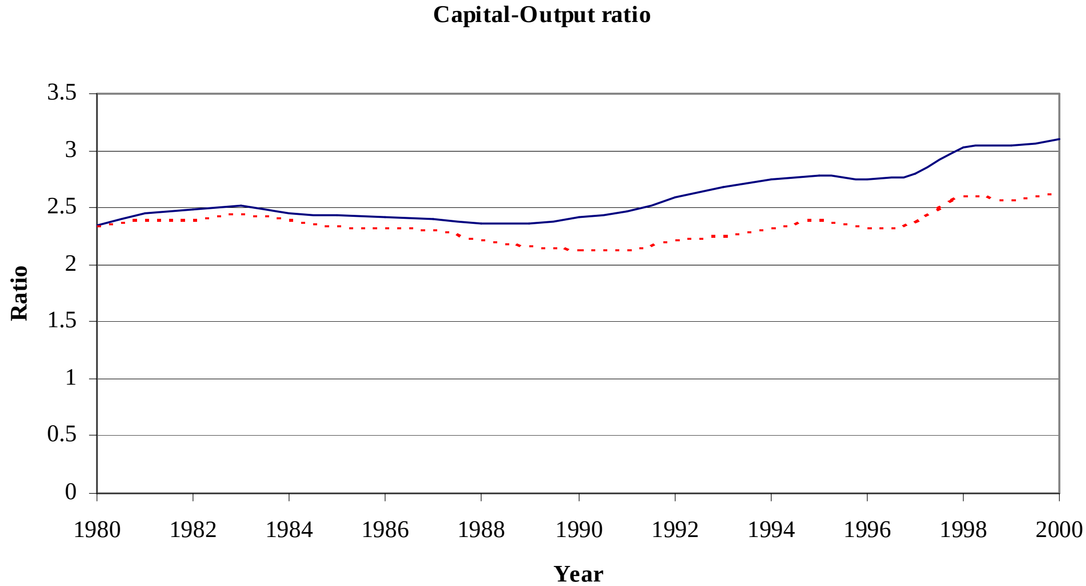

Figure 9 Capital output ratio allowing for TFP & land tax fluctuations
(---- data; -----model)

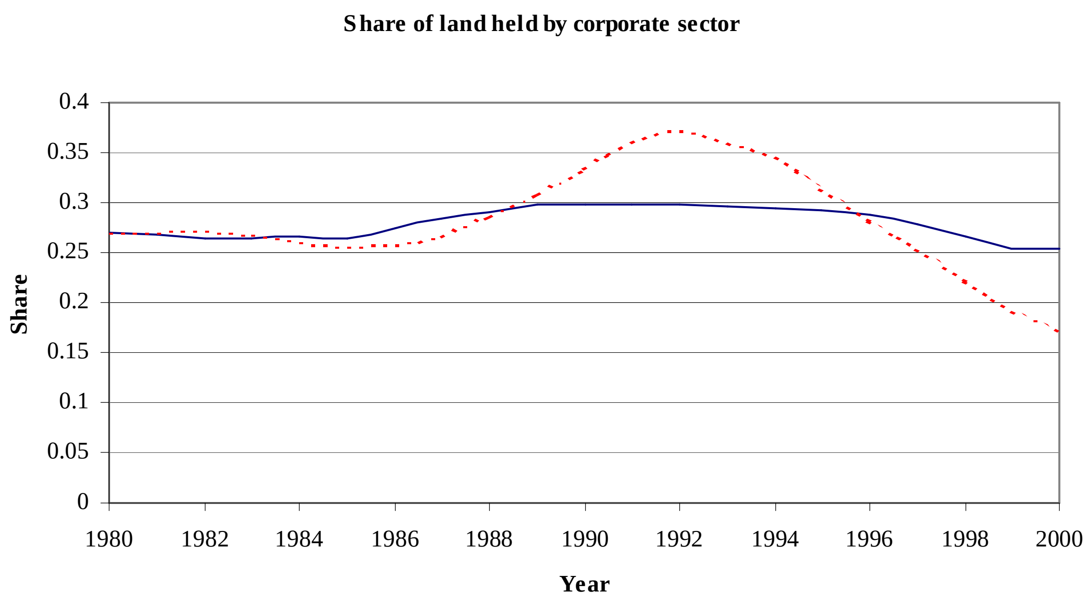

Figure 10 Share of total land under corporate ownership allowing for TFP & land tax fluctuations
(---- data; -----model)

Feeding in land tax fluctuations alone in the model

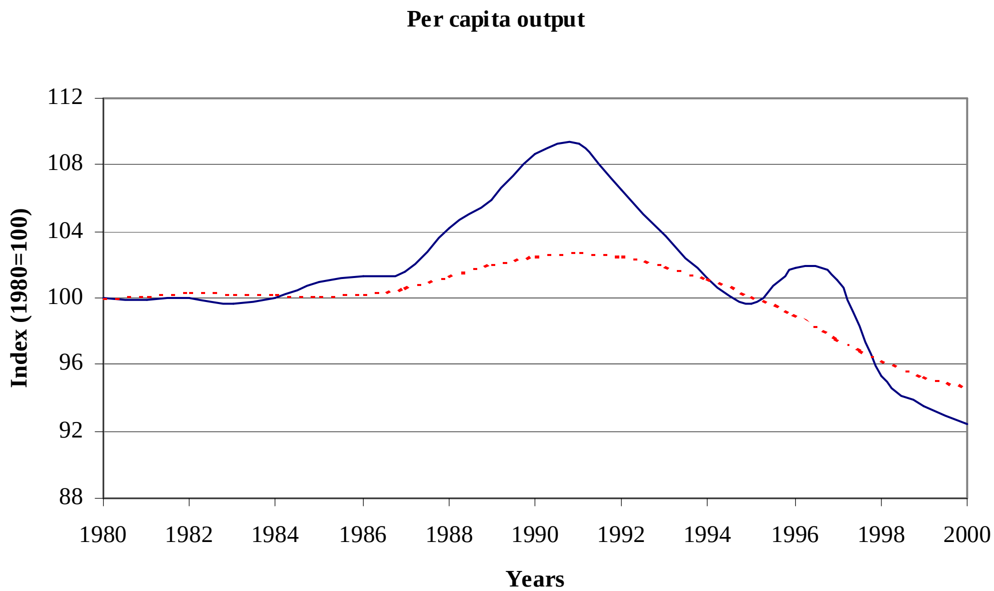

Figure 11 Per capita output with respect to long-term trend allowing only land tax fluctuations (---- data; -----model)

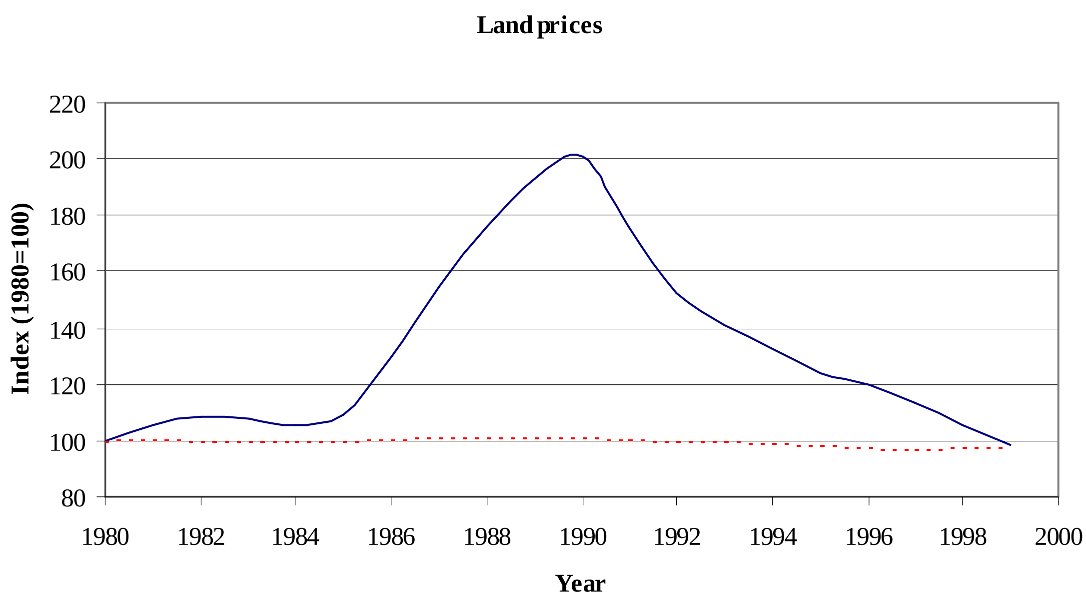

Figure 12 Land price with respect to long-term trend allowing only land tax fluctuations (---- data; -----model)

Feeding in land tax fluctuations alone in the model

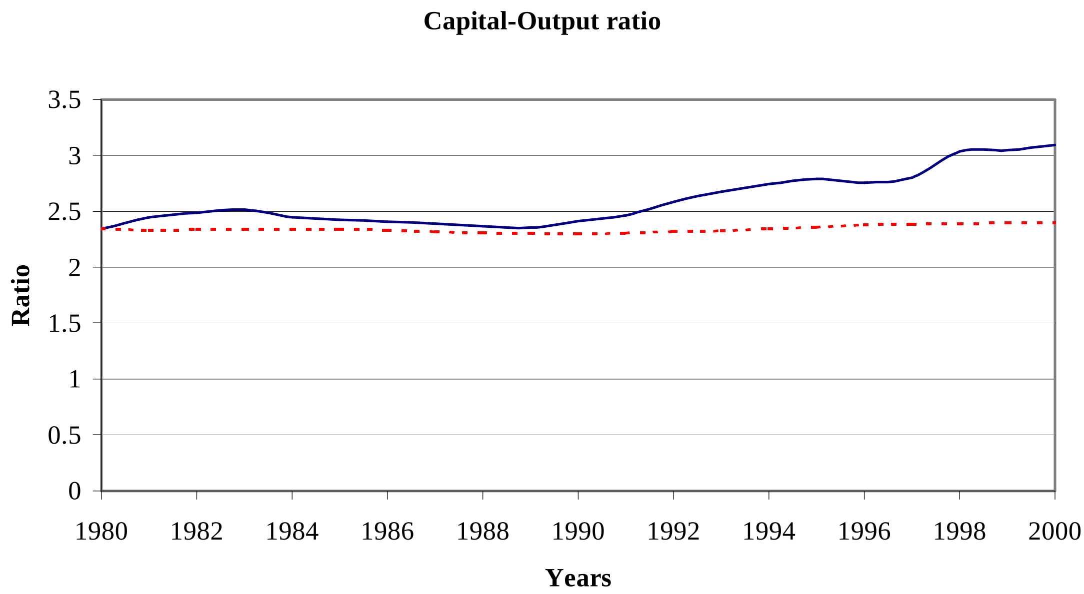

Figure 13 Capital output ratio allowing only land tax fluctuations
(---- data; -----model)

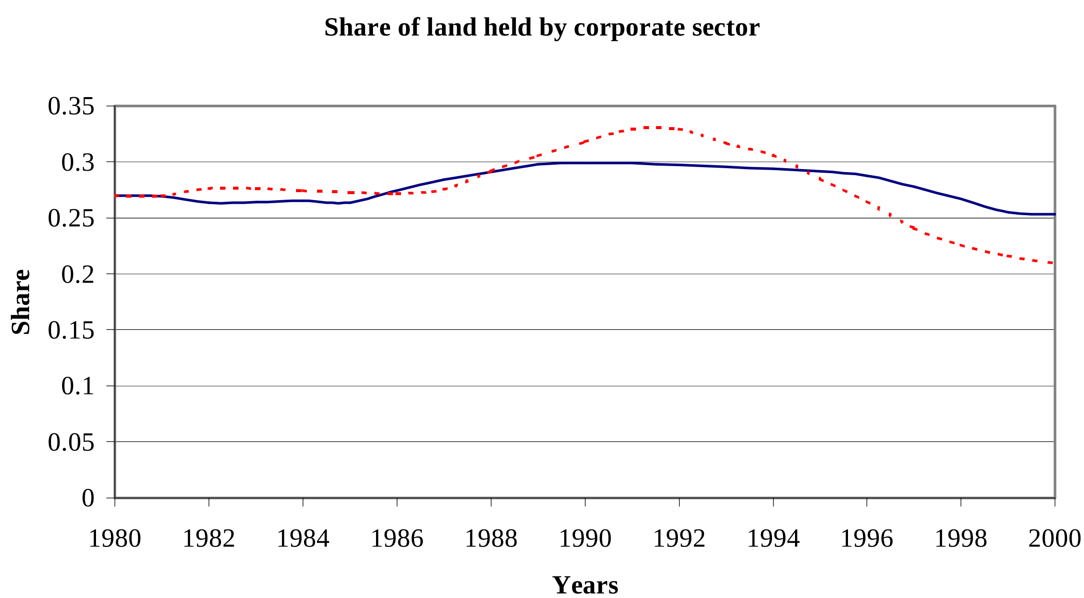

Figure 14 Share of total land under corporate ownership allowing only land tax fluctuations
(---- data; -----model)

Feeding in TFP fluctuations alone in the model

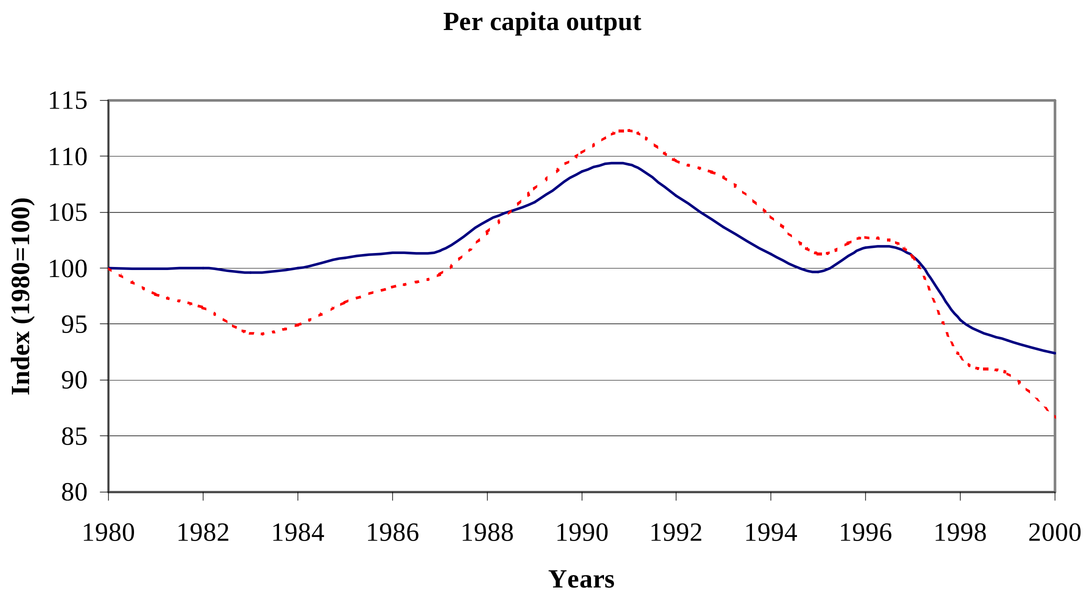

Figure 15 Per capita output with respect to long-term trend allowing only TFP fluctuations (---- data; -----model)

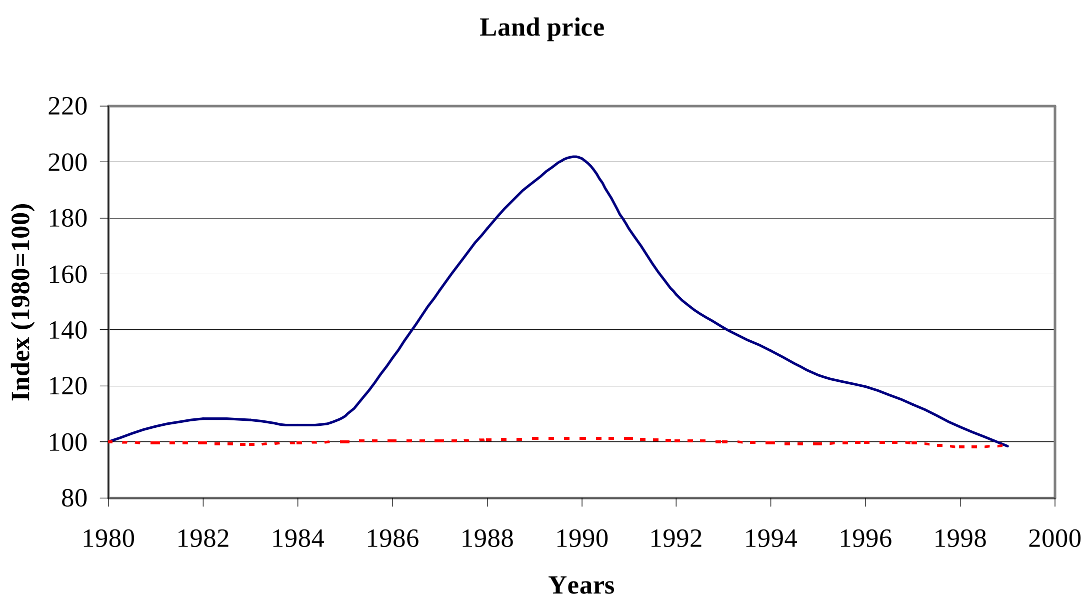

Figure 16 Land price with respect to long-term trend allowing only TFP fluctuations (---- data; -----model)

Feeding in TFP fluctuations alone in the model

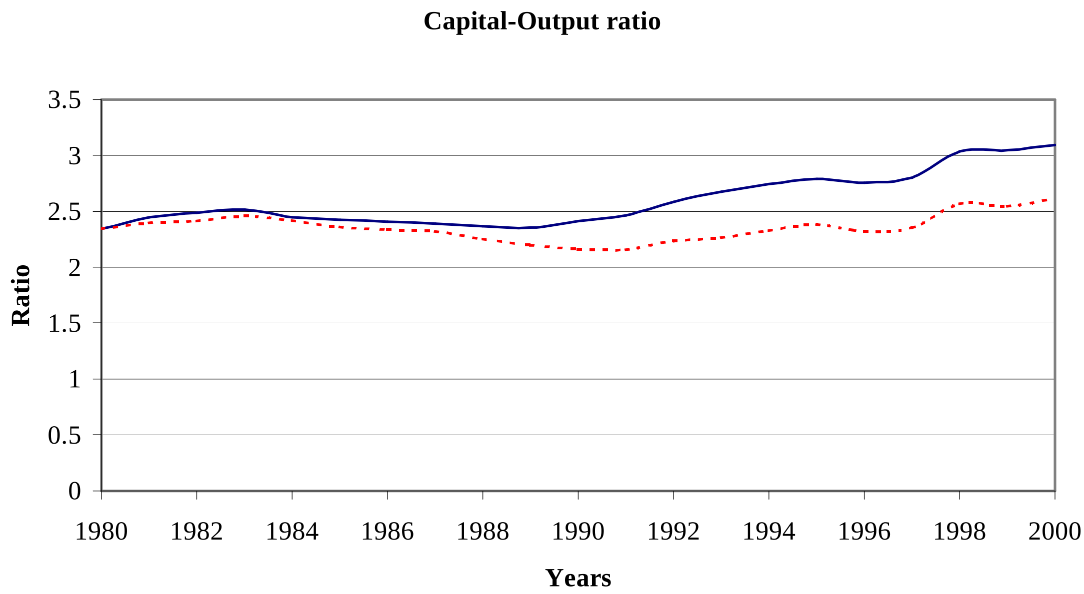

Figure 17 Capital output ratio trend allowing only TFP fluctuations
(---- data; -----model)

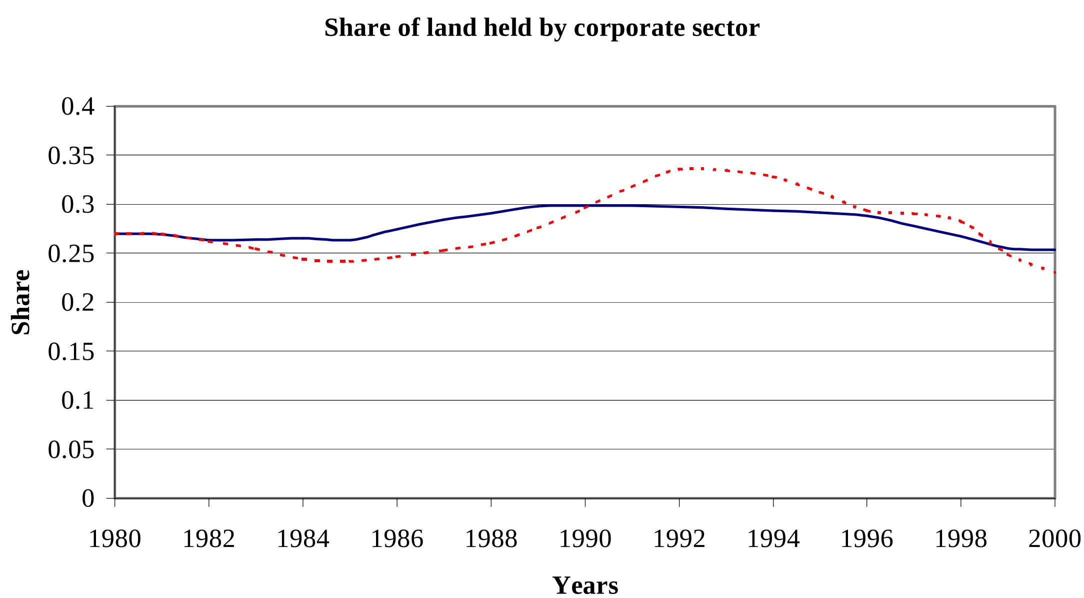

Figure 18 Share of total land under corporate ownership allowing only TFP fluctuations
(---- data; -----model)

Experiment 1: **Agents expect changes in land taxes to be permanent**

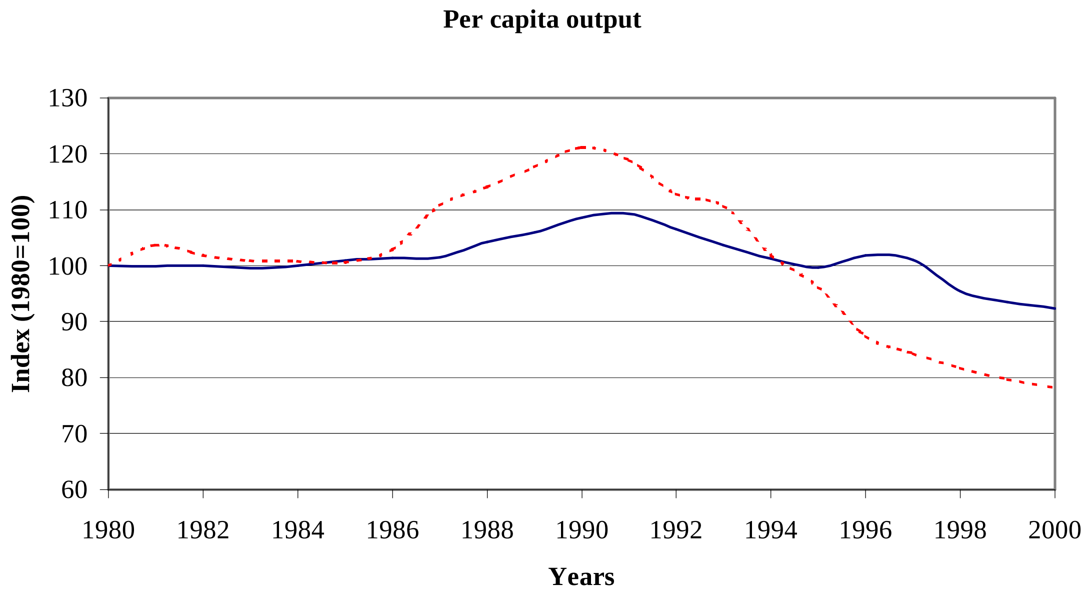

Figure 19 Per capita output with respect to long-term trend allowing only land tax fluctuations (---- data; -----model)

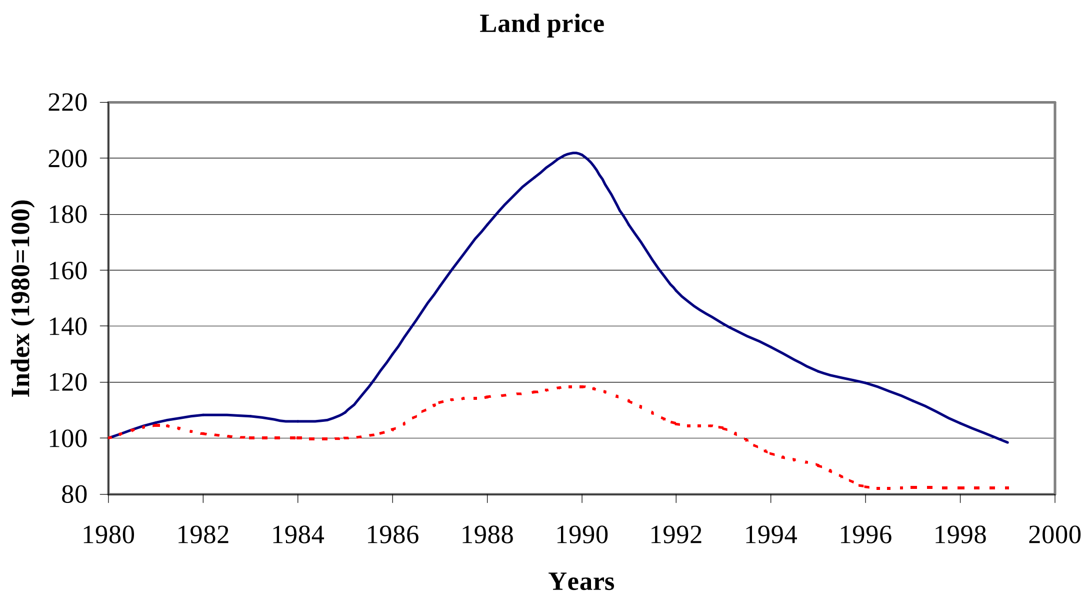

Figure 20 Land price with respect to long-term trend allowing only land tax fluctuations (---- data; -----model)

Experiment 1: **Agents expect changes in land taxes to be permanent**

Capital-Output ratio

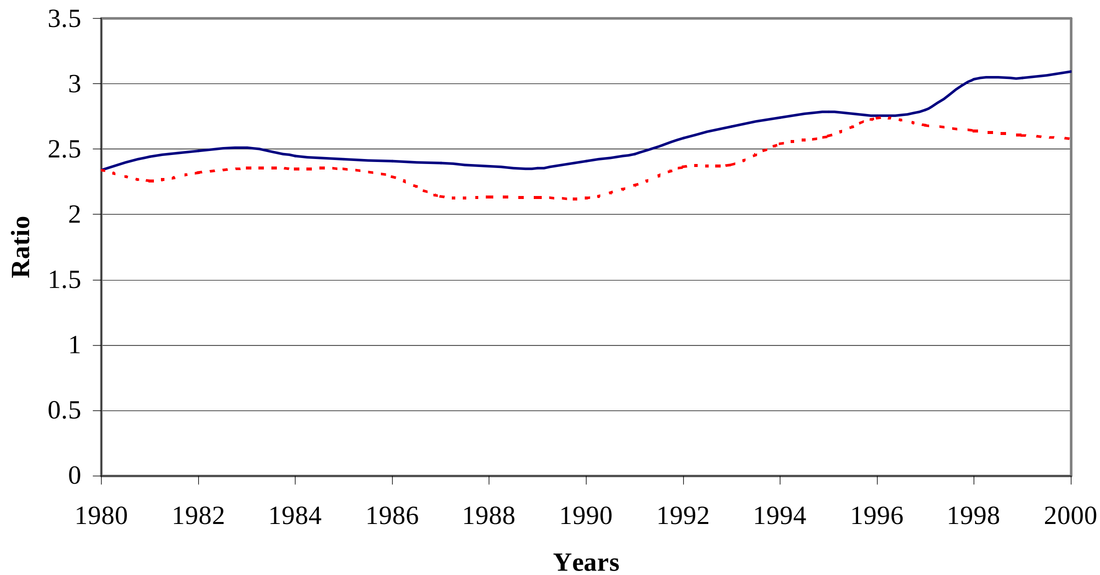

Figure 21 Capital output ratio allowing only land tax fluctuations
(---- data; -----model)

Share of land held by corporate sector

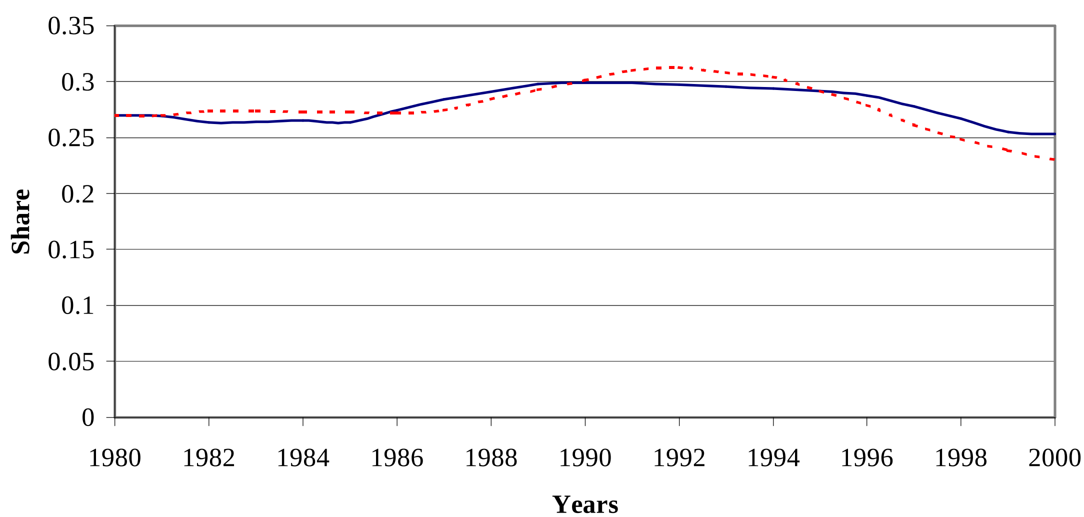

Figure 22 Share of land owned by the corporate sector allowing only land tax fluctuations
(---- data; -----model)

Experiment 1: Agents expect changes in TFP to be permanent

Per capita output

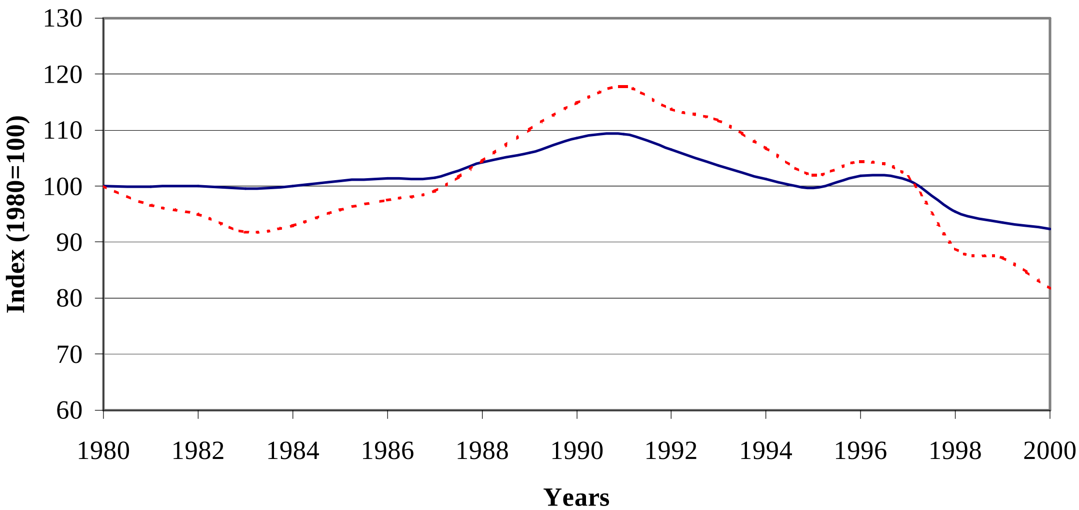

Figure 23 Per capita output with respect to long-term trend allowing only TFP fluctuations (---- data; -----model)

Land price

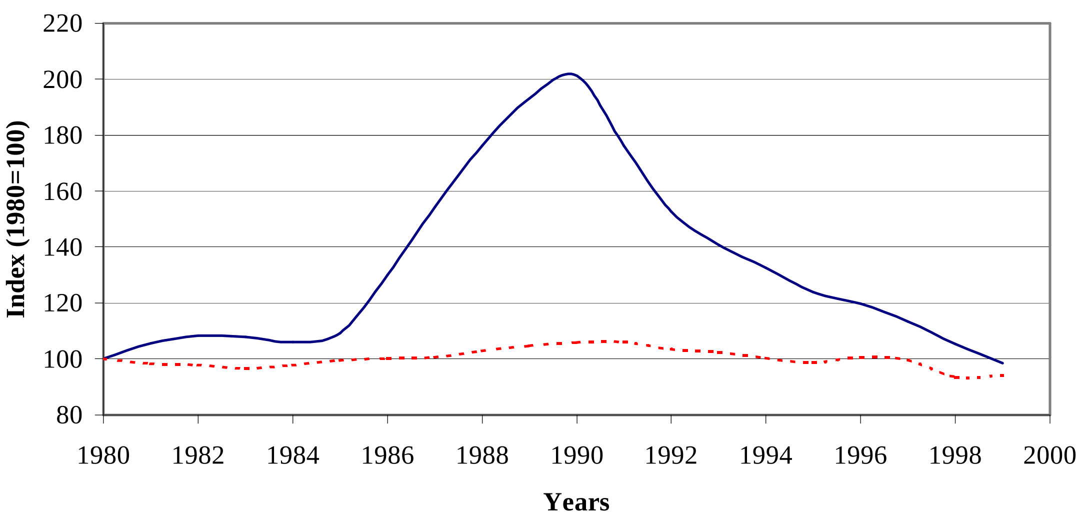

Figure 24 Land price with respect to long-term trend allowing only TFP fluctuations (---- data; -----model)

Experiment 1: Agents expect changes in TFP to be permanent

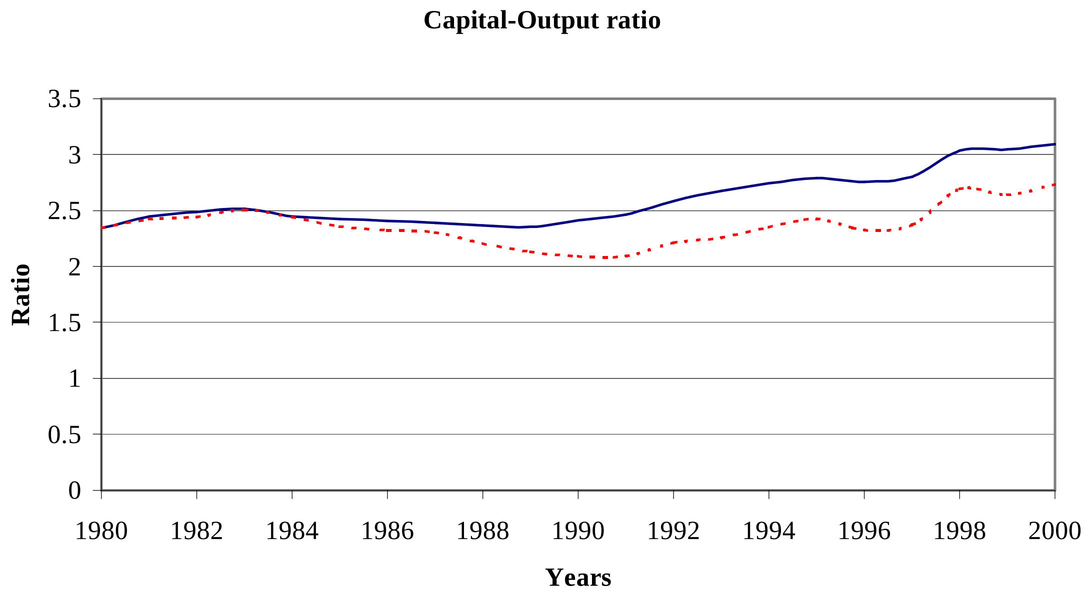

Figure 25 Capital output ratio allowing only TFP fluctuations
(---- data; -----model)

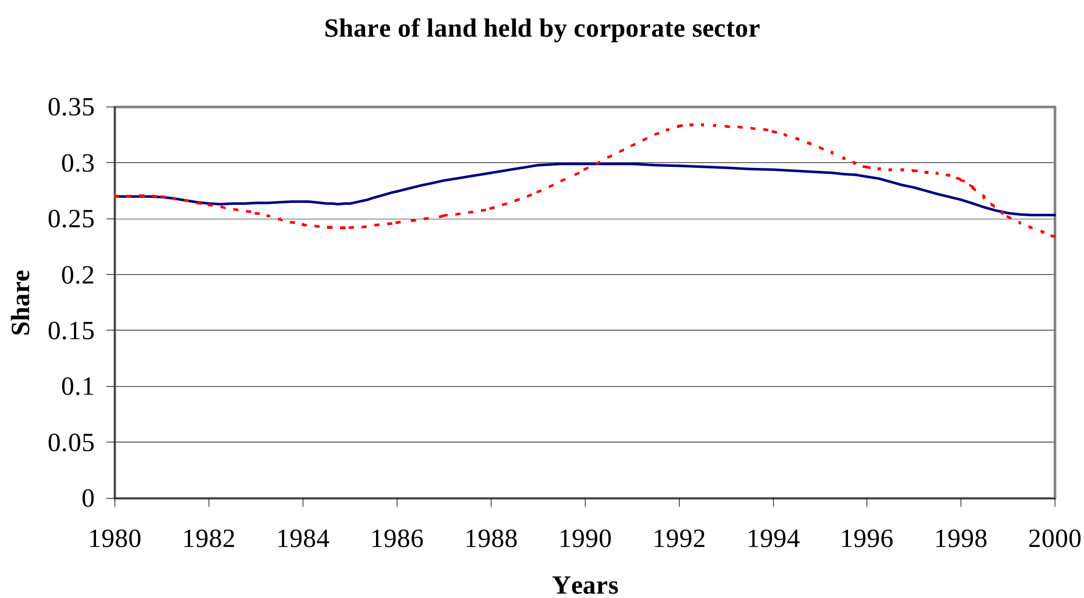

Figure 26 Share of land owned by the corporate sector allowing only TFP fluctuations
(---- data; -----model)

Experiment 2: **Amplification resulting from endogenous borrowing constraint**
Agents do not expect changes to be permanent.

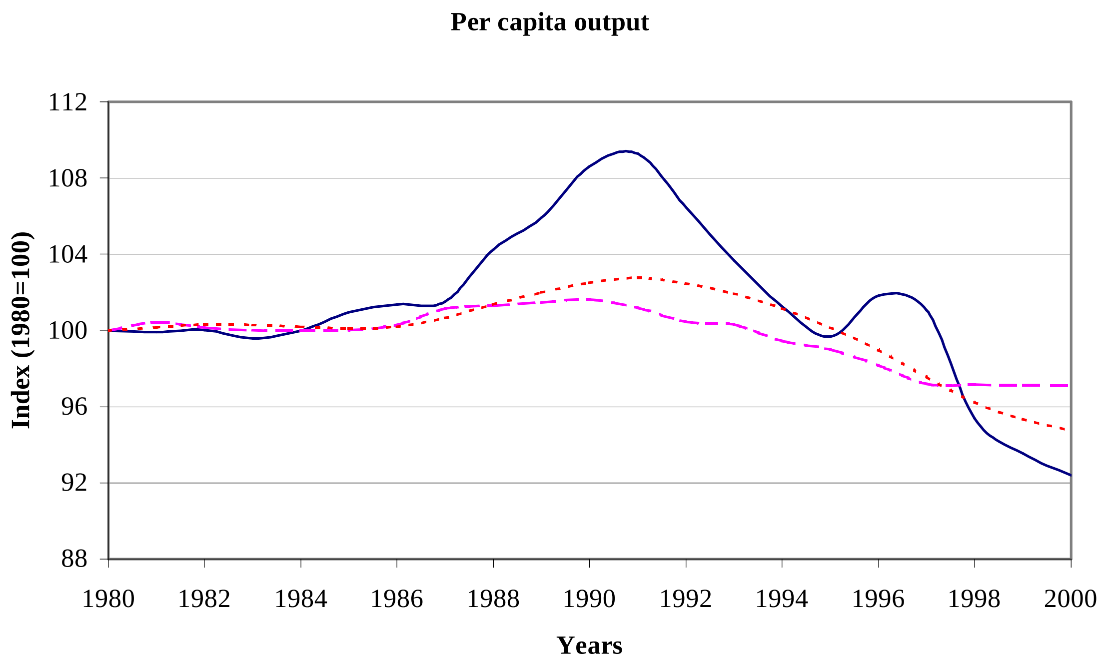

Figure 27 Per capita output with respect to long-term trend allowing only land tax fluctuations (---- data; -----model-bendog.; -----model-bexog)

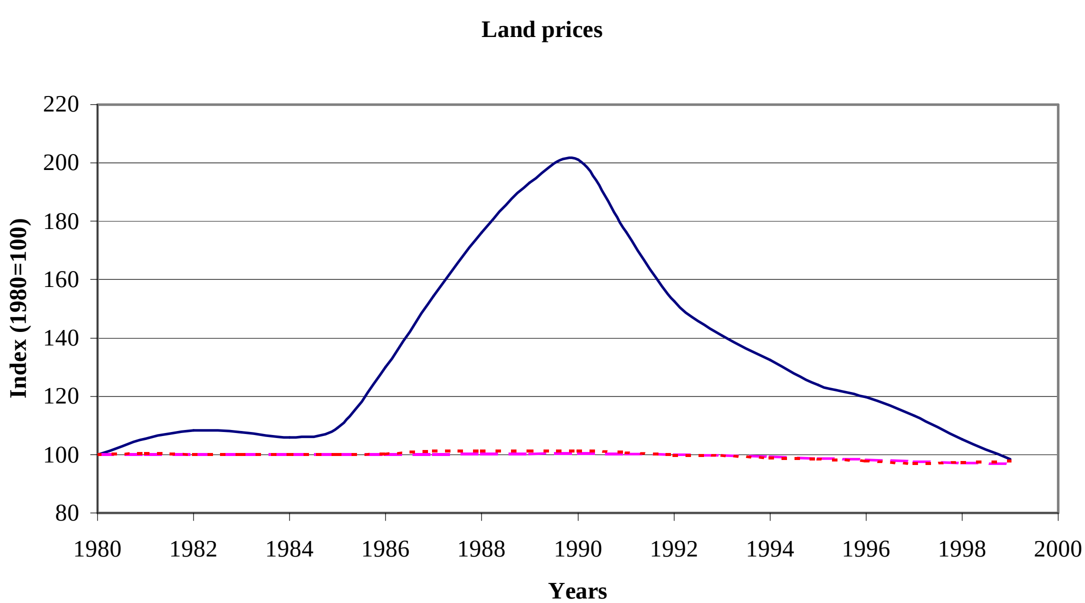

Figure 28 Land price with respect to long-term trend allowing only land tax fluctuations (---- data; -----model-bendog.; -----model-bexog)

Experiment 2: **Amplification resulting from endogenous borrowing constraint**
Agents expect changes to be permanent.

Per capita output

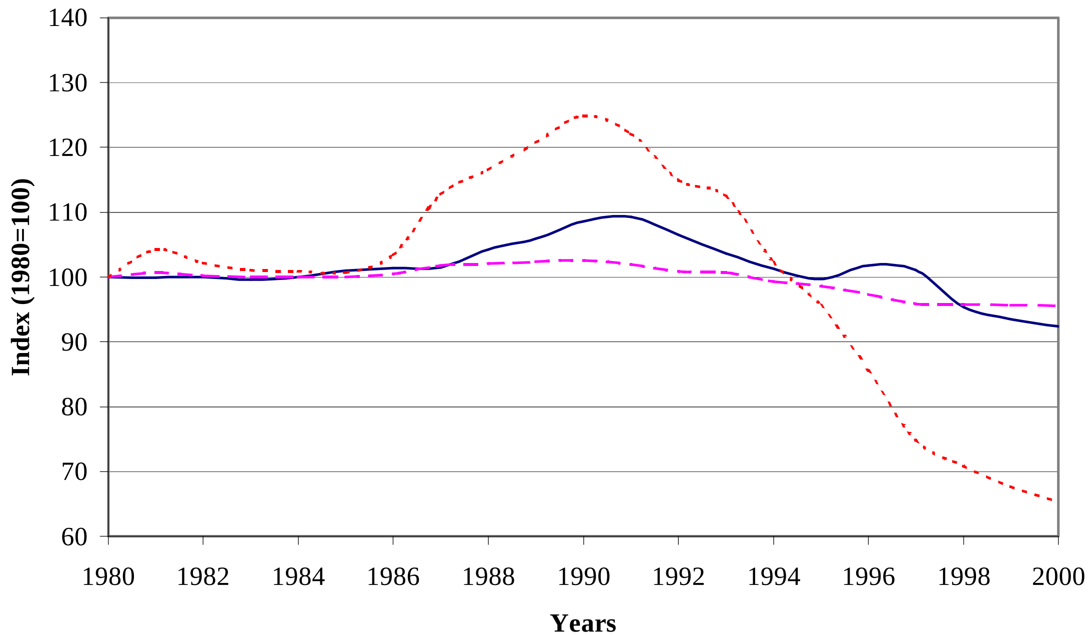

Figure 29 Per capita output with respect to long-term trend allowing only land tax fluctuations
(---- data; -----model-bendog.; -----model-bexog)

Land price

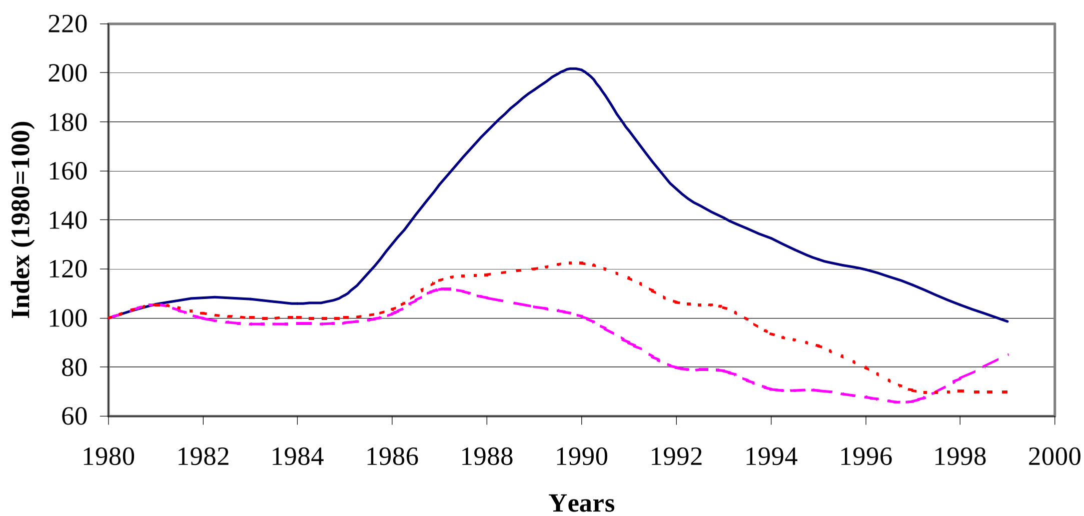

Figure 30 Land price with respect to long-term trend allowing only land tax fluctuations
(---- data; -----model-bendog.; -----model-bexog)

APPENDIX 1 PROOFS OF PROPOSITIONS & STEADY STATE EQUATIONS

Lagrangian for Households:

Let us first write the Lagrange with the detrended variables. In this appendix all the variables have been appropriately detrended.

$$L = E_0 \sum_{t=0}^{\infty} \left[\beta\eta\right]^t N^w \left(\begin{array}{l} [\log c_t^w + \alpha_1 \log\left(1-h_t^w\right) + \alpha_2 \log l_t^w + t\log\left(1+g_z\right) + t\log\eta] \\ + \left\{ \lambda_t^w \left[\begin{array}{l} \left(1-\tau_h\right) w_t h_t^w + \left[1+\left(1-\tau_b\right) r_t\right] a_t \\ + T_t^w - c_t^w - \eta(1+g_z) a_{t+1} - q_t (l_{t+1}^w - l_t^w) - \tau_{lt}^w q_t l_t^w \end{array} \right] \right\} \end{array} \right)$$

Lagrangian for Entrepreneurs:

$$L_e = \sum_{t=0}^{\infty} \left[\beta\eta\right]^t N^e \left\{ \begin{array}{l} [\log c_t^e + \log\left(1-h_t^e\right) + t\log\left(1+g_z\right)] + \mu_t\left[\eta\left(1+g_z\right)\left(B_{t+1} - b_{t+1}\right)\right] + \\ \lambda_t^e \left[\begin{array}{l} e^{z_t} k_t^{\theta_k} h_t^{wd} l_t^{e\theta_l} h_t^{e(1-\theta_h-\theta_l-\theta_k)} + \eta\left(1+g_z\right) b_{t+1} + T_t^e - \tau_{lt}^e q_t l_t^e - \\ \tau_y \left[e^{z_t} k_t^{\theta_k} h_t^{w\theta_h} l_t^{e\theta_l} h_t^{e(1-\theta_h-\theta_l-\theta_k)} - w_t h_t^{wd} - \delta k_t - r_t b_t \right] \\ - c_t^e - \eta\left(1+g_z\right) k_{t+1} + \left(1-\delta\right) k_t - q_t\left(l_{t+1}^e - l_t^e\right) - w_t h_t^{wd} - \left(1+r_t\right) b_t \end{array} \right] \end{array} \right\}$$

Necessary Conditions for households

c_t^w: $$1 = \lambda_t^w c_t^w \qquad \text{(a)}$$

h_t^w: $$\alpha_1 = \lambda_t^w \left(1-\tau_h\right) w_t \left(1-h_t^w\right) \qquad \text{(b)}$$

l_{t+1}^w: $$\beta\eta E_t\left[\frac{\alpha_2}{l_{t+1}^w}\right] + \beta\eta E_t \lambda_{t+1}^w q_t \left(1-\tau_{lt+1}^w\right) = \lambda_t^w q_t \qquad \text{(c)}$$

b_{t+1}: $$\frac{\beta}{1+g_z} E_t \lambda_{t+1}^w \left[1+\left(1-\tau_b\right) r_{t+1}\right] = \lambda_t^w \qquad \text{(d)}$$

Necessary Conditions for entrepreneurs:

c_t^e : $$1 = \lambda_t^e c_t^e \tag{e}$$

h_t^w : $$\alpha_1 = \lambda_t^e \left(1-\tau_y\right)\left(1-\theta_k-\theta_h-\theta_e\right)\frac{y_t}{h_t^e}\left(1-h_t^e\right) \tag{f}$$

h_t^w : $$w_t = \theta_h \frac{y_t}{h_t^{wd}} \tag{g}$$

k_{t+1} $$\frac{\beta}{1+g_z} E_t \lambda_{t+1}^e \left\{1+\left(1-\tau_y\right)\left[\theta_k \frac{y_{t+1}}{k_{t+1}}-\delta\right]\right\} = \lambda_t^e - \phi\mu_t \tag{h}$$

- In a model with endogenous borrowing constraint

$$\frac{\beta}{1+g_z} E_t \lambda_{t+1}^e \left\{1+\left(1-\tau_y\right)\left[\theta_k \frac{y_{t+1}}{k_{t+1}}-\delta\right]\right\} = \lambda_t^e \tag{i}$$

- In a model with exogenous borrowing constraint

l_{t+1}^e : $$\beta\eta E_t \lambda_{t+1}^e \left\{\left(1-\tau_y\right)\left[\theta_l \frac{y_{t+1}}{l_{t+1}^e}\right]+\left(1-\tau_{lt+1}^e\right)q_{t+1}\right\} = \left(\lambda_t^e - \phi\mu_t\right)q_t \tag{j}$$

- In a model with endogenous borrowing constraint

$$\beta\eta E_t \lambda_{t+1}^e \left\{\left(1-\tau_y\right)\left[\theta_l \frac{y_{t+1}}{q_t l_{t+1}^e}\right]+\left(1-\tau_{lt+1}^e\right)\frac{q_{t+1}}{q_t}\right\} = \lambda_t^e \tag{k}$$

- In a model with exogenous borrowing constraint

b_{t+1} : $$\frac{\beta}{1+g_z} E_t \lambda_{t+1}^e \left[1+\left(1-\tau_y\right)r_{t+1}\right] = \lambda_t^e - \mu_t \tag{l}$$

In a steady state:

$$\frac{ql^e}{y} = \frac{\theta_l}{\frac{1}{\beta\eta}\left[(1-\phi) - \frac{\phi\beta}{(1+g_z)}\left(1+(1-\tau_y)r\right)\right] - 1 + \tau_l^e} \tag{m}$$

- In a model with endogenous borrowing constraint.

$$\frac{ql^e}{y} = \frac{\theta_l * (1-\tau_y)}{\frac{1}{\beta\eta} - 1 + \tau_l^e} \tag{n}$$

- In a model with exogenous borrowing constraint.

$$\frac{k}{y} = \frac{\theta_k}{\frac{1-\tau_y}{\frac{\beta}{(1+g_z)}}\left[(1-\phi)\left(1 - \frac{\beta}{(1+g_z)}\right)\right] + \delta + \phi r} \tag{o}$$

- In a model with endogenous borrowing constraint.

$$\frac{k}{y} = \frac{\theta_k}{\frac{\left(\frac{1+g_z}{\beta} - 1\right)}{1-\tau_y} + \delta} \tag{p}$$

-In a model with exogenous borrowing constraint.

where

$$r = \frac{\left[\frac{1+g_z}{\beta}\right] - 1}{\left(1-\tau_b\right)}$$

Now, to prove that borrowing constraint holds with equality in the steady state we need to show that μ >0.

$$r = \frac{\left[\left(1-\frac{\mu}{\lambda^e}\right)*\frac{1+g_z}{\beta}\right]-1}{\left(1-\tau_y\right)}$$

Then we can equate r so that

$$\frac{\mu}{\lambda^e} = \left(\frac{\tau_y-\tau_b}{1-\tau_b}\right)*\left[1-\frac{\beta}{1+g_z}\right]$$

If corporate tax rate τ_y is greater than the tax rate on interest earnings of workers, τ_b , then μ >0, as λ^e >0, since in equilibrium budget constraint of entrepreneur holds with equality.

Steady state equations for estimating parameter values

$$\delta = \frac{x}{k} - \eta * (1+g_z) + 1 \qquad (1)$$

$$\beta = \frac{1+g_z}{1+r*(1-\tau_b)} \qquad (2)$$

$$\theta_h = \frac{wh^w}{y} \qquad (3)$$

$$\theta_k = \frac{k}{y} * \left[\frac{1-\tau_y}{\frac{\beta}{(1+g_z)}} \left[(1-\phi)\left(1-\frac{\beta}{(1+g_z)}\right)\right] + \delta + \phi r \right] - endogenous\ B_t$$

$$\theta_k = \frac{k}{y} * \left[\frac{\left(\frac{1+g_z}{\beta} - 1\right)}{1-\tau_y} + \delta \right] - exogenous\ B_t \qquad (4)$$

$$\theta_l = \frac{ql^e}{y} * \left[\frac{1}{\beta\eta} \left[(1-\phi) - \frac{\phi\beta}{(1+g_z)}\left(1+(1-\tau_y)r\right) \right] - 1 + \tau_l^e \right] - endogenous\ B_t$$

$$\theta_l = \frac{ql^e}{y} * \left[\frac{\frac{1}{\beta\eta} - 1 + \tau_l^e}{(1-\tau_y)} \right] - exogenous\ B_t \qquad (5)$$

$$\theta_e = 1 - \theta_k - \theta_l - \theta_h \qquad (6)$$

$$\alpha_1 = \frac{wh^w}{c^w} * \left(1-\tau_h\right) * \frac{1-h^w}{h^w} \qquad (7)$$

$$\alpha_2 = \left(\frac{1}{\beta\eta} - 1 + \tau_l^w \right) * \frac{ql^w}{c^w} \qquad (8)$$

$$\phi = \frac{b}{\left(\frac{k}{y} + \frac{ql^e}{y}\right)} \qquad (9)$$

APPENDIX 2 NOTES

The Japanese Tax System-An Overview

The Japanese Tax system is very complicated. Taxes are charged at three levels: National, Municipal and Local. In this segment, I shall provide an overview of the different types of taxes that are used in the model and for calibration. I also explain how I calculate the taxes used. For a detailed analysis of the tax system, a good source is the book 'Japanese Tax System' by Ishi.

The broad categories of taxes are taxes on individuals and taxes on the corporate sector.

Taxes on individuals

- **Tax rate on interest earnings on bonds**

I consider the interest from fixed-term deposits and bonds, dividends of profits from jointly administered investment trusts and bond investment trusts. Under the Maruyu system of taxation, the interest on bonds can be taxed by two alternative methods. Under the first alternative, the interest income is charged at a rate of 20 % withholding at source, but it cannot be exempted from calculation of taxable income. The second method of taxation is optional separate withholding taxation at source (35% withholding at source), and it can be exempted from calculation of income taxation. I am assuming the second alternative and I take the tax on interest earnings on bonds to be 35%.

- **Tax rate on wage income**

All taxable income in excess of the minimum taxable level is subject to tax at progressive income tax rate. National income tax rate starts at 10% for income up to 2 million yen, and it rises to 37% for income above 18 million yen. By contrast, the local income tax rates consisting both municipal income tax rate and prefecture tax rates are simple. The prefecture income tax rate is 2% on the first 7 million yen and 3% above it. The standard rate of municipal tax rate begins at 3% and rises to 10% for the income above 7 million yen.

I shall consider the middle-income tier of annual income of 7-9 million yen and I consider the tax rate charged to this group: National tax rate of 20% + Prefecture income tax rate of 3% + Municipal income tax rate of 10% =33% tax rate on individual income.

- **Tax rate on consumption**

For tax charged on consumption, I calculate the net indirect tax.

Net Indirect Tax = (Indirect business taxes-Subsidies).

The average for 1955-2000 is 15%.

I adjust consumption on the expenditure side of NIA by deducting the Net Indirect Taxes. I also adjust the GDP from Income side to factor out the Net Indirect tax.

Tax on Corporate Sector

- **Tax rate on corporate income**

Corporate income is taxed on all levels of government 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 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 prefecture and the municipal inhabitant's taxes and the prefecture enterprise tax. The inhabitants' taxes on corporate income are levied as surtax on the national corporate tax, whereby a standard rate of 5% is levied on national corporate tax at the prefecture level and another 12.3% is levied at the municipal level neither of which is 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%. The effective corporate income tax rate was around 55% for retained 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%; very close to its counterparts in the US and Europe. I shall consider the average for 1980-1984, which is 49.5%.

- **Tax on corporate property**

Taxes on corporate 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.

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 are 3.1%. However, the effective tax rates for land are much lower.

This is due to the underassessment 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 have 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)]. Given that the official land values are already around 70%-80% of their market values, the effective marginal tax rate on corporate land was about 1.68% in early 80s. This ratio dropped to 0.9% by 1991 mainly due to the fall in local government assessments. 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 1.5% 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. I use the statutory tax rates, an official land price to market price of 80% for all periods and assessment to official value ratios reported by Ishi to arrive at an effective marginal tax rate on land holdings. 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. The tax base on the individuals is ½ to ¼ of the tax charged on corporate sector. I assume the tax rate on individuals to be 1/3rd the tax rate of the corporate sector. Further, I have accounted for the agricultural sector as a part of the corporate sector in my model. The statutory tax rate of the agricultural sector is 1/3rd the statutory tax rate of the corporate sector. So, in calculating the effective tax rate for the corporate sector in my model, we have to be aware of this difference.

Notes for defining Recursive Competitive Equilibrium for the model.

Before defining the recursive equilibrium for this model we should note a few things.

Predetermined state variables for the economy: Aggregate savings, A, Aggregate borrowings, B, Land held by workers, L^w, Land held by entrepreneurs, L^e. Let $S \in R_+^4$ be the vector of aggregate state variables. Vector of exogenous state variables: $\tau = \left(z, \tau_l^e, \tau_l^w\right) \in R_+^3$ Predetermined state variable for representative worker: savings, a, land held, l^w, and predetermined aggregate and exogenous state variables. The vector of state variables of representative worker, $s^w = \left(s, l^w, S, \tau\right) \in R_+^9$ Predetermined state variable for representative entrepreneur: borrowings, b, land held, l^e, capital k, and predetermined aggregate and exogenous state variables. The vector of state variables of representative worker, $s^e = \left(s, l^e, k, S, \tau\right) \in R_+^{10}$.

BIBLIOGRAPHY

[1] ALPANDA, SAMI (2004), "Land and Corporate Valuation in Japan", Ph.D. dissertation, University of Minnesota

[2] AMARAL, PEDRO & MACGEE, JAMES (2002), "The Great Depression in Canada and the United States: A Neoclassical Perspective", *Review of Economic Dynamics* 5(1), pp. 45-72

[3] BACKUS, DAVID K; KEHOE, PATRICK J. AND KYDLAND, FINN E (1992), "International Real Business Cycle", *Journal of Political Economy* 100(4), pp. 745-775

[4] BAYOUMI, TAMIM (2001), 'The Morning After: Explaining the Slowdown in Japanese Growth in 1990s' IMF Working Paper

[5] BERNANKE, B. & GERTLER, M (1987), "Financial Fragility and Economic Performance", *NBER Working Paper*, 3487

[6] BERNANKE, BEN & MARK GERTLER (1989), "Agency Costs, Net Worth, and Business Fluctuations,'' *American Economic Review*, 79, 14-31.

[7] BERNANKE, BEN, & MARK GERTLER (1995), ''Inside the Black Box: The Credit Channel of Monetary Policy Transmission,'' *Journal of Economic Perspectives*, 9, 27-48.

[8] BERGOEING, RAPHAEL; KEHOE, PATRICK; KEHOE, TIMOTHY & SOTO, RAIMUNDO (2002), "A Decade Lost and Found: Mexico and Chile in the 1980s", *Review of Economic Dynamics* 5(1), pp. 45-72

[9] BLOMSTROM MAGNUS, CORBETT JENNIFER, HAYASHI, FUMIO AND KASHYAP ANIL (edited) "Structural Impediments to Growth in Japan", NBER

[10] BORDO, MICHAEL; ERCEG, CHRISTOPHER AND EVANS, CHARLES (1997), " Money, Sticky Wages and Great Depression", *NBER Working Paper*, No. W6071

[11] BURNSIDE, CRAIG; EICHENBAUM, MARTIN & REBELO, SERGEI (1993), "Labor Hoarding and the Business Cycles", *Journal of Political Economy* 101(2), pp. 245-273

[12] CABALLERO RICARDO, HOSHI TAKEO AND KASHYAP ANIL (2004) "Zombie lending and depressed restructuring in Japan" *NBER Working Paper*, 2004

[13] CARLSTROM, CHARLES & FUERST, TIMOTHY S (1997), "Agency Costs, Net Worth and Business Fluctuations: A Computable General Equilibrium Analysis", *American Economic Review* 87(5), pp. 893-910

[14] CHARI, V V; KEHOE, PATRICK AND MACGRATTAN, ELLEN R (2002), "Accounting for the Great Depression", *FederalReserve Bank of Minneapolis Quarterly Review*, Volume 27, Number 2

[15] COLE, HAROLD L. & OHANIAN, LEE E (1999), "The Great Depression in the United States from a Neoclassical Perspective", *Federal Reserve Bank of Minneapolis Quarterly Review*, Volume 23, pp. 2-24

[16] COOLEY, THOMAS F (edited) "Frontiers of Business Cycle Research"

[17] DEKLE, ROBERT & KLETZER, KENNETH (2003), " The Japanese Banking Crisis and Economic Growth: Theoretical and Empirical Implications of Deposit Guarantees and Weak Financial Regulation", *Working Paper*

[18] GAN, JIA (2004), "Collateral Channel and Credit Cycle: Evidence from the Land-Price Collapse in Japan" Working Paper

[19] HAYASHI, F. (1997), "Understanding Savings: Evidence from the United States and Japan", Cambridge: MIT Press.

[20] HOSHI, T. & KASHYAP, A (1999), "The Japanese Banking Crisis: Where Did It Come From and How Will It End?" *NBER Macro Annual*, 129-201

[21] HOSHI, T. & KASHYAP, A (2003), "Japan's Economic and Financial Crisis: An Overview", *Journal of Economic Perspectives*, Forthcoming Winter 2004

[22] IACOVIELLO, MATTEO (2002), "House prices, borrowing constraints and monetary policy in business cycles", *Boston College Working Papers in Economics* 542

[23] ITO, TAKAHASHI & KRUEGER ANNE O (edited), "Growth Theories in Light of the East Asian Experience", NBER-East Asia Seminar on Economics

[24] KING, ROBERT; PLOSSER, CHARLES AND REBELO SERGIO (1988), "Production, growth, and business cycles: The basic neoclassical model", *Journal of Monetary Economics* 21(2), pp. 195-232.

[25] KIYOTAKI, NOBUHIRO & JOHN MOORE (1995), "Credit Cycles", NBER Working Paper No. W5083

[26] MARIMON, RAMON & SCOTT ANDREW (edited), "Computational Methods for the Study of Dynamic Economies", Oxford

[27] MCGRATTAN, ELLEN R (1996), "Solving the Stochastic Growth Model with a Finite Element Method", *Journal of Economic Dynamics and Control*, pp. 19-42

[28] MIRANDA, MARIO J & FACKLER PAUL L, "Applied Computational Economics and Finance", MIT Press.

[29] PRESCOTT, EDWARD C (1999), "Theory Ahead of Business Cycle Measurement", *Federal Reserve Bank of Minneapolis Quarterly Review*, 23(1), pp. 25-31

[30] PRESCOTT, EDWARD C & HAYASHI, FUMIO (2002), "The 1990s in Japan: A Lost Decade", *Review of Economic Dynamics* 5(1), pp. 206

[31] WOO (1999), 'In search of Capital Crunch-Supply Factors behind the Credit Slowdown in Japan", *IMF Working paper 99/3*

[32] WOO & KANAYA (2000), 'Japanese Banking Crisis of the 1990s-Sources and Lessons', *IMF Working paper 00/7*