Non Performing Loans, Prospective Bailouts, and Japan's Slowdown

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Abstract

Over the last twelve years Japan has experienced a prolonged slowdown in economic activity, accompanied by a significant deterioration of the financial position of the banking sector. In this paper I argue that the delay in the government bailout of the financial sector has played a key role in Japan's ongoing stagnation. I construct a dynamic general equilibrium model in which the government provides deposit insurance to the financial sector. The model has the following property: the existence of non performing loans, combined with a delay in the government bailout, leads to a persistent decline in economic activity. The decline in output is caused not only by a fall in investment, but also by an endogenous decline in productivity and the number of firms. These features are consistent with Japan's experience over the last decade. Calibration results indicate that the delay in the government bailout contributes significantly to Japan's slowdown.

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1 Introduction

Over the last twelve years Japan has experienced a prolonged slowdown in economic activity. During this period the growth rate of Japan's per capita GDP was 1.17% per year, versus 3.51% in the previous decade. This decline has been accompanied by a decline in the growth rates of investment, total factor productivity, and number of enterprises (see Figure 1.1).

It has been widely argued that the large amount of non performing loans (so called *bad loans*) held by Japanese financial institutions lies at the heart of Japan's ongoing economic stagnation. However, the exact mechanism underlying this link remains unknown. This paper begins with the premise that bad loans represent a public liability. I then argue that the delay in expected government bailouts is the main link between the failing banking system and Japan's slowdown. I articulate this argument by constructing a dynamic general equilibrium model with the following key property: when the government provides deposit guarantees to the banks, the existence of bad loans, combined with a delay in a government bailout, leads to a persistent decline in aggregate economic activity. Using a version of the model calibrated to Japanese data I argue that this mechanism has played a quantitatively important role in Japan's slowdown.

The basic intuition behind the central argument of the paper is as follows: when the government provides full deposit guarantees to the banks, losses incurred by the banks (i.e., bad loans) translate into prospective government debt. Suppose the government postpones the actual payment of this debt, but insists that banks honor in full their obligations to depositors. Now the banks face a dilemma: how they can honor their obligations to old depositors, given some of their assets have disappeared. The only thing the banks can do is to run a Ponzi scheme: pay the flow obligations to old depositors using funds from new deposits. As long as the interest rate is positive, the amount of new deposits used by the banks to pay old depositors rises over time. Over time this leads to a smaller fraction of savings being used to finance capital purchases. If Ricardian Equivalence does not hold, total private savings will not rise enough to offset the increase in the present value of future tax liabilities stemming from the prospective bailout[1]. Consequently, in equilibrium, less total funds will be allocated for capital purchases. This in turn implies that the capital stock will fall over time, leading to a persistent decline in output. Note that a positive interest rate and the failure of Ricardian Equivalence imply that the banks cannot run the Ponzi scheme forever: eventually the new deposits will not be enough to pay off old depositors. At this stage, the government will have no option but to bail the banks out.

If capital is irreversible, the decline in economic activity will be followed by an ongoing fall in the price of capital, a low net return on capital and a low interest rate. To see this, note that the decline in the total amount of funds available for capital purchases leads to a fall in the demand for capital. The latter effect

[1] The same effect may arise in a number of cases that do not rely on the failure of Ricardian Equivalence. For example, when taxes are distortionary, or when the government finances the bailout by decreasing government purchases.

implies that the price of capital declines over time, which generates capital losses that offset increases in the marginal product of capital stemming from the fall in the stock of capital. Consequently, the rate of return on capital and the interest rate are unusually low.

The delay in the government bailout acts like the crowding out effect on capital the government debt has in many models. One way to see this in my model is to suppose that the government immediately bails the banks out, financing the bailout by issuing new debt. Absent Ricardian Equivalence, private savings will not rise enough to offset the new government debt. Consequently, the capital stock will fall, and so too will output.

The existing literature has provided alternative hypotheses linking the Japan's weak financial sector and the slowdown in Japan. For example, it is often claimed that the weak financial sector caused a credit crunch, i.e., an inability of Japanese firms to finance profitable projects[2]. A related argument is that Japanese firms found it difficult to borrow because the value of their collateral (mostly real estate) declined precipitously over the past decade[3]. While a priori appealing, these explanations have received little support from existing empirical studies[4].

A third hypothesis is that Japan's slowdown is due to an inefficient allocation of resources. For example, Kashyap (2002a), (2002b) argues that the slowdown partly reflects the presence of a large number of inefficient and unprofitable firms, so called "zombies", which "distort competition. Other firms that could enter an industry or gain market share are held back"(Kashyap (2002b), p.54)[5]. The basic idea is that the banks are unwilling to disclose bad loans. Consequently they support non performing zombie firms by offering low cost loans[6]. Because of this, zombie firms continue to operate, and drag overall productivity down.

Finally, Hayashi and Prescott (2002) argue that the decline in the growth rate of total factor productivity has played a significant role in the slowdown of Japan's economy.

I extend my benchmark model to show that the delay in the government bailout leads to a decline in overall productivity. This decline reflects a rise in the fraction of low productivity firms that are operating. I model output as a function of entrepreneurial ability, capital, and labor. There is a fixed operating cost, denominated in units of capital associated with producing output. When investment is irreversible, a

[2] See, for example, Bayoumi (2000) and Shimizu (2000).

[3] Ramaswamy (2000) discusses a number of possible reasons behind the decline in Japanese business investment.

[4] After analyzing several data sources, Hayashi and Prescott (2002) conclude that "there is no evidence of profitable investment opportunities not being exploited due to lack of access to capital markets". Also, based on a review of the existing literature, they argue that "credit crunch" could have occurred only for a very short period between the end of 1997 and the beginning of 1998, as a result of tighter capital requirements imposed by the Basel Accord. For more details, see Hayashi and Prescott (2002) and references therein.

[5] In more general terms, Hubbard (2002) states that "the real problem is that capital is not being allocated to its most productive uses".

[6] See, for example, Kashyap (2002a), (2002b). Bergoeing at al. (2002) have a related discussion in the context of Mexico and Chile. Chu (2002) shows that a similar argument applies when there are barriers to exit rising from government's policies.

delay in the government bailout leads to a persistent decline in the price of capital. This means that the fixed operating costs are low. Consequently, low productivity entrepreneurs can operate in equilibrium. To generate a fall in the number of firms *per se*, I assume that there is a fixed cost of setting up a firm. One key effect of the delayed bailout is to drive up the rental rate on capital. Because of this, fewer entrepreneurs would be willing to incur the fixed cost of setting up a firm. To summarize, the extended version of my model implies that overall productivity will be low and less firms will be set up. The actual number of firms that are operating may or may not decline. These results do not rely on quantity rationing of either bank loans or capital. Instead, they reflect the fall in the price of capital and capital stock that are generated by the delay in the government bailout.

To assess the quantitative effect of the delay in the government bailout I calibrate a version of my model using Japanese data. I assume that the bailout starts in year 2003, and the government will finance it by lowering government purchases or by increases taxes[7]. Under my assumptions, a conservative estimate of the impact of the delay in the government bailout is a 0.21-0.53% yearly decline in output. Since the actual decline of the growth rate of Japan's per capita GDP was 0.83-1.4%, I conclude that the delay in the bailout has contributed significantly to Japan's slowdown.

The results in the first part of my paper are derived in a closed economy setting. The second part of the paper extends the analysis to the case of a small open economy. It is important to note that with unrestricted flows of foreign capital a delay in the bailout does not have an impact on investment and output. This is because in such a model the supply of domestic funds does not affect the capital stock. The latter is entirely determined by the world interest rate. If the government delays the bailout, an inflow of foreign funds will offset the deficit stemming from bad loans. The fact is that there was no inflow of foreign capital: Japan actually increased its holdings of foreign assets over the relevant period.

I use an open economy version of my model to address the question of why the outflow of capital from Japan had continued, despite the decline in funding of domestic investment. To this end I introduce three key assumptions whose net effect is to restrict the inflow of the foreign capital in *one period only,* the period prior to the bailout: A) no entry into the banking sector; B) deposit guarantees fully protect only domestic depositors; and C) households and (at least a fraction of) domestic firms cannot borrow directly from abroad. With these assumptions in place, I show that delaying the bailout leads to a recession which can be accompanies by an increase in foreign asset holdings by the domestic economy.

The intuition for this result is as follows. Suppose that the bailout occurs in period T. Because foreign deposits are not guaranteed, in period $T-1$ the funds available to the domestic banks are limited by the amount of domestic savings. Banks must use part of these savings to cover ongoing obligations to depositors.

[7] This does not need to be the case: the bailout may be delayed even further, or may be financed by new government debt. In both cases, the decline in economic activity will be more profound.

Thus, the total amount of funds available for capital purchases will be low in period $T-1$, and therefore the demand for capital will be low. If capital is irreversible, this implies that the price of capital will be low in period $T-1$. From the perspective of the investors at time $T-2$ this means, other things equal, that the return to holding capital from period $T-2$ to period $T-1$ is low. This in turn lowers their desire to invest in capital. The latter effect results in a fall in investment and in a low price of capital in period $T-2$. This argument shows that the future low price of capital implies low current investment and low current price of capital. Using the same logic, I show that the price of capital and investment are low until period $T-1$. Throughout this process, household savings remain high relative to investment. Since households invest abroad, the country's net holdings of foreign assets rise.

The rest of the paper is organized as follows. In Section 2 I briefly review the conditions of Japan's financial sector during the period 1990-2001. In Section 3 I present the basic closed economy version of the model. In Section 4 I describe the model of endogenous productivity and entry. In Section 5 I present the calibration results. In Section 6 I address the open economy considerations, and in Section 7 I provide concluding remarks.

2 The Conditions of Japan's Financial Sector in 1990-2001: An Overview[8]

Japan's economy is highly bank dependent. While large corporations (especially in manufacturing) have a relatively easy access to alternative ways of fund-raising, small and medium enterprises[9] rely heavily on banks and other domestic lending institutions for their borrowing needs. Bond financing for small and medium enterprises is essentially nonexistent, and the equity financing is small[10]. The main sources of funds for these enterprises are the banks, followed by government affiliated financial institutions[11].

The profitability of Japanese banks has been declining over the last two decades, and has been negative most of the last decade. As Hoshi and Kashyap (2000) extensively argue, the primary reason for this decline is the financial deregulation which had taken place in Japan in the 1980s. Hoshi and Kashyap (2000) predict that to regain profitability, the banking sector must shrink at least by 30%. As long as the massive reduction in the number of operating banks does not occur, the profits will remain low or even negative. Perhaps not surprisingly, during the same period of time there has been no entry into Japan's banking sector[12].

[8] A detailed analysis of the Japanese banking system and of the origins of the financial distress is provided, for example, by Hoshi and Kashyap (2000), (2001).

[9] As Table 2.1 indicates, these enterprises play a very significant role in Japan's economy.

[10] For small and medium enterprises, the equity is only about 1/8 of their total liabilities. This number is more than twice larger for large enterprises.

[11] Source: White Paper on Small and Medium Enterprises (2001). See Table 2.2 for more details.

[12] The role of foreign banks present in Japan in the domestic market remains negligible: their shares of loan and

A major source of problems for Japan's banks is the bad loans. A bad loan is a loan whose payment has been suspended or renegotiated[13]. On average, the amount of repayment on these loans has been about 12% of the original amount[14]. Hence, banks would bear significant losses if they wrote the debt off. According to official sources, the bad loans held by Japan's private deposit taking institutions amount to ¥53 trillion (10.5% of GDP)[15]. However, most observers agree that this number is highly understated. For example, analysts of Goldman Sachs estimate the bad loans to be ¥236 trillion (47% of GDP), and similarly, Credit Suisse First Boston estimates that the actual amount of bad loans is about four times higher than the disclosed figure[16].

The origins of the bad loans are seen in a continued decline in real estate and stock prices, which followed the real estate and stock market collapse of 1991[17]. As some borrowers could not repay their obligations towards the banks, the latter were reluctant to liquidate the loans through sale of collateral (mostly real estate), since the recovered amount would fall short of the original loan, and result in significant losses. The policy of *regulatory forbearance and non-transparency* pursued by Japan's financial authorities, combined with wishful thinking that the economy (and the non performing loans with it), would recover[18], led to an increase in the amount of bad loans throughout the decade. Public opposition to the attempts of using government funds for helping troubled banks[19] further delayed the resolution of the problem.

Bad loans are held not only by the private sector, but also by public financial institutions, which play a significant role in Japan's economy. For example, the share of government sponsored financial institutions in the loan market is 26%, in the deposit market is 34%, and in the life insurance market is 40%[20]. As Doi and Hoshi (2002) indicate, by March 2001 Fiscal and Investment Loan Program, Japan's primary public lender,

deposits markets are below .75% and 1.4% respectively. Also, fund raising of Japan's non-financial sector via overseas markets is about 30 times less than via domestic markets. Source: Flow of Funds Accounts, available on-line at http://www.boj.or.jp/en/siryo/siryo_f.htm.

[13] Japan's Financial Services Agency defines *risk management loans* as 1) loans to borrowers in legal bancruptcy, 2) past due loans in arrears by 6 month and more, 3) past due loans arrears by 3 month or more and less than 6 month, and 4) restructured loans.

[14] Author's calculation, based on Figure 2-1-2 of "Annual Report on Japan's Economy and Public Finance, 2000-2001".

[15] The total cumulative loss on Disposal of Non-Performing Loans by the end of fiscal year 2001 was ¥81.5 trillion (16.3% of GDP). A significant part of these losses had occurred in recent years. In fiscal year 2001 alone the loss was ¥9.7 trillion.

[16] This estimates are from Kashyap (2002b).

[17] See, for example, Ueda (2001).

[18] Cargill (2001) provides a thourough discussion highlighting the main aspects of the Bank of Japan and Ministry of Finance policies regarding the bad loan problem.

[19] Government funds were used to fight the bad loan problem for the first time in 1996, in the case of the loans to the so called *jusen*. The jusen are housing loan cooperatives, which heavily borrowed from the banks before 1991's real estate market crush. As the real estate prices dropped, the jusen became incapable to fulfill their obligations to the lenders. Amid public opposition, the government intervention to solve the problem was delayed by more than 3 years. See Ito (2001) for more details on the jusen problem.

[20] Source: Fukao (2002).

held as much as ¥266.6 trillion of bad loans, most of which were loans to insolvent public corporations. The estimated taxpayers cost for cleaning up the bad debt held by public financial institutions is around ¥78.3 trillion. The most conservative estimates of the cost for cleaning up banks' balance sheets is about ¥40 trillion (Kashyap (2002b)). Therefore, the total cost to the government for resolving the bad loans problem is at least ¥118.3 trillion (24% of GDP).

Finally, an important feature of Japan's financial sector is the presence of government guarantees. Until March 2002 all domestic deposits to the banks were protected by deposit insurance provided by the government. As a result of Japan's deposit insurance reform, starting March 2003 only deposits up to ¥10 million will be fully insured. Despite such guarantees and numerous public statements by Japanese government officials in support of the banking system, the confidence in Japan's banking sector has not been very high. For example, households heavily favored government's Postal Savings deposits to bank deposits (between 1991 and 1999, Postal Savings Deposits have increased by 62%, while deposits to banks increased only by 18%[21]). Further, in the second half of the last decade, Japanese banks found it difficult to borrow abroad, and at times they faced significantly higher interest rates on interbank loans than non-Japanese banks. The so called *Japan's premium,* at its peak, was about 10 basis points on *recorded* transactions.

3 Bad Loans in an Overlapping Generations Model with Banking Sector and Government Deposit Insurance

The origins of Japan's bad loans problem have been widely studied. In this paper I do not offer new explanations for its causes. Rather, I focus on the impact that the bad loans and the delay in the bailout have on the aggregate economic activity. To this end, I model the bad loans as a consequence of a one time unanticipated shock to the return on bank loans.

The model in this section is based on Diamond's (1965) overlapping generations model.

I modify the original model in two dimensions: I assume that capital is irreversible, and I incorporate a banking sector into the model. The banks in this economy are financial intermediaries which transform savings into loans. They are competitive both in the savings and loan markets, but regulated by the government. The government serves as guarantor for bank deposits and can commit public funds to back up its guarantees.

[21] Source: Flow of Funds Accounts, available on-line at http://www.boj.or.jp/en/siryo/siryo_f.htm.

3.1 The Model

The economy is populated by two period lived households and entrepreneurs, infinitely lived banks and the government.

3.1.1 Households

Households live for two periods. In the first period they inelastically supply one unit of labor. They use their wage earnings, net of taxes, to finance their consumption and savings. Households deposit their savings into the banks, and withdraw them in the next period to purchase consumption goods. The households' problem is given by:

$$\begin{aligned} &\max U(c_t^Y) + \beta U(c_{t+1}^O) \\ &\text{s.t. } c_t^Y + S_t = w_t - \tau_t, \\ &c_{t+1}^O = R_{t+1} S_t; \end{aligned}$$

where $U(c) = \begin{cases} \frac{C^{1-\sigma}}{1-\sigma} \text{ if } \sigma > 0, \sigma \neq 1 \\ \log(c) \text{ if } \sigma = 1 \end{cases}$, w_t is the wage at time t, τ_t is the lump sum tax, S_t are the savings, and R_{t+1} is gross interest rate paid by the banks on the deposits. The government guarantees insure that households receive $R_{t+1}S_t$ on their deposits. The households' saving decision is a function of the wage, the lump sum tax and the interest rate:

$$S_t = S(w_t - \tau_t, R_{t+1}). \tag{3.1}$$

3.1.2 Entrepreneurs

Entrepreneurs live for two periods. They are perfectly competitive. In the first period they borrow from the banks to purchase capital goods: existing capital, which depreciates at rate δ, and consumption goods which can be transformed one-to-one into capital. In the next period they hire labor and production takes place. Entrepreneurs sell their output and capital stock, and pay wages and their debt to the banks. Thus, the entrepreneurs' problem is given by:

$$\begin{aligned} &\max_{k_t^E \geq 0, I_t \geq 0, L_t, n_{t+1}} \{F(k_{t+1}, n_{t+1}) - R_{t+1} L_t - w_{t+1} n_{t+1} + (1-\delta) p_{t+1}^k k_{t+1}\} \\ &s.t. \\ &k_{t+1} = k_t^E + I_t; \\ &L_t \geq p_t^k k_t^E + I_t; \end{aligned}$$

where L_t is the amount of loans borrowed from the banks, k_t^E is the purchase of existing capital stock, I_t is the purchase of consumption goods, p_t^k is the price of the existing capital, and n_{t+1} is the amount of labor hired in the period $t+1$. The production function is $F(k, n) = k^\alpha n^{1-\alpha}$.

Capital is irreversible, that is the cost of transforming capital goods into consumption goods is infinite. Note that in equilibrium the price of the existing capital cannot exceed 1. Otherwise, entrepreneurs would buy only consumption goods and not the existing capital. If the equilibrium price of capital is below 1, entrepreneurs buy only existing capital and investment is zero. Therefore, it is immediate to see that the first order conditions (FOC) for the entrepreneur's problem with respect to capital, investment and labor can be written as

$$p_t^k R_{t+1} = F_k(k_{t+1}, n_{t+1}) + (1-\delta)p_{t+1}^k,$$
$$[p_t^k - 1]I_t = 0,$$
$$w_{t+1} = F_n(k_{t+1}, n_{t+1}).$$

3.1.3 Banks

Banks are infinitely lived agents which operate in a perfectly competitive environment, but regulated by the government. They transform households' savings into loans to entrepreneurs. At date zero *all* banks suffer losses on previously made loans. The government provides insurance against this type of aggregate shocks[22]. In particular, let B_0 denote the loss incurred by the representative bank, and $\{G_t\}$ denote the sequence of government transfers to it. Then:

$$B_0 = \sum_{t=0}^{\infty} \frac{1}{\prod_{j=0}^{t-1} R_{j+1}} G_t.$$

That is, the net present value of government transfers is equal to the losses (bad loans from now on) incurred by the bank. It is convenient to denote B_t the stock of bad loans at the beginning of period t, that is, the present value of banks' losses for which the latter have not been compensated:

$$B_t = R_t[B_{t-1} - G_{t-1}].$$

The definition above states that the bad loans at the beginning of the next period are equal to the value of the current bad loans minus the government transfer.

Each period the banks perform the following actions:

collect new deposits;
collect payments on loans made in the previous period;
receive government transfers (if any);
pay off previous period depositors;
make loans to entrepreneurs.

[22] The losses incurred by a bank could also be covered by the bank's own capital. However, in the case when the amount of losses is sufficiently large, the government's intervention is necessary in order to honor deposit guarantees. To this end, introducing equity capital will not change the conclusions of the model.

The government guarantees that the deposits are always paid back. The banks must satisfy the following constraints:

- Non-negative net worth constraint:

$$\begin{aligned} D_t &\leq Q_t; \\ Q_t &\equiv L_t + [B_t - G_t], \end{aligned} \tag{3.2}$$

  where D_t is the total amount of deposits the bank collects at date t, and Q_t is the total amount of assets the bank has at the same date. The latter consists of new loans the bank makes at date t and the outstanding amount of bad loans by the end of the period: the bad loans B_t at the beginning of the period minus the government transfer.

- Lending constraint:

$$\begin{aligned} L_0 &\leq D_0 + [(R_0^L - \frac{B_0}{L_{-1}})L_{-1} - R_0 D_{-1}] + G_0; \\ L_t &\leq D_t + [R_t^L L_{t-1} - R_t D_{t-1}] + G_t, \ t > 0, \end{aligned} \tag{3.3}$$

  where R_t^L denotes the rate of return on loans for $t > 0$. At time 0, the banks' expected rate of return is R_0^L, but the actual return is $(R_0^L - \frac{B_0}{L_{-1}})$. The lending constraint simply states that the bank cannot loan more funds then it has available. The latter consists of new deposits, the payment on loans made in the previous period, and the government transfer minus the payment on previous deposits.

First notice that, as long as the banks are profit maximizing agents operating in a perfectly competitive environment, in equilibrium

$$R_{t+1}^L = R_{t+1}.$$

Otherwise the banks could make infinite profits. Next, I integrate the lending constraint (3.3) using the definitions of bad loans B_t and the result above to get:

$$L_t \leq \prod_{j=0}^{t} R_t [L_{-1} - D_{-1}] + D_t - B_t + G_t.$$

I assume that assets and liabilities of the bank were initially equal: $L_{-1} = D_{-1}$. Therefore,

$$L_t \leq D_t - B_t + G_t.$$

Comparing this expression with the non-negative net worth condition (3.2), it is immediate to see that:

$$L_t = D_t - B_t + G_t. \tag{3.4}$$

This equation is the key to understanding the effect of bad loans on economic activity. It states that the loans to entrepreneurs are equal to the deposits minus the outstanding amount of bad loans. Therefore, as long as the deposits do not rise by the amount of the outstanding bad loans or more, the bad loans will cause a reduction in loans to entrepreneurs.

Finally, note that the profits of the banks are zero in all periods. This is an immediate consequence of the perfect competition in the banking sector and of the full deposit guarantees. Because of perfect competition, the interest rate on deposits is equal to the expected rate of return on loans. The expected and actual rates of return on loans coincide in all periods but period 0. On the other hand, banks are fully compensated by the government for the losses incurred in period 0. Therefore, the banks do not make any profits or losses.

3.1.4 The government

The government provides deposit guarantees can transfer funds to the banks from the current young generation through lump sum taxes. The government's budget constraint is

$$G_t = \tau_t.$$

3.1.5 Resource constraint

The resource constraint is given by:

$$c_t^Y + c_t^O + I_t \leq F(k_t, n_t);$$

3.1.6 Equilibrium

The equilibrium is defined as sequences of prices $\{p_t^k, R_t, w_t\}$, quantities $\{k_{t+1}, k_t^E, I_t, n_t, c_t^Y, c_t^O, S_t, L_t, D_t\}$, and a government policy $\{\tau_t\}$ such that,

- the government policy is feasible: $\tau_t \leq w_t$ for all t; the government's budget constraint holds;

and given prices and the government policy:

- consumption and savings sequences solve the households' problem in each period;
- capital, labor and loan sequences solve the entrepreneurs' problem in each period;
- savings and loan sequences solve the banks problem in each period;

- markets clear in each period:

$$\begin{aligned} S_t &= D_t, \\ c_t^Y + c_t^O + I_t &= F(k_t, n_t); \\ n_t &= 1; \\ k_t^E &= (1-\delta)k_t. \end{aligned}$$

3.1.7 The steady state

In the steady state there are no bad loans; taxes, and transfers to the banks are zero. Thus, the steady state of the economy is identical to the one in the standard model:

$$k^{ss} = S^{ss}.$$

3.2 The Dynamics of the Economy

Initially, the economy's capital stock is at its steady state level. At date zero, unexpectedly, a fraction q of entrepreneurs does not pay back the amount borrowed from the banks. The difference between expected and actual amount received back by the banks are the bad loans:

$$B_0 = qR^{ss}k^{ss}.$$

In this economy there are full deposit guarantees. This implies that the old generation must receive in full its savings. I consider two extreme cases:

1. The government chooses to tax the young generation by the amount of bad loans, $\tau_0 = G_0 = B_0$, and transfer the latter to the banks.

2. The government postpones the intervention.

In the first case, the transfer from the government offsets the bad loan shock. The banks use the transfer along with the amount collected back from the entrepreneurs to repay in full the depositors, and loan out the savings collected in the period of the shock:

$$L_0 = S_0 - B_0 + G_0 = S_0.$$

Savings decrease because of the tax imposed on the current savers. Consequently, the capital in the next period falls. However, from the next period on the economy will grow until it reaches the steady state.

Delaying the Bailout

Consider the case in which the government postpones the intervention until time T, [23] that is, the government transfers are zero for all periods prior to period T :

$$\begin{aligned} G_t &= \tau_t = 0 \text{ for } 0 \leq t < T, \\ G_T &= \tau_T = B_T. \end{aligned} \tag{3.5}$$

In this case the bad loans will grow at the rate of interest:

$$B_{t+1} = R_{t+1}B_t = \prod_{s=0}^{t} R_{s+1}B_0, \; t < T.$$

Therefore, the dynamics of the economy prior to the bailout is characterized by the following system of equations:

$$\begin{aligned} & L_t = S_t - B_t \\ & B_{t+1} = R_{t+1}B_t \\ & p_t^k R_{t+1} = F_k(k_{t+1}, 1) + (1-\delta)p_{t+1}^k \\ & L_t = p_t^k(1-\delta)k_t + I_t \\ & k_{t+1} = \begin{cases} L_t \text{ if } L_t > (1-\delta)k_t \\ (1-\delta)k_t \text{ otherwise} \end{cases} \end{aligned} \tag{3.6}$$

where the last equation comes from the capital market clearing condition: if the amount of loans available to the entrepreneurs exceeds the existing capital stock, then the price of capital is 1, and there is positive investment. If the amount of loans is less than the existing capital stock, investment is zero, that is $k_{t+1} = (1-\delta)k_t$, and the price of capital must fall to clear the capital market:

$$p_t^k = \frac{L_t}{(1-\delta)k_t}.$$

Figure 3.1 highlights the intuition behind the dynamics of the economy in this case. Originally the economy is in the steady state, and savings and loans curves coincide. When the shock hits the economy, the loan curve (*L(0)* in the figure) shifts down by the amount of bad loans B_0. If the amount of bad loans was constant over time (i.e. the interest rate was one), the economy would converge to the new steady state (point *X(0)* in the figure). The capital stock and output would be lower than before the bad loan shock. However, with positive interest rates the bad loans rise over time, forcing the banks to use larger fractions of new savings to pay old depositors, that is the loan curve shifts down even more (*L(1)* in the figure), causing a further fall in the capital stock. When the amount of new loans falls below the existing stock of capital, the price of capital must fall to clear the capital market (see Figure 3.2). From then on investment is zero, and the capital stock falls at the rate of depreciation. Output falls because the capital stock falls.

[23] The condition which determines the upper bound on T will be derived below.

It remains to characterize the behavior of the interest rate (see Figure 3.3). Initially, when investment is positive and the price of capital is 1, the interest rate rises with the rise in marginal product of capital. However, as bad loans grow over time, investment becomes zero and the price of capital starts falling. The future lower price of capital implies capital losses for the entrepreneurs. In equilibrium, the capital losses put downward pressure on the rate of return on capital. For example, with logarithmic preferences, the capital losses exactly offset the rise in the marginal product of capital so that the rate of return on capital (i.e. the interest rate), is constant[24]. Depending on the parameter values, the latter can be higher or lower than the steady state interest rate.

Summarizing, until the bailout occurs, capital stock, output, and price of capital decline. The interest rate may rise initially, but is constant afterwards until the period prior to the bailout. After the bailout, the banks loan to entrepreneurs all new deposits, and consequently the economy converges back to the steady state.

The recession in the model economy is a direct consequence of the crowding out effect of bad loans on the capital stock. As banks are forced to use larger fractions of households' savings to pay off old depositors, the amount of funds available for capital purchases decreases. The irreversibility of capital prevents the capital stock from falling too fast. Instead, the price of capital declines to clear the capital market. Without the irreversibility assumption, the recession would be even more profound. However, the price of capital would not be falling, and the interest rate would be rising.

In this economy, the crowding out effect of the bad loans on capital is identical to the crowding out effect of the government debt on capital. Indeed, consider a case when the government conducts an immediate bailout, but finances it by issuing debt. As long as the government keeps the debt rolling over, less savings would be allocated for loans to entrepreneurs, causing the capital stock to fall, exactly as in the case of the bad loans. This fact implies that the bailout financed by issuing debt will not stop the decline in the capital stock. Instead, the bailout financed by raising taxes will eliminate the crowding out effect on the capital stock, and the economy will be on its way back to the steady state.

The recession generated by the bad loans can last as long as the banks have enough resources to fully cover their obligations to the old depositors, i.e.

$$S_t - B_t \geq 0.$$

Eventually the amount of bad loans will exceed the new savings, i.e. the banks will not be able to honor their obligations on deposits collected in the previous period[25]. At this stage, the government will have to

[24] See Appendix A for derivation of this result.

[25] The bad loans in this economy are an asset equivalent to government debt. As Tirole (1985) shows, no (unproductive) asset can grow faster than the economy's growth rate, because eventually the resources of the economy will not be enough to purchase all outstanding stock of this asset.

conduct the bailout.

The government's ability to raise funds in the bailout period to fully repay banks' obligations to the depositors is essential for the recession to occur. Consider an economy in which there are no government guarantees. In this case an unanticipated negative shock to the return on loans results in losses for the banks. Because perfect competition implies that the deposit rates R_t are equal to the returns on loans R_t^L, the banks cannot offset these losses by higher profits in the following periods. On the other hand, if it attempts to run a Ponzi scheme and finance the deficit by using new deposits, in a finite period of time it will run out of funds. In other words, new savings will not be enough to pay in full the old deposit obligations. Knowing this, households will not make deposits to such banks prior to the bankruptcy period. By backwards induction, banks would not be able to collect deposits in any other period. However, with government guarantees, from the banks' point of view, the bad loan is not "bad". Indeed, the net present value of a bad loan is exactly the same as the net present value of new loans. The only difference is that the new loans pay off next period, while the bad loans pay off on the day of the bailout. Thus, the net present value of the banks' assets is unaffected by the bad loans[26].

In this model the Ricardian Equivalence does not hold: the savings decision of the households is not affected by the future tax increase associated with the bailout. In the standard neoclassical model with infinitely lived agents and nondistortionary taxes this would not be the case. In anticipation of a future tax increase, savings would rise. In fact, the increase in savings would exactly offset the crowding out effect of the bad loans on capital, and the recession would not occur.

Finally, the results above do not rely on frictions in the credit market: entrepreneurs in the model are not credit rationed, nor they are facing borrowing constraints of any type. In each period, given the interest rate and the price of capital, they acquire the optimal amount of capital. Therefore, the predictions of the model would remain valid even if entrepreneurs had a direct access to the households savings. Under full deposit protection, households would be indifferent between lending to banks or directly to entrepreneurs, as both activities in equilibrium would guarantee the same return, while the banks still would use the necessary amounts of new deposits to cover the deficits arising from the bad loans.

[26] An interesting question is whether the dynamics of the economy would be different if the government guarantees were limited, that is, if only a particular amount of deposits were to be repaid in the period of the bailout. In this case, in the period prior to the bailout, the deposits to the banks would not exceed the guaranteed amount. If the latter is lower than the households' desired level of savings, savings would decline, causing the price of capital to decline. In all other periods the behavior of the households would not change. Therefore, the dynamics of the economy would be identical to the one described above, except in the period prior to the bailout the savings and the price of capital would be lower, with respective adjustments in the interest rates.

4 A Model with Endogenous Productivity and Entry

In this section I ask the following question: *What caused the declines in (the growth rate of) productivity and number of enterprises observed in Japan during the 1990s?* I argue that the presence of bad loans *per se* may lead to such declines. As I have shown in the previous section, the delay in the government bailout leads to declines in the price and the stock of capital. In the model presented below, the latter effects cause a decline in firms' average productivity, and entry. In addition, the number of firms may fall.

In the remaining of this section I introduce the model of entrepreneurial activity and use it to discuss the effects of low price of capital and low capital stock on the productivity and the number of firms. In Appendix B I briefly discuss the relation between the average productivity of entrepreneurs and the total factor productivity (TFP).

4.1 The Model

Consider an economy populated by a continuum of exante identical, profit maximizing agents: the potential entrepreneurs. To become an entrepreneur they must pay a fixed entry cost ψ. After the cost is paid, each entrepreneur draws an index j, where j is independently and identically distributed on the unit interval with density g, and which determines its productivity. The productivity of the j^{th} entrepreneur is given by $a(j)$, where a is an increasing, positive-valued function. Once the productivity is observed, entrepreneurs decide whether they will produce in the next period or not. If an entrepreneur decides to produce, she must borrow to buy capital for the next period. In the next period the entrepreneur hires workers, produces, sells her capital (net of depreciation), pays back her debt, and retires.

The production function of an entrepreneur is given by:

$$a^{1-\gamma}\left[F(k,n)\right]^{\gamma},$$

where $F(k,n) = k^{\alpha}n^{1-\alpha}$, and k and n are capital and labor respectively. The parameter γ determines the degree of diminishing returns to scale in capital and labor. The entrepreneurs' capital in the next period is given by the following relationship[27]:

$$k_{t+1} = k_t^E - \phi,$$

where k_t^E is the amount of capital stock the entrepreneur has purchased, and $\phi > 0$ is the fixed operating cost (in units of capital)[28].

[27] For expositional purposes I abstract from the investment decision of entrepreneurs. When conducting the quantitative analysis, investment decision will be incorporated into the model.

[28] The fixed operating cost ϕ may also be interpreted as a part of capital which depreciates completely every period. Another way to introduce ϕ into the analysis is to assume that investment adjustment costs are in terms of capital (as, for example, in

Consider the decision of the j^{th} entrepreneur. If she decides to produce, her profits are

$$\pi_{t+1}^P(j) = \max_{k_{t+1},n_{t+1}} [a(j)]^{1-\gamma} \left[k_{t+1}^{\alpha} n_{t+1}^{1-\alpha}\right]^{\gamma} - R_{t+1}p_t^k(k_{t+1}+\phi) - w_{t+1}n_{t+1} + (1-\delta)p_{t+1}^k k_{t+1}, \tag{4.1}$$

where p_t^k, and R_{t+1} are, respectively, the price of capital and the interest rate. The decision of whether to produce or not depends on whether π_{t+1}^P is positive or not, that is the profits of the j^{th} entrepreneur are

$$\pi_{t+1}^E(j) = \max\{\pi_{t+1}^P(j), 0\}.$$

Free entry implies that in equilibrium a potential entrepreneur must be indifferent between becoming an entrepreneur or not. Therefore, the cost of entry ψ must be equal to the expected discounted profits:

$$\psi = \frac{1}{R_{t+1}} E_t \pi_{t+1}^E. \tag{4.2}$$

4.2 The Effect of a Fall in Price of Capital and Capital Stock

Below I describe the effects of a decline in the price of capital and in the capital stock on the productivity and the number of producers.

First, I determine the lowest productivity level necessary for an entrepreneur to be a producer. Consider the maximization problem in (4.1). The first order conditions for this problem are:

$$\begin{array}{l} \alpha\gamma\frac{y_{t+1}(j)}{k_{t+1}(j)} = R_{t+1}p_t^k - p_{t+1}^k(1-\delta); \\ (1-\alpha)\gamma\frac{y_{t+1}(j)}{n_{t+1}(j)} = w_{t+1}. \end{array} \tag{4.3}$$

where $y_{t+1}(j)$ is the gross output of the j^{th} entrepreneur. These conditions, along with the linear homogeneity of the production function, imply that:

$$\frac{y_{t+1}(j)}{y_{t+1}(i)} = \frac{k_{t+1}(j)}{k_{t+1}(i)} = \frac{n_{t+1}(j)}{n_{t+1}(i)} = \frac{a(j)}{a(i)}. \tag{4.4}$$

That is, in equilibrium, the output, capital, and labor ratios of any two entrepreneurs are equal to their productivity ratio. The first order conditions in (4.3) also imply that the profits of a producing entrepreneur are equal to the entrepreneur's share of output minus the operating cost:

$$\pi_{t+1}^P(j) = (1-\gamma)y_{t+1}(j) - R_{t+1}p_t^k\phi.$$

Let J_{t+1} be the entrepreneur who is indifferent between producing or not[29], i.e.

$$(1-\gamma)y_{t+1}(J_{t+1}) - R_{t+1}p_t^k\phi = 0. \tag{4.5}$$

Uzawa (1969) and Hayashi (1982a)), and that these costs contain a fixed component. Stating the fixed cost in terms of overhead labor would not change the conclusions of this section, since in the recession generated by the bad loans the wages fall.

[29] Note that J_{t+1} may not exist, because it can be the case that it is optimal to produce at any level of productivity: $\pi_{t+1}^P(j) > 0$ for all j. I assume that this is not the case.

Because output is increasing in productivity, the producers' profits are increasing in productivity. Therefore, entrepreneurs with productivity higher then $a(J_{t+1})$ will be producers, and those with lower productivity will not. This implies that the expected profits are:

$$E\pi_{t+1}^{E} = \int_{J_{t+1}}^{1} \left[(1-\gamma)y_{t+1}(j) - p_t^k \phi_t R_{t+1}\right] g(j)dj. \tag{4.6}$$

Using equations (4.4)-(4.6), the zero expected profits condition in (4.2) can be written as:

$$\psi = p_t^k \phi \int_{J_{t+1}}^{1} \left[\frac{a(j)}{a(J_{t+1})} - 1\right] g(j)dj. \tag{4.7}$$

The expression above defines the cutoff J_{t+1} as an implicit function of p_t^k. It is straightforward to show that $J_{t+1}(p_t^k)$ is an increasing function[30].

Let ν_{t+1} denote the entry size, i.e. the number of entrepreneurs who decide to enter. The aggregate capital, labor (workers), and output are given by:

$$K_{t+1} \equiv \nu_{t+1} \int k_{t+1}(j)g(j)dj;$$
$$N_{t+1} \equiv \nu_{t+1} \int n_{t+1}(j)g(j)dj;$$
$$Y_{t+1} \equiv \nu_{t+1} \int y_{t+1}(j)g(j)dj = \left[\nu_{t+1} \int_{J_{t+1}}^{1} a(j)g(j)dj\right]^{1-\gamma} K_{t+1}^{\alpha\gamma} N_{t+1}^{(1-\alpha)\gamma},$$

where the last equality follows from equation (4.4).

Further, let A_{t+1} and μ_{t+1} denote respectively the average productivity of (producing) entrepreneurs and the number of *producers*:

$$A_{t+1} \equiv \frac{\int_{J_{t+1}}^{1} a(j)g(j)dj}{\int_{J_{t+1}}^{1} g(j)dj};$$
$$\mu_{t+1} \equiv \nu_{t+1} \int_{J_{t+1}}^{1} g(j)dj.$$

First, note that from equation (4.7) it directly follows that:

- When the price of capital falls, the average productivity of entrepreneurs declines;
- The changes in the capital stock K_{t+1} do not have an effect on the average productivity of entrepreneurs.

Indeed, the average productivity is an increasing function of the cutoff J_{t+1}. When the price of capital falls, the cutoff J_{t+1} falls, causing a decline in the average productivity. On the other hand, the changes in capital

[30] An increase in the cutoff J_{t+1} has two effects: profits of a producing entrepreneur j, $\pi_{t+1}^{P}(j) = p_t^k \phi \left[\frac{a(j)}{a(J_{t+1})} - 1\right]$ decline, and also the number of producers declines. Therefore, the right hand side of (4.7) is decreasing in J_{t+1}, while it is clearly increasing in p_t^k.

stock do not affect the cutoff J_{t+1}, and therefore do not affect the average productivity of entrepreneurs either.

Next, I analyze the response of the number of producers μ_{t+1} to changes in the price of capital and in the capital stock.

In the model there are two ways to use capital: directly for production, and to cover the operating cost. In equilibrium the return from the two uses must be the same. The return from using capital to cover the operating costs is defined by the zero profit condition of the entrepreneur J_{t+1} in (4.5). The return from using capital directly for production is given by (4.3). Once again, using the linear homogeneity of the production function, those two equations can be written as

$$R_{t+1}p_t^k = \frac{1}{\phi} \cdot \frac{a(J_{t+1})}{\nu_{t+1} \int_{J_{t+1}}^1 a(j)g(j)dj} \left[\nu_{t+1} \int_{J_{t+1}}^1 a(j)g(j)dj \right]^{1-\gamma} K_{t+1}^{\alpha\gamma} N_{t+1}^{(1-\alpha)\gamma}. \tag{4.8}$$

and

$$R_{t+1}p_t^k = \alpha\gamma \left[\nu_{t+1} \int_{J_{t+1}}^1 a(j)g(j)dj \right]^{1-\gamma} K_{t+1}^{\alpha\gamma-1} N_{t+1}^{(1-\alpha)\gamma} + p_{t+1}^k(1-\delta). \tag{4.9}$$

Combining these equations, it follows that:

$$\begin{aligned} &\tfrac{a(J_{t+1})}{\phi} \left[\nu_{t+1} \textstyle\int_{J_{t+1}}^1 a(j)g(j)dj \right]^{-\gamma} K_{t+1}^{\alpha\gamma} N_{t+1}^{(1-\alpha)\gamma} + \dots \\ &-\alpha\gamma \left[\nu_{t+1} \textstyle\int_{J_{t+1}}^1 a(j)g(j)dj \right]^{1-\gamma} K_{t+1}^{\alpha\gamma-1} N_{t+1}^{(1-\alpha)\gamma} - p_{t+1}^k(1-\delta) = 0. \end{aligned} \tag{4.10}$$

The left hand side of the equation above is increasing in the cutoff J_{t+1} and the capital stock K_{t+1}, and is decreasing in the entry ν_{t+1}. Since the cutoff J_{t+1} is an increasing function of the price of capital p_t^k, the left hand side is increasing in the price of capital. Therefore,

- When the price of capital falls, the entry size ν_{t+1} falls;
- When the aggregate capital stock falls, the entry size ν_{t+1} falls.

Recall that the number of producers is given by

$$\mu_{t+1} = \nu_{t+1} \int_{J_{t+1}}^1 g(j)dj.$$

When the price of capital falls, both the entry size ν_{t+1} and the cutoff J_{t+1} decline. Therefore the effect of the fall in the price of capital has an ambiguous effect on the number of producers. On the other hand, when the capital stock falls the entry ν_{t+1} falls, but the cutoff J_{t+1} remains constant. Therefore, the number of producers μ_{t+1} falls in response to the fall in the capital stock.

Summarizing, the fall in the price of capital has a negative effect on the average productivity of entrepreneurs, and entry, but has an ambiguous effect on the number of producers.

The decline in the capital stock has a negative effect on entry and the number of producers, and has no effect on the average productivity of entrepreneurs.

5 Quantitative Analysis

In this section I examine how much of Japan's slowdown can be explained by the bad loans problem. The main finding is that the delay in the bailout generates 0.21-0.53% decline in output per year. Whether this should be regarded as quantitatively significant or not depends on what the growth rate of Japan's GDP per capita would have been in the last decade, absent the bad loans problem and other factors possibly slowing the economy down.

After an extremely fast growth in the 1960s, Japan's economy has been slowing down. In the 1970s the growth rate of GDP per capita was 3.33%, while it was above 9% in the 1960s. In 1981-1986, GDP per capita grew at the average rate of 2.56%. This slowdown is consistent with the neoclassical growth model[31]. According to the latter, after the initial catching up period, the growth rate of Japan's economy should converge to the long run growth rate of the leader economy. Assuming that the high growth during the bubble period of 1987-1991 was not justified by the long run fundamentals, the neoclassical theory would have predicted that during the 1990s the growth rate of Japan's per capita GDP would be lower than 2.56%, but higher than 2%[32]. The average per capita growth rate during the period 1991-2000 was 1.17%. Therefore, a rough estimate of Japan's slowdown would be 0.83-1.4% of decline in per capita GDP growth, indicating that the contribution of the delay in the bailout to the slowdown is significant.

In the model, about 60% of the decline in output is due to the decline in the capital stock, and the rest is due to the declines in productivity and number of producers.

5.1 The model

The model below is a modified version of the benchmark model. First, I substitute the overlapping generations framework with Blanchard's (1986) Perpetual Youth framework. The appeal of the latter is that it allows one to control the extent to which Ricardian Equivalence fails, while permitting study of the dynamics of the economy at yearly frequencies.

Second, I modify the capital accumulation rule. In what follows, entrepreneurs' capital is given by:

$$k_{t+1} = k_t^E + H(i_t, k_t^E) - \phi,$$

where k_t^E is the existing capital and i_t is the investment. The function H is given by $H(i,k) = \eta_0 i^{\eta} (k^E)^{1-\eta}$, where η_0 and η are parameters. This modification is primarily done to allow for variable price of capital[33].

Third, I introduce a tax on capital. Capital taxes are very high in Japan, and revenues from them constitute a significant share of total government revenues. Therefore the capital tax cannot be ignored. In

[31] This point is similar to the one advanced by Hayashi and Prescott (2002).

[32] 2% is the long run growth rate of per capita GDP of the U.S., the leader economy. The average growth rate of per capita GDP for the OECD countries during the 1990s was roughly 2%. For the G7 countries excluding Japan this figure was 1.8%.

[33] In the benchmark model the price of capital was constant if investment was positive.

the model below the rate of return on capital and the interest rate are related as follows:

$$R - 1 = (1 - \tau^K)(R^K - 1),$$

where R is the interest rate, $\tau^K \in [0, 1]$ is the capital tax, and R^K is the rate of return on capital.

Finally, I incorporate into the analysis the model of entrepreneurial activity developed in Section 4.

Below I present the model used in quantitative experiments. The equilibrium conditions for the model are derived in Appendix C.

5.1.1 Households[34]

In each period a new generation of measure p is born. Each household faces a constant probability p of dying in the next period; p is also the inverse of the expected life time of the household.

The economy is also populated by perfectly competitive insurance companies, which pay a premium $\frac{p}{1-p}$ per unit of non-human wealth the households possess. In exchange, insurance companies collect the households wealth in the event of their death.

The households' utility function is

$$u_t(\cdot) = \begin{cases} \log(\cdot) \text{ if alive in period } t \\ 0 \text{ otherwise} \end{cases}.$$

With this utility function the problem of a household who is alive at time t is given by

$$\max p \textstyle\sum_{s=t}^{\infty} [\beta(1-p)]^{s-t} \log c_s,$$
$$s.t. \; v_{s+1} + c_s = R_s[1 + \tfrac{p}{1-p}]v_s + y_s,$$

where v_s is the (non-human) wealth in period s, y_s is the labor income, and c_s is the consumption. The term $R_s \frac{p}{1-p} v_s$ is the premium received from the insurance companies[35].

To capture the idea of retirement, it is assumed that the share of labor income of a household born in generation t in period s is given by:

$$y(s,t) = \bar{w}_t \left(a_1[1-\theta_1]^{t-s} + a_2[1-\theta_2]^{t-s} \right)$$

where $a_1 < 0, a_2 > 0$, and $0 < \theta_2 < \theta_1 < 1$ are parameters, and $\bar{w}_t$ is the aggregate labor income in period t. The latter is equal to the wage w_t minus the labor tax τ_t :

$$\bar{w}_t = w_t - \tau_t.$$

[34] In modeling the households' side of the economy I follow closely Blanchard and Fischer (1989), Ch. 3.

[35] The probability of death reduces the households' effective discount factor, and the existence of the insurance provides additional income in the states of the world relevant for the households.

With this specification, the labor income of the households rises initially, but declines afterwards.

It is well known that the solution of the problem above yields the following equations for aggregate consumption C_t, and wealth V_{t+1}:

$$C_t = [1-\beta(1-p)][R_t V_t + W_t];$$
$$V_{t+1} = R_t V_t + \bar{w}_t - C_t.$$

where W_t is the aggregate human wealth, that is, the value of the future labor income of current households.

5.1.2 Entrepreneurs

Entrepreneurs are identical to the ones in Section 3, except the entrepreneurs' capital is given by:

$$k_{t+1} = k_t^E + H(i_t, k_t^E) - \phi,$$

where k_t^E is the amount of capital stock entrepreneurs have purchased, i_t is the investment, and ϕ is the fixed operating cost.

In what follows most of the notation is the same as in Section 4. The entrepreneurs problem is given by:

$$\psi = \tfrac{1}{R_{t+1}^K} \textstyle\int_0^1 \pi_{t+1}^E(j) g(j) dj;$$
$$\pi_{t+1}^E(j) = \max\{\pi_{t+1}^P(j), 0\};$$

where

$$\pi_{t+1}^P(j) = \max_{L_t, k_t, i_t, n_{t+1}} [a(j)]^{1-\gamma} \left[k_{t+1}^{\alpha} n_{t+1}^{1-\alpha}\right]^{\gamma} - R_{t+1}^K L_t - w_{t+1} n_{t+1} + (1-\delta) p_{t+1}^k k_{t+1}$$
$$k_{t+1} = k_t^E + \eta_0 i_t^{\eta} (k_t^E)^{1-\eta} - \phi$$
$$L_t = p_t^k k_t^E + i_t.$$

It is straightforward to show that for all producing entrepreneurs the following condition must be satisfied:

$$p_t^k = \frac{1 + H_{k,t}}{H_{I,t}}.$$

Therefore, the investment capital ratio $\frac{i_t}{k_t^E}$ is the same across all producers. This in turn implies that the aggregate capital stock in the next period is given by:

$$K_{t+1} = (1-\delta)K_t + H(I_t, (1-\delta)K_t) - \phi\nu_{t+1} \int_{J_{t+1}}^1 g(j) dj.$$

where I_t is the aggregate investment, and $\phi\nu_{t+1} \int_{J_{t+1}}^1 g_0(j) dj$ is the aggregate operating cost. Finally, the analogs of equations (4.7), (4.8), and (4.9) are given respectively by:

$$\psi = \frac{1}{H_{I,t}} \phi \int_{J_{t+1}}^1 \left[\frac{a(j)}{a(J_{t+1})} - 1\right] g(j) dj;$$

$$R_{t+1}^K \frac{1}{H_{I,t}} = \frac{(1-\gamma)}{\phi} a(J_{t+1}) \left[\nu_{t+1} \int_{J_{t+1}}^1 [a(j)]^{1-\gamma} g(j) dj\right]^{-\gamma} K_{t+1}^{\alpha\gamma};$$

$$R_{t+1}^K \frac{1}{H_{I,t}} = \alpha\gamma \left[\nu_{t+1} \int_{J_{t+1}}^1 [a(j)]^{1-\gamma} g(j) dj\right]^{1-\gamma} K_{t+1}^{\alpha\gamma - 1} + p_{t+1}^k (1-\delta).$$

5.1.3 Banks

The banks in the model are identical to the ones in the benchmark model, which results in the following: the interest rate on deposits coincides with the rate of return on loans, and the loans to entrepreneurs are equal to the deposits minus the outstanding amount of bad loans:

$$R^L_{t+1} = R_{t+1};$$
$$L_t = D_t - B_t + G_t.$$

5.1.4 The Government

The government guarantees deposits to the banks and can transfer funds to the banks from current young generation. The government's budget constraint is given by

$$G_t + g^P_t = \tau_t + \tau^{K,A}_t.$$

where G_t is the transfer to the banks, g^P_t is the government spending other than the transfer to the banks, τ_t is the labor tax, and $\tau^{K,A}_t$ are the revenues from capital taxation.

5.1.5 Resource Constraint

The resource constraint is given by:

$$C_t + I_t + g^P_t + \nu_{t+1}\psi \leq \left[\nu_t \int_{J_t}^1 a(j)g(j)dj\right]^{1-\gamma} K^{\alpha\gamma}_t.$$

5.1.6 Equilibrium

Equilibrium is defined as sequences of prices $\{p^k_t, R_{t+1}, w_t\}$, quantities $\{\{k_{t+1}(j), k^E_t(j), I_t(j), n_t(j)\}_{j\in[0,1]}, \{c(s,t), v(s,t+1)\}_{s\leq t}, L_t, D_t, \nu_t\}$, and the government policy $\{\tau_t, \tau^K_t, g^P_t, G_t\}$ such that,

- the government policy is feasible: $\tau_t \leq w_t$ for all t; the government's budget constraint holds;

  and given prices and the government policy:

- consumption and wealth sequences solve the households' problem in each period;
- capital, labor, investment and loan sequences solve entrepreneurs' problem in each period;
- deposit and loan sequences solve the banks problem in each period;

- and markets are clear in each period:

$$V_{t+1} = p_t^k(1-\delta)K_t + I_t + \nu_{t+1}\psi + B_t;$$
$$C_t + I_t + g_t^P + \nu_{t+1}\psi = \left[\nu_t \int_{J_t}^1 a(j)g(j)dj\right]^{1-\gamma} K_t^{\alpha\gamma};$$
$$\nu_{t+1}\int n_{t+1}(j)g(j)dj = 1;$$
$$\nu_{t+1}\int_{J_{t+1}}^1 k_t^E(j)g(j)dj = (1-\delta)K_t.$$

5.2 The Experiment

The main difficulty in quantifying the effect of the bad loans problem on Japan's economy is uncertainty regarding the actual amount of bad loans and the government's bailout policy. As described in Section 2, at the time of this writing the estimates for the actual size of non-performing loans vary significantly, while the timing and financing of the bailout remain uncertain[36]. Due to these facts, it is only possible to provide a rough estimate of the effect that bad loans have on the economy by considering different estimates for the amount of bad loans and different bailout schemes[37].

The amount of bad loans. The latest available data on the bad loans are for the end of the fiscal year 2001. As previously discussed, the estimates of the amount of bad loans vary significantly: from 24% of GDP to 63% of GDP. I consider three cases: A) the actual amount of bad loans is 24% of GDP; B) the actual amount of bad loans is 37% of GDP; and C) the actual amount of bad loans is 43% of GDP[38].

Timing of the bailout. As a benchmark I consider the case when the bailout starts as soon as possible, that is in 2003. In the model it corresponds to the 13$^{\text{th}}$ period after the bad loan shock occurs. If the bailout was set to start later, the effects of the bad loans on the economy would be larger.

The bailout policy. In the model, the government can finance the bailout in four different ways: by increasing labor income taxes, by increasing capital income taxes, by reducing government spending or by issuing debt. As I have argued earlier, financing the bailout by government debt does not eliminate the crowding out effect on capital. Thus I do not consider the last case as a bailout. I will consider the following four bailout policies:

P1 The government raises labor and capital taxes by 10% and reduces government spending by 10%;

[36] In the end of 1990s, in a series of measures to fundamentally restructure the financial sector (so called "Big Bang"), Japan's government had committed about ¥60 trillion for deposit protection, bank recapitalization, and nationalization of failed banks. A part of these funds has been disbursed (See Hoshi and Kashyap (2001), Ch. 8, for more details). During the same period, Japan's budget deficit was financed by government debt.

[37] It is important to note that, in principle, given the amount of bad loans, the model can used to identify the set of different bailout policies which are consistent with the savings behavior of the Japanese households during the 1990s.

[38] B) is the lower bound plus one third of the difference between the upper and the lower bounds, and C) is the average of lower and upper bounds. It it important to emphasize that a very large amount of bad loans (18% of GDP) has been written off, and a significant part of it only recently. Including this amount into the analysis would make the effect of the bad loans on the economic activity larger.

P2 The government raises the labor tax by 10%, and the capital tax by 5%, and reduces government spending by 13.5%;

P3 The government raises the capital tax by 5%, and reduces government spending by 15%;

P4 The government raises the labor tax by 15%, and reduces government spending by 15%.

The initial conditions and the bad loan shock. In all simulations it is assumed that initially the economy is in steady state. At date 0, unexpectedly a fraction q of entrepreneurs does not repay the banks the amount borrowed. I consider two cases. In the first case, the funds which has not been repaid to the banks, i.e., $B_0 = qR^{ss}L^{ss}$, are distributed to the households in a lump sum fashion. To insure that the aggregation properties of the model are not altered, it is assumed that the share of B_0 distributed to each household is equal to the labor income share of the latter in that period. In the second case, B_0 units of consumption goods vanish from the economy in the period of the shock.

Considering these two cases allows to assess the effect of the bad loans on the economy, *regardless* of the nature of the shock which generates the bad loans.

Parameter values[39]**.** The parameters in the model can be divided into three categories: "neoclassical", "perpetual youth" and "endogenous productivity" parameters. The "neoclassical" parameters are constructed based on findings of Hayashi and Prescott (2002). In particular, the share of capital is set to 1/3 [40], the capital tax rate is set to .48. In the steady state the depreciation rate of capital is 10%, and the interest rate is 5.2%.

The "perpetual youth" parameters p, θ_1, θ_2, a_1 and a_2 are chosen as follows. Parameter p is chosen such that the resulting age distribution of the households comes closest to that in the data[41]. With this value of p the expected life time of the household is equal to 41.66 years. Parameters θ_1, θ_2, a_1 and a_2 are chosen such that the resulting life-cycle pattern of labor income comes closest to that in the data.

The "endogenous productivity" parameters γ, ϕ, and $a(j)$ are chosen as follows. Parameter γ is set to 2/3. Atkeson and Kehoe (1995) report that the plausible range for this parameter is [.5, .85]; 2/3 is roughly the mean of this interval. In the steady state the fixed operating cost ϕ is equal to .1% of capital stock, and accounts approximately for 10% of the total capital depreciation. The productivity function $a(j)$ in the experiments below is given by $a(j) = C_{1,a} + C_{2,a}j^{n_a}$.[42]

[39] The complete list of parameter values is provided in Appendix D.

[40] The share of capital reported by Hayashi and Prescott (2002) is .362. Setting it to 1/3 significantly reduces the computational burden.

[41] In the mean square sense.

[42] The choice of this functional form is motivated by computational reasons. However, it must be noted that the functional form of function $a(j)$ per se does not directly affect the dynamics of the economy. The latter depends on the behavior of the function $a(j)$ around the cutoff J_{t+1}.

5.3 Results

Figure 5.1 presents the dynamics of the economy for the case in which the government finances the bailout by a 10% increase in labor and capital taxes and a 10% reduction in the government spending and the bad loans are at 37% of GDP. Under this policy it takes the government 16 years to fully eliminate the bad loans. Before the bailout starts, output, capital, entrepreneurs' average productivity, and number of producers[43] fall respectively at average yearly rates of 0.34%, 0.59%, 0.22% and 0.21%[44]. Roughly 60% of the decline in output is due to the fall in capital, and the rest is due to the changes in the entrepreneurs' average productivity and the number of producers.

The first part of Table 5.1-A reports the effect of the bad loans on the economic activity under the bailout policies P1-P4, when the amount of bad loans is 24% of GDP, and B_0 is distributed back to the households. The average yearly decline of output in these cases is 0.21-0.27%.

The first parts of Table 5.1-B and 5.1-C report the results of the same experiments for the cases when the bad loans are at 37% and 43% of GDP respectively. The average yearly decline in output in these cases is higher.

Tables also report the results of the experiments described above for the case in which the parameter p is set to 0.1[45]. Higher p implies that the households care less about the future, therefore they save less than in the benchmark case. The latter effect causes a larger fall in loanable funds. Consequently, investment decline is sharper and recession is deeper.

Finally, the second part of Tables 5.1-A, B and C report the results for the case in which in the period of the shock B_0 units of consumption goods vanish from the economy. The decline in capital and output is deeper in this case, since in the first period the amount of consumption goods available for consumption and investment is reduced significantly. The latter effect causes a larger fall in investment. Consequently, recession is deeper.

The results described above suggest that the delay in the bailout can be contributing significantly to the slowdown of Japan's economy. In the experiments above, the bad loans problem causes a 0.21-0.53% yearly decline in output. A significant part of this decline, about 40%, is caused by the declines in the productivity and in the number of producers.

[43] Initially, as the bad loan shock hits the economy, the number of producers increases, however it falls afterwards.

[44] With the particular function $a(\cdot)$ used in this experiment, 1% fall in output is accompanied by .37% fall in the Solow residual. In Japan in the 1990s, as measured by Hayashi and Prescott (2002), a 1% fall in (the growth rate of) output was accompanied by roughly a 1% fall in (the growth rate of) the Solow residual.

[45] The parameter p in the model is the difference between the discount rate for the human wealth and the interest rate. Hayashi's (1982b) estimates suggest that the discount rate for human wealth is higher than the interest rate, and in particular that the implied value of p is .10. See Hayashi (1982b) and Blanchard (1985) for more details.

6 Open Economy Considerations

In this section I study the implications of the bad loans problem in the case of a small open economy. With unrestricted flows of foreign capital, the delay in the government bailout has no impact on the economic activity. In such a model the rate of return on loans is equal to the world interest rate, and the economy covers the deficit of loanable funds arising from the bad loans by borrowing from abroad. Yet, in Japan's case an inflow of foreign capital did not occur. To the contrary, Japan increased its holdings of foreign assets.

In this section I extend the benchmark model to explain this phenomenon. In the model below, as in Section 3, entrepreneurs can borrow only from domestic banks and capital is irreversible. In addition,

A) there is no entry to the banking sector; and

B) deposit guarantees are asymmetric, that is, they fully protect only domestic depositors.

I show that in this economy delaying the government bailout leads to a decline in economic activity. Moreover, during this recession a part of domestic savings is lent abroad.

An important feature of the model below is that there is *only one period* in which domestic banks are constrained in the amount of funds they can raise: the period prior to the bailout. In particular, as long as the bailout is not set to occur in the next period, domestic banks, and therefore the economy, can freely borrow from abroad at the world interest rate. It is an equilibrium outcome that the economy does not borrow, but lends abroad in these periods.

In the remaining of this section I present the formal model and use it to analyze the effects of the delay in the government bailout on the economic activity.

6.1 The Model

The economy is populated by households, entrepreneurs, banks and the government. The households can lend but not borrow from abroad. The banks have free access to the world capital markets. The world interest rate R^W is constant over time. The entrepreneurs can borrow only from domestic banks[46]. The households' and entrepreneurs problems are identical to the ones in Section 3. Therefore, the households' savings are given by

$$S_t = S(w_t - \tau_t, \max(R_{t+1}, R^W)),$$

where R_{t+1} is the interest rate on domestic deposits, and the entrepreneurs first order condition with respect to capital is given by:

[46] One can show that this assumption can be relaxed: the results of this section would remain valid even if only a fraction of entrepreneurs were bank dependent, as long as there is enough complementarity between goods produced by the bank dependent sector and goods produced by the rest of the economy (e.g., non-tradables vs. tradables).

$$p_t^k R_{t+1}^L = F_k(k_{t+1}, n_{t+1}) + (1-\delta)p_{t+1}^k.$$

where R_{t+1}^L is the rate of interest the banks charge the entrepreneurs. As in Section 3, capital is irreversible.

6.1.1 Banks

Banks perfectly competitive, infinitely lived agents, regulated by the government. It is assumed that there is no entry into the banking sector. The banks transform the households' savings into loans to the entrepreneurs. In each period the banks perform the following actions:

collect new deposits (both from domestic and foreign agents);
collect payments on loans made in the previous period;
receive the government transfer (if any);
pay off previous period depositors;
make loans to entrepreneurs.

Initially, assets and liabilities of all banks are identical. At date zero *all* banks suffer losses on previously made loans. The government protects domestic depositors against this type of aggregate shocks, that is, it guarantees that all domestic deposits will be paid back. However, these guarantees do not extend to foreigners. In the period of the bailout all bad loans are written off and the banks remain liable only for the new deposits they collect in that period. The government implements its policy by making a transfer G_T in the period of the bailout to the banks, and by imposing a non-negative net worth constraint on the banks. Let B_0 denote the loss incurred by the representative bank. It is convenient to denote by B_t bad loans in period t, that is the value of B_0 in that period,

$$B_t = R_t B_{t-1}.$$

For all periods prior to the bailout the non-negative net worth constraint imposed by the government takes the form:

$$\begin{aligned} D_t &\leq Q_t; \qquad (6.1) \\ Q_t &\equiv L_t + B_t. \end{aligned}$$

where D_t is the total amount of deposits the bank collects at date t, and Q_t is the total amount of assets the bank has at the same date. The government counts as assets the new loans L_t that the bank makes at date t and the bad loans B_t.

The bank also faces the lending constraint:

$$\begin{aligned} L_0 &\leq D_0 + [(R_0^L - \frac{B_0}{L_{-1}})L_{-1} - R_0 D_{-1}]; \\ L_t &\leq D_t + [R_t^L L_{t-1} - R_t D_{t-1}],\ t > 0. \end{aligned} \tag{6.2}$$

At time 0, the banks expected rate of return is R_0^L, but the actual return is $(R_0^L - \frac{B_0}{L_{-1}})$.

Notice that because of the unrestricted flows of foreign capital in all periods, except the period prior to the bailout, the interest rate on deposits is equal to the world interest rate, and the rate of return on loans is equal to the world interest rate:

$$R_{t+1}^L = R_{t+1} = R^W,\ \text{for } t \neq T-1,$$

where T is the period of the bailout. In the period prior to the bailout, because only domestic deposits are protected by the government guarantees, the flow of funds to the banks may be limited. This may cause the rate of return on capital to be higher than the world interest rate.

Integrating the lending constraint (6.2) and comparing it with the non-negative net worth constraint (6.1), it follows that the new loans of the banks are equal to the deposits minus the bad loans in all periods prior to period $T-1$:

$$L_t = D_t - B_t,\ \text{for } t < T-1.$$

Finally, it remains to determine the amount of new loans in the period prior to the bailout. The insurance scheme implies that only domestic deposits will be paid back when the bailout occurs. Therefore, in the period prior to the bailout,

$$D_{T-1} \leq S_{T-1}.$$

Consequently

$$L_{T-1} \leq S_{T-1} - B_{T-1}.$$

Summarizing, in all periods except period $T-1$, the banks' lending and borrowing capacity is not affected by the bad loans. They can take as many deposits and make as many loans as they find optimal. Because of perfect competition, the return on the loans is equal to the deposit rate, i.e., the world interest rate. In period $T-1$ banks are constrained in the amount of deposits they can take, because the government's bailout policy implies that only domestic deposits will be repaid. This may create a shortage of loanable funds, and consequently the rate of return on loans may be higher.

6.1.2 The Government

I assume that when the government conducts the bailout, it repays in full only the domestic depositors. In particular, the rate of return on foreign deposits is below the world interest rate. The government's budget constraint is:

$$G_t = \tau_t.$$

6.1.3 Resource constraint

Aggregate consumption and investment should not exceed total output:

$$c_t^Y + c_t^O + I_t + NX_t \leq F(k_t, n_t),$$

where NX_t are the net exports.

6.1.4 Net Foreign Assets

Net foreign assets in period t are given by

$$F_t = S_t - D_t.$$

6.1.5 Equilibrium

The equilibrium is defined as sequences of prices $\{p_t^k, R_t, R_t^L, w_t\}$, quantities $\{k_{t+1}, k_t^E, I_t, n_t, c_t^Y, c_t^O, S_t, L_t, D_t\}$, and a government policy $\{\tau_t\}$ such that,

- the government policy is feasible: $\tau_t \leq w_t$ for all t; the government's budget constraint holds;

and given prices and the government policy:

- consumption and savings sequences solve the households' problem in each period;
- capital, labor and loan sequences solve the entrepreneurs' problem in each period;
- savings and loan sequences solve the banks problem in each period;
- markets clear in each period:

$$\begin{aligned} c_t^Y + c_t^O + I_t + NX_t &= F(k_t, n_t); \\ n_t &= 1; \\ k_t^E &= (1-\delta)k_t. \end{aligned}$$

6.1.6 The steady state

In the steady state there are no bad loans; taxes and transfers to the banks are zero. I assume that the parameters of the model are such that in the steady state net foreign assets are zero:

$$\begin{aligned} F_k(k^{ss}, 1) &= R^W - 1 + \delta; \\ k^{ss} &= S^{ss}. \end{aligned}$$

6.2 The Dynamics of the Economy

Initially, the economy's capital stock is at its steady state level. At date zero, unexpectedly, a fraction q of entrepreneurs does not pay back the amount borrowed from the banks. The difference between expected and actual amount received back by the banks are the bad loans:

$$B_0 = qR^{ss}k^{ss}.$$

Figure 6.1 shows the dynamics of the economy when the government postpones the bailout. To understand the dynamics of the economy it is useful to start from characterizing its behavior in the period of the bailout. After the government's intervention the bad loans problem will be eliminated, and the banks will use new deposits only to finance new loans. Therefore, from that period on, the economy will behave as in the standard case. There will be positive investment equating the capital stock to its steady state level, and the price of capital will be 1:

$$\begin{matrix} k_{t+1} = k^{ss} \\ p_t^k = 1 \end{matrix} \quad \text{for } t \geq T.$$

In the period prior to the bailout the banks' deposits are limited by the amount of domestic savings, S_{T-1}, and consequently the loans are limited by the amount of deposits the banks can collect minus the bad loans, $S_{T-1} - B_{T-1}$. If the latter amount is small enough, the market clearing price of capital will be low. In fact, if

$$\frac{S_{T-1} - B_{T-1}}{(1-\delta)^T k^{ss}} < 1, \tag{6.3}$$

then p_{T-1}^k is less than one. This is because the lower bound on the capital stock at the end of period $T-1$ is $(1-\delta)^T k^{ss}$ (it is the economy's capital stock if there is zero investment from period zero until period $T-1$), and therefore

$$p_{T-1}^k \leq \frac{S_{T-1} - B_{T-1}}{(1-\delta)^T k_{ss}}.$$

Assuming that condition (6.3) holds, the price of capital in period $T-1$ will be less than 1.

The future low price of capital implies a lower return on capital. This in turn implies that the price of capital and the capital stock may be declining until period $T-1$. The basic reason is as follows. In all periods prior to $T-1$, since the banks are not constrained in the amount of deposits they can collect, the rate of return on loans must be equal to the world interest rate:

$$R^W = \frac{1}{p_t^k}[F_k(k_{t+1},1) + (1-\delta)p_{t+1}^k],\ t < T-1. \tag{6.4}$$

When the future price of capital is low, for the return on capital to remain equal to the world interest rate one of the following must happen: either the capital stock must decline so that the rise in the marginal product of capital offsets the fall in the future price of capital, or the current price of capital must fall. What happens exactly depends on how low the capital can be in the next period. Under the irreversibility assumption, the lower bound on k_{t+1} is given by $(1-\delta)k_t$. If

$$F_k((1-\delta)k_t,1) + (1-\delta)p_{t+1}^k < R^W,$$

a decline in capital will not be enough for (6.4) to hold. Therefore the price of capital must decline too. That is, to induce the entrepreneurs to buy the existing stock of capital, the price of capital must decline to equate the return on capital to the world interest rate:

$$\begin{aligned} k_{t+1} &= (1-\delta)k_t; \\ p_t^k &= \frac{1}{R^W}\left[F_k(k_{t+1},1) + (1-\delta)p_{t+1}^k\right] < 1. \end{aligned}$$

Thus, as long as the future price of capital is sufficiently low, the price of capital and the capital stock will be falling. The decline in the price of capital and in the capital stock imply that the demand for loans declines, which lowers the amount of deposits the banks collect. Savings decline because wages fall. It can be the case that the rate of decline of savings is small relative to the rate of decline of deposits, and therefore some of domestic savings are deposited abroad (see Figure 6.2).

Summarizing, the limited availability of funds in the future implies a lower demand for capital, and therefore a lower price of capital, which results in capital losses. This effect exerts a downward pressure on the rate of return on capital, causing entrepreneurs to reduce their holdings of capital, and the price of capital to fall. On the other hand, the households' savings remain high relative to the value of capital purchases by entrepreneurs, creating an outflow of funds.

The irreversibility of capital plays an essential role in this model. With fully reversible capital, the investment in this economy would fall only in one period: $T-1$, when the amount of banks loans is constrained by domestic savings minus the bad loans. However, in earlier periods, since the price of capital is always one in this case, there will be no capital losses, and therefore, for the return on capital to remain equal to the world interest rate, the capital stock must remain constant.

In this economy there is only one period in which the rate of return on loans exceeds the world interest rate: the period prior to the bailout, when the existing banks face a limit in the amount of funds they can raise. In all other periods the lending rates coincide with the world interest rate. Therefore, the no entry assumption used in the model will not be violated if these profits are lower then an implied sunk cost of entry into the banking sector. In a more complex environment than it is considered here, banks are multi-period lived establishments, and the entry into the banking sector is determined by comparing the cost of entry with the net present value of profits in all future periods. Therefore, the overall (actual and projected) profitability of Japan's banking sector is an important determinant of whether, under the scenarios considered above, the number of banks would expand or not. As I have argued in Section 2, as long as the massive reduction in the number of operating banks does not occur, the profits in the banking sector will remain low or even negative. Based on these observations, one may conclude that even if there could be benefits for an entrant from being "at the right place at the right time", the overall conditions of Japan's banking sector suggest that the entry may not be profitable after all[47].

The asymmetric deposit insurance[48] plays a key role in the analysis. If the deposit guarantees were to cover all deposits, in the model above the recession could not occur: in the period prior to the bailout there is an incentive for the banks to borrow from abroad and increase the lending to the entrepreneurs until the rate of return on loans becomes equal to the world interest rate. Consequently, in the period prior to the bailout there will be positive investment and the price of capital will be one. By backwards induction, the price of capital and the stock of capital will remain at the steady state level in all prior periods.

Finally, the results of this section would remain valid if one dropped Assumptions A) and B), but assumed instead that the government finances the bailout by taxing capital (or banks) in the period of the bailout. Indeed, the rate of return on capital in the period prior to the bailout may then be low enough, so that there is no incentive for opening new banks nor there is an incentive for existing banks to raise more funds.

[47] The opinion that entry into the Japanese financial sector would not be beneficial prior to the recovery of domestic banks has been expressed, for example, by Analytica Japan. See "Entry into Japanese Financial Services", (1998).

[48] The Japan's premium occurred in the late 1990s is a strong evidence that the world markets perceive that if the comprehensive government intervention has to occur, foreign obligations of the banks may not be honored in full. Also, the new deposit insurance set to take effect in March 2003 explicitly states that the guarantees do not extend to banks' foreign obligations (see Appendix E for the Scope of Deposit Insurance).

7 Conclusion

This paper argued that the delay in the government bailout of the financial sector forces the banks to take the resources of the economy away from investment financing. Consequently, the economy falls into a prolonged recession. The latter is characterized by declines in output, investment, price of capital, productivity, and number of operating firms. These features are consistent with Japan's experience over the last decade. The results of the paper do not rely on inability of firms to finance profitable investment projects. This is consistent with recent empirical studies (e.g., Hayashi and Prescott (2002)).

Calibrating the model to Japanese data I showed that the delay in the government bailout contributes significantly to Japan's slowdown.

I investigated the implications of the delay in the government bailout in an open economy setting. I showed that the recession caused by the delay in the bailout can be accompanied by an increase in foreign asset holdings of the domestic economy. This is consistent with Japan's recent experience.

As a final remark, this paper does not reject the possibility that other forces may have been contributing to Japan's slowdown. Most importantly, driven by the fact that investment financing in Japan was not constrained, I abstracted from the bank-borrower relationship. Closer studies of this relation in a general equilibrium framework may reveal additional channels through which the bad loans cause a fall in economic activity, not necessarily inconsistent with unconstrained investment.

Appendix

A The Interest Rate with Logarithmic Preferences

With logarithmic preferences, the savings are given by the following expression:

$$S_t = \frac{\beta}{1+\beta}(1-\alpha)k_t^{\alpha}.$$

From the entrepreneurs' FOC I have that:

$$F_k(k_{t+1}, 1) = R_{t+1}p_t^k - (1-\delta)p_{t+1}^k.$$

Substituting for the price of capital from the capital market clearing condition: $p_t^k = \frac{L_t}{k_{t+1}}$, and noting that $R_{t+1}L_t - L_{t+1} = R_{t+1}S_t - S_{t+1}$ I get that

$$F_k(k_{t+1}, 1) = R_{t+1}\frac{L_t}{k_{t+1}} - \frac{(1-\delta)L_{t+1}}{k_{t+2}} = \frac{R_t S_t - S_{t+1}}{k_{t+1}};$$

and therefore:

$$R_{t+1} = \frac{F_k(k_{t+1}, 1)k_{t+1} + S_{t+1}}{S_t} = \frac{\alpha+\beta}{(1-\alpha)\beta}(1-\delta)^{\alpha}.$$

Note that this interest rate can be lower then in the steady state. Indeed, the steady state interest rate is given by

$$R^{ss} = \frac{\alpha+\beta}{(1-\alpha)\beta} - \delta.$$

Thus if :

$$\frac{\alpha+\beta}{(1-\alpha)\beta}(1-\delta)^{\alpha} < \frac{\alpha+\beta}{(1-\alpha)\beta} - \delta,$$

then $R_{t+1} < R^{ss}$. This relation is true for a wide range of parameters. For example, $\alpha > .33$, $\beta < .4$, and $\delta > .3$.

B The Relation Between Entrepreneurial Productivity and the TFP

In this Appendix I establish a link between the entrepreneurs' average productivity and a conventional measure of total factor productivity: the Solow residual. Following Lucas (1978) and Atkeson and Kehoe (1995) I treat the entrepreneurs as part of aggregate labor:

$$N_{t+1}^{\mathrm{AG}} = \mu_{t+1} + N_{t+1}.$$

This implies that the share of capital in the model must be equal to that in the data, and the shares of workers and entrepreneurs must add up to the share of labor in the data.

Therefore, according to the model, the Solow residual is given by:

$$S_{t+1} = \frac{Y_{t+1}}{K_{t+1}^{\alpha\gamma}[\mu_{t+1} + N_{t+1}]^{1-\alpha\gamma}} = A_{t+1}^{1-\gamma} \frac{\mu_{t+1}^{1-\gamma} N_{t+1}^{(1-\alpha)\gamma}}{[\mu_{t+1} + N_{t+1}]^{1-\alpha\gamma}}.$$

Linearizing around the steady state, leads to the following expression:

$$\hat{S}_{t+1} = (1-\gamma)\hat{A}_{t+1} + c_0[\hat{N}_{t+1} - \hat{\mu}_{t+1}],$$

where $\hat{X}_{t+1}$ denotes the percentage deviation of the variable X from its steady state value, and c_0 is a constant which depends on the parameters γ and α as well as on the ratio of entrepreneurs to workers in the steady state. Thus, the movements in the Solow residual reflect changes in the average productivity of entrepreneurs, as well as changes in the ratio of entrepreneurs to workers.

C The Quantitative Model

C.1 Households

The households' utility function is

$$u_t(\cdot) = \left\{ \begin{array}{l} \log(\cdot) \text{ if alive in period } t \\ 0 \text{ otherwise} \end{array} \right\}.$$

With this utility function maximizing expected utility is equivalent to maximizing the following expression:

$$\max p \sum_{s=t}^{\infty} [\beta(1-p)]^{s-t} \log c_s.$$

The budget constraint is given by

$$v_{s+1} + c_s = R_s[1 + \frac{p}{1-p}]v_s + y_s;$$

where R_s is the interest rate in the period s; v_s (non-human) wealth, y_s is the labor income, and c_s is the consumption. The term $R_s \frac{p}{1-p} v_s$ is the premium received from the insurance companies.

Denote households' effective discount factor as $R(t,s)$:

$$R(t,s) = \left\{ \begin{array}{ll} \frac{[1-p]^{s-t}}{\prod_{m=t+1}^{s} R_m^H} & \text{if } s \geqslant t+1 \\ 1 & \text{if } s = t \end{array} \right\}.$$

Then, the transversality condition is given by

$$\lim_{s\to\infty} R(t,s) v_s = 0$$

Consequently, the households' intertemporal budget constraint can be written as:

$$\sum_{s=t}^{\infty} c_s R(t,s) = \frac{R_t}{1-p} v_t + h_t;$$

where h_t denotes the human wealth of the household in period t :

$$h_t = \sum_{s=t}^{\infty} y_s R(t,s).$$

FOC of the households' problem imply that:

$$c_t = [1-\beta[1-p]]\,[\frac{R_t}{1-p} v_t + h_t].$$

Next step is to derive dynamic behavior of aggregate consumption, and aggregate wealth:

$$\begin{aligned} C_t &= p \sum_{s=-\infty}^{t} c(s,t)[1-p]^{t-s}; \\ V_{t+1} &= p \sum_{s=-\infty}^{t} v(s,t+1)[1-p]^{t-s}; \\ W_t &= p \sum_{s=-\infty}^{t} h(s,t)[1-p]^{t-s}; \end{aligned}$$

where (s,t) refers to the household born on date s and present at date t. FOC of the households' problem can be aggregated directly:

$$C_t = [1-\beta(1-p)][R_t V_t + W_t].$$

Finally, non-human wealth accumulation equation is given by:

$$V_{t+1} = R_t V_t + \bar{w}_t - C_t.$$

where $\bar{w}_t = w_t - \tau_t$ is aggregate after tax labor income, w_t is the wage, and τ_t is the labor tax.

To capture the idea of the retirement it is assumed that the share of labor income of the household born in generation t in period s is given by:

$$y(s,t) = \bar{w}_t \left(a_1[1-\theta_1]^{t-s} + a_2[1-\theta_2]^{t-s}\right)$$

where $a_1 < 0, a_2 > 0$, $0 < \theta_1 < \theta_2 < 1$, and[49]

$$1 = \frac{a_1 p}{\theta_1 + p - \theta_1 p} + \frac{a_2 p}{\theta_2 + p - \theta_2 p}.$$

Then

$$h(s,t) = [1-\alpha]^{t-s} \sum_{z=t}^{\infty} \bar{w}(z)[a_1[1-\theta_1]^{z-t} + a_1[1-\theta_2]^{z-t}]R(t,z).$$

Denote $W_{1,t}$ and $W_{2,t}$ the following quantities:

$$\begin{aligned} W_{1,t} &= \sum_{s=-\infty}^{t} a_1 p[[1-p][1-\theta_1]]^{t-s} \sum_{z=t}^{\infty} \bar{w}(z)[1-\theta_1]^{z-t} R(t,z) = \\ &= \frac{a_1 p}{\theta_1 + p - \theta_1 p} \sum_{z=t}^{\infty} \bar{w}(z)[1-\theta_1]^{z-t} R(t,z). \\ W_{2,t} &= \frac{a_2 p}{\theta_2 + p - \theta_2 p} \sum_{z=t}^{\infty} \bar{w}(z)[1-\theta_2]^{z-t} R(t,z). \end{aligned}$$

The dynamics of $W_{1,t}$ and $W_{2,t}$ is given by:

$$\begin{aligned} W_{1,t+1} &= \frac{R_{t+1}}{[1-\theta_1][1-p]}[W_{1,t} - \frac{a_1 p}{\theta_1 + p - \theta_1 p}\bar{w}_t]. \\ W_{2,t+1} &= \frac{R_{t+1}}{[1-\theta_2][1-p]}[W_{2,t} - \frac{a_2 p}{\theta_2 + p - \theta_2 p}\bar{w}_t] \end{aligned}$$

Then

$$W_t = W_{1,t} + W_{2,t}.$$

To summarize the aggregate behavior of the households in this economy is characterized by the following system of equations:

$$\begin{aligned} &C_t = [1-\beta(1-p)][R_t V_t + W_{1,t+1} + W_{2,t+1}]; \\ &V_{t+1} = R_t V_t + \bar{w}_t - C_t; \\ &W_{1,t+1} = \tfrac{R_{t+1}}{[1-\theta_1][1-p]}[W_{1,t} - \tfrac{a_1 p}{\theta_1+p-\theta_1 p}\bar{w}_t]. \\ &W_{2,t+1} = \tfrac{R_{t+1}}{[1-\theta_2][1-p]}[W_{2.t} - \tfrac{a_2 p}{\theta_2+p-\theta_2 p}\bar{w}_t] \end{aligned}$$

[49] By definition, aggregate labor income is given by:

$$\begin{aligned} \bar{w}_t &= p \sum_{s=-\infty}^{t} y(s,t)[1-p]^{t-s} \Longrightarrow \\ 1 &= p \sum_{s=-\infty}^{t} \left(a_1[1-\theta_1]^{t-s} + a_2[1-\theta_2]^{t-s}\right)[1-p]^{t-s} \\ 1 &= \frac{a_1 p}{1-[1-\theta_1][1-p]} + \frac{a_2 p}{1-[1-\theta_2][1-p]} \\ 1 &= \frac{a_1 p}{\theta_1 + p - \theta_1 p} + \frac{a_2 p}{\theta_2 + p - \theta_2 p}. \end{aligned}$$

C.2 Entrepreneurs

Economy is populated by a continuum of exante identical profit maximizing agents: potential entrepreneurs. To become an entrepreneur each of the latter must pay a fixed cost ψ. After the cost is paid, each entrepreneur gains access to a set of projects $\{j\}$ distributed with density g over $[0,1]$. The projects differ by their productivity, given by a parameter $a(j)$. For each project the entrepreneur decides to undertake she must borrow to buy capital and investment goods. In the next period the entrepreneur hires labor for each project, produces, sells her capital (net of depreciation), pays back her debt and retires.

The production function of an entrepreneur is given by:

$$a^{1-\gamma}\left[F(k,n)\right]^{\gamma},$$

where $F(k,n)=k^{\alpha}n^{1-\alpha}$, k and n are capital and labor respectively. Parameter γ determines the degree of diminishing returns to scale in capital and labor. Entrepreneurs capital in the next period for each project it decides to undertake is given by the following relationship:

$$k_{t+1}(j)=k_t^E(j)+\eta_0[I_t(j)]^{\eta}[k_t^E(j)]^{1-\eta}-\phi,$$

where $k_t^E(j)$ is the amount of capital stock entrepreneur has purchased for project j, $I_t(j)$ is the investment and ϕ is a fixed operating cost.

Consider a decision of an entrepreneur whether to activate project j or not. If she decides to undertake project j, her profits are

$$\begin{aligned}
\pi_{t+1}^P(j) &= \max_{L_t,k_t,I_t,n_{t+1}}\left[a(j)\right]^{1-\gamma}\left[k_{t+1}^{\alpha}n_{t+1}^{1-\alpha}\right]^{\gamma}-R_{t+1}^K L_t-w_{t+1}n_{t+1}+(1-\delta)p_{t+1}^k k_{t+1},\\
L_t &= p_t^k k_t^E+I_t;\\
k_{t+1} &= k_t^E+\eta_0 I_t^{\eta}(k_t^E)^{1-\eta}-\phi.
\end{aligned}$$

where p_t^k is the price of capital, and $R_{t+1}^K=\frac{R_{t+1}-1}{1-\tau_{t+1}^K}+1$. The decision to produce or not depends on whether π_{t+1}^P is positive or not, that is the profits from j^{th} project are

$$\pi_{t+1}^E(j)=\max\{\pi_{t+1}^P(j),0\}$$

Lastly, free entry implies that in equilibrium a potential entrepreneur must be indifferent between becoming an entrepreneur or not. Therefore, the cost of entry ψ must be equal to the expected profits:

$$\psi=\frac{1}{R_{t+1}^K}\int_0^1\pi_{t+1}^E(j)g(j)dj. \tag{C.1}$$

Note, that problem of the entrepreneur with regard to j^{th} project admits the following representation[50]:

$$\max_{k_t, I_t, L_t, n_{t+1}} \{[a(j)]^{1-\gamma}\left[k_{t+1}^{\alpha} n_{t+1}^{1-\alpha}\right]^{\gamma} - R_{t+1}^{K}(L_t^k + L_t^{\phi}) - w_{t+1}n_{t+1} + (1-\delta)p_{t+1}^k k_{t+1}\}$$

$$\begin{array}{ll}
L_t^k = p_t^k k_t^k + I_t^k; & \mu_t^k \\
L_t^{\phi} = p_t^k k_t^{\phi} + I_t^{\phi}; & \mu_t^{\phi} \\
k_{t+1} = k_t^k + h\left(\frac{I_t^k}{k_t^k}\right) k_t^k; & \lambda_t^k \\
\phi = k_t^{\phi} + h\left(\frac{I_t^{\phi}}{k_t^{\phi}}\right) k_t^{\phi}. & \lambda_t^{\phi}
\end{array}$$

where $h(x) = \eta_0 x^{\eta}$, and μ_t^i, λ_t^i, $i = k, \phi$ are the Lagrange multipliers associated with respective constraints.

The entrepreneurs first order conditions are:

$$\begin{aligned}
\alpha\gamma\,[a(j)]^{1-\gamma}\left[k_{t+1}^{\gamma\alpha-1} n_{t+1}^{\gamma(1-\alpha)}\right] + p_{t+1}^k(1-\delta) &= \lambda_t^k; \\
R_{t+1}^K - \mu_t^i &= 0; \\
\lambda_t^i(1 + H_{k,t}) - \mu_t^i p_t^k &= 0; \\
\lambda_t^i H_{I,t} - \mu_t^i &= 0; \\
(1-\alpha)\gamma\,[a(j)]^{1-\gamma}\left[k_{t+1}^{\gamma\alpha} n_{t+1}^{\gamma(1-\alpha)-1}\right] - w_{t+1} &= 0;
\end{aligned}$$

where $i = k, \phi$. Further, from FOC directly follows that

$$\begin{aligned}
\alpha\gamma\,[a(j)]^{1-\gamma}\left[k_{t+1}^{\gamma\alpha-1} n_{t+1}^{\gamma(1-\alpha)}\right] + p_{t+1}^k(1-\delta)k_{t+1} &= R_{t+1}^K k_{t+1}\frac{1}{H_{I,t}}; \\
\frac{(1 + H_{k,t})}{H_{I,t}} &= p_t^k.
\end{aligned}$$

Let me prove that:

$$p_t^k\left[k_{t+1}^k \frac{1}{1 + H_{k,t}} - k_t^k\right] = I_t^k.$$

[50] This directly follows from the linear homogeneity of the function H. Indeed, denote $x_{\phi} = \frac{\phi_t}{k_{t+1}+\phi_t}$. Then,

$$\begin{aligned}
k_{t+1} + \phi_t &= k_t + I_t^{\eta} k_t^{1-\eta} = \\
&= \left[\left(1 - x_{\phi}\right) k_t + \left(1 - x_{\phi}\right) I_t^{\eta} k_t^{1-\eta}\right] + \left[x_{\phi} k_t + x_{\phi} I_t^{\eta} k_t^{1-\eta}\right] = \\
&= \left[(1 - x_{\phi})k_t + \left[(1 - x_{\phi})k_t\right]^{\eta}\left[(1 - x_{\phi})I_t\right]^{1-\eta}\right] + \left[x_{\phi} k_t + \left[x_{\phi} k_t\right]^{\eta}\left[x_{\phi} I_t\right]^{1-\eta}\right].
\end{aligned}$$

Indeed,

$$\begin{aligned}
p_t^k\left[k_{t+1}^k\frac{1}{1+H_k}-k_t^k\right] &= I_t^k;\Longleftrightarrow\\
p_t^k\left[\frac{k_{t+1}^k-k_t^k-\eta H(I_t^k,k_t^k)}{1+H_{k,t}}\right] &= I_t^k;\Longleftrightarrow\\
p_t^k\left[\frac{k_{t+1}^k-k_t^k-(1-\eta)H(I_t^k,k_t^k)}{1+H_{k,t}}\right] &= I_t^k;\Longleftrightarrow\\
p_t^k\left[\frac{\eta H(I_t^k,k_t^k)}{1+H_{k,t}}\right] &= I_t^k;\Longleftrightarrow\\
p_t^k\left[\frac{H_{I,t}}{1+H_{k,t}}\right] &= 1.
\end{aligned}$$

Therefore,

$$\begin{aligned}
L_t^k &= p_t^k k_t^k + I_t^k = p_t^k k_{t+1}^k\frac{1}{1+H_k} = k_{t+1}^k\frac{1}{H_{I,t}};\\
R_{t+1}^K L_t^k &= \alpha\gamma\,[a(j)]^{1-\gamma}\left[k_{t+1}^{\gamma\alpha-1}n_{t+1}^{\gamma(1-\alpha)}\right]+p_{t+1}^k(1-\delta)k_{t+1}.
\end{aligned}$$

Denote $y_{t+1}(j)$ the output from the j^{th} project. The entrepreneur's of output (gross of the fixed cost) is $(1-\gamma)y_{t+1}(j)$.

Entrepreneur will produce with this project if

$$(1-\gamma)y_{t+1}(j)\geq R_{t+1}^K L_t^{\phi} = R_{t+1}\frac{\phi}{H_{I,t}}. \tag{C.2}$$

Then, the zero profit condition (C.1) can be written as

$$\int_{J_{t+1}}^{1}\left[(1-\gamma)y_{t+1}(j)-R_{t+1}^K\frac{\phi}{H_{I,t}}\right]g(j)di=\psi R_{t+1}^K; \tag{C.3}$$

where J_{t+1} is the cutoff above which the entrepreneurs will produce

$$(1-\gamma)y_{t+1}(J_{t+1}) = R_{t+1}^K\frac{\phi}{H_{I,t}}. \tag{C.4}$$

Note that similar to Section 4 can be rewritten as

$$\frac{1}{a(J_{t+1})}\int_{J_{t+1}}^{1}a(j)g(j)dj-\int_{J_{t+1}}^{1}g(j)dj=\frac{\psi}{\phi}H_{I,t}.$$

Next, due to the same reasoning as in section 4, the FOC with respect to capital and the cutoff equation (C.4) can be written as

$$\begin{aligned}
R_{t+1}^K &= H_{I,t}\left[\alpha\gamma\left[\nu_{t+1}\int_{J_{t+1}}^1 a(j)g(j)dj\right]^{1-\gamma}K_{t+1}^{\alpha\gamma-1}+p_{t+1}^k(1-\delta)\right],\\
R_{t+1}^K &= \tfrac{(1-\gamma)H_{I,t}}{\phi}a(J_{t+1})\left[\nu_{t+1}\int_{J_{t+1}}^1 a(j)g(j)dj\right]^{-\gamma}K_{t+1}^{\alpha\gamma}.
\end{aligned}$$

Finally, because of the linear homogeneity of the function H, the aggregate capital accumulation is given by:

$$K_{t+1} = (1-\delta)K_t + H(I_t, (1-\delta)K_t) - \phi\nu_{t+1} \int_{J_{t+1}}^{1} g(j)dj.$$

To summarize, the entrepreneurs' problem gives rise to the following relations:

$$\begin{aligned}
&R_{t+1}^K = H_{I,t}\left[\alpha\gamma\left[\nu_{t+1}\int_{J_{t+1}}^1 a(j)g(j)dj\right]^{1-\gamma} K_{t+1}^{\alpha\gamma-1} + p_{t+1}^k(1-\delta)\right]\\
&R_{t+1}^K = \frac{(1-\gamma)H_{I,t}}{\phi}a(J_{t+1})\left[\nu_{t+1}\int_{J_{t+1}}^1 a(j)g(j)dj\right]^{-\gamma} K_{t+1}^{\alpha\gamma}\\
&K_{t+1} = (1-\delta)K_t + H(I_t, (1-\delta)K_t) - \phi\nu_{t+1}\int_{J_{t+1}}^1 g(j)dj\\
&\psi = \frac{1}{H_{I,t}}\phi[\frac{1}{a(J_{t+1})}\int_{J_{t+1}}^1 a(j)g(j)dj - \int_{J_{t+1}}^1 g(j)dj]\\
&p_t^k = \frac{1+H_{k,t}}{H_{I,t}}.
\end{aligned}$$

C.3 Banks

The banks in the model are identical to the ones in the benchmark model, which results in the following: the interest rate on deposits coincides with the rate of return on loans, and the loans to entrepreneurs are equal to the deposits minus the outstanding amount of bad loans:

$$\begin{aligned}
R_{t+1}^L &= R_{t+1};\\
L_t &= D_t - B_t + G_t.
\end{aligned}$$

C.4 The Government

The government guarantees deposits to the banks and can transfer funds to the banks from current young generation. The government budget constraint is given by

$$G_t + g_t^P = \tau_t + \tau_t^{K,A}.$$

where G_t is the transfer to the banks, g_t^P is the government spending other than G_t, τ_t is the labor tax, and $\tau_t^{K,A}$ are the revenues from capital taxation.

C.5 The Interest Rate

In this model the interest rate and the rate of return on capital are related as follows:

$$R_t = (1-\tau_t^K)(R_t^K - 1) + 1.$$

C.6 Resource Constraint

The resource constraint is given by:

$$C_t + I_t + g_t^P + \nu_{t+1}\psi \leq \left[\nu_t \int_{J_t}^1 a(j)g(j)dj\right]^{1-\gamma} K_t^{\alpha\gamma}.$$

C.7 Equilibrium

Equilibrium is defined as sequences of prices $\{p_t^k, R_{t+1}, w_t\}$, quantities $\{\{k_{t+1}(j), k_t^E(j), I_t(j), n_t(j)\}_{j=[0,1]}, \{c(s,t), v(s,t+1)\}_{s\leq t}, L_t, D_t, \nu_t\}$, and the government policy $\{\tau_t, \tau_t^K, g_t^P, G_t\}$ such that,

- the government policy is feasible: $\tau_t \leq w_t$ for all t; the government's budget constraint holds;

and given prices and the government policy:

- consumption and wealth sequences solve the households' problem in each period;
- capital, labor, investment and loan sequences solve entrepreneurs' problem in each period;
- deposit and loan sequences solve the banks problem in each period;
- and markets are clear in each period:

$$
\begin{aligned}
&V_{t+1} = p_t^k(1-\delta)K_t + I_t + \nu_{t+1}\psi + B_t;\\
&C_t + I_t + g_t^P + \nu_{t+1}\psi = \left[\nu_t \int_{J_t}^1 a(j)g(j)dj\right]^{1-\gamma} K_t^{\alpha\gamma};\\
&\nu_{t+1}\int n_{t+1}(j)g(j)dj = 1;\\
&\nu_{t+1}\int_{J_{t+1}}^1 k_t^E(j)g(j)dj = (1-\delta)K_t.
\end{aligned}
$$

D The Parameter Values

Parameter[51]	Value
γ	.6666
α	.5000
δ	.89
R	1.05
θ_1	.0803
θ_2	.0800
a_1	-294.54
a_2	295.54
η_0	1.004
η	.95
ψ	.2436
ϕ	.0018
$C_{1,a}$	.00025
$C_{2,a}$	1
n_a	26
$\frac{\mu}{N}^*$	.1
$\frac{I}{Y}^*$	17%
$\frac{g^P}{Y}^*$	15%

[51] $*$ refers to the steady state values.

E Deposit Insurance System[52]

Financial Institutions covered by Deposit Insurance Corporation of Japan

Financial Institutions covered by Deposit Insurance System are:

- banks as defined in the Banking Law,
- long-term credit banks as defined in the Long-Term Credit Bank Law,
- shinkin banks, credit cooperatives,
- labor banks,
- the Shinkin Central Bank,
- the Shinkumi Federation Banks, and
- the Rokinren Bank.

Following financial institutions are not covered by Deposit Insurance System:

- overseas branches of the above financial institutions,
- government related financial institutions, and
- Japanese branches of foreign banks.

The scope of deposits and others insured under Deposit Insurance System

Deposit and others insured under Deposit Insurance System are

- Deposits,
- installment savings,
- money trusts with guaranteed principal (including loan trusts),
- and bank debentures (safe deposit products),
- as well as accumulating and asset forming products using these deposits.

Following type of deposits and others are not covered by Deposit Insurance System:

- Foreign currency deposits,

[52] From FY 2001 Version of "The New Deposit Insurance System" published by Deposit Insurance Corporation of Japan. Availalbe on-line at http://www.dic.go.jp/english/.

- negotiable certificates of deposit,
- deposits accounted for in special transaction accounts (off-shore market deposits),
- deposits from the Bank of Japan (except treasury funds),
- and member financial institutions,
- deposits from Deposit Insurance Company of Japan,
- bearer deposits,
- deposits under alias,
- money trusts with no guaranteed principal,
- and bank debentures other than safe deposit products.

The Scope of Protection

- As a special arrangement, the full amount of deposits is protected up to the end of March 2002 (by law, the special arrangement requires that an application for financial assistance and other procedures be carried out by the end of March 2002).
- After the end of the special arrangement, the guaranteed sum insured is up to maximum principal of 10 million yen per depositor per financial institution, plus (limited coverage). However, for the current deposits, ordinary savings, and specified deposits, the full amount is protected up to the end of March 2003.
- For insured deposits whose principal exceeds 10 million yen, plus interest, as well as those not covered by deposit insurance, a liquidating dividend is payable depending on the asset situation of the failed financial institution. The payments may therefore be subject to deductions.

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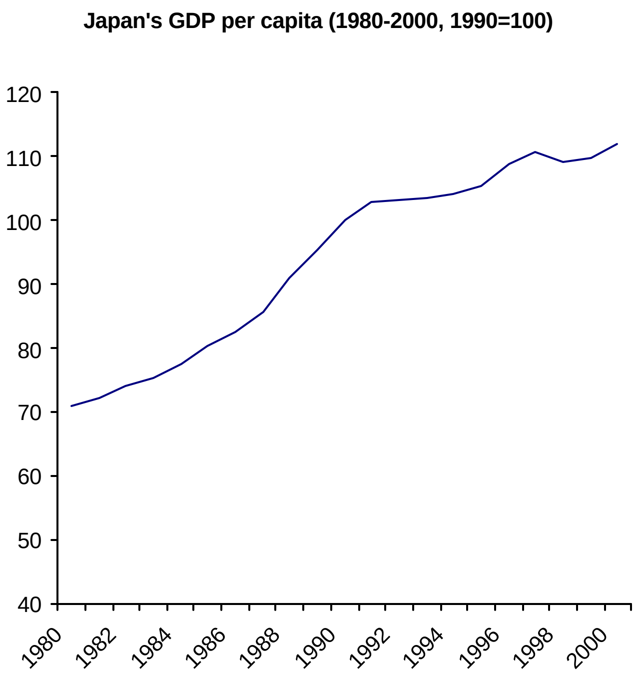
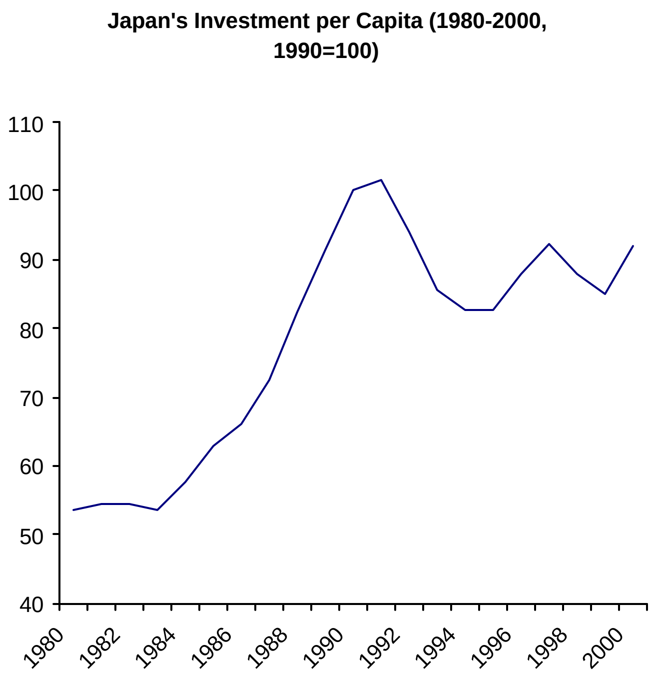
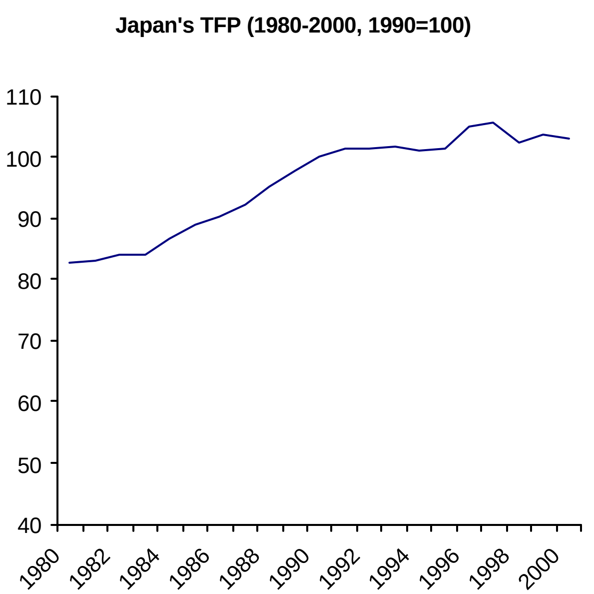
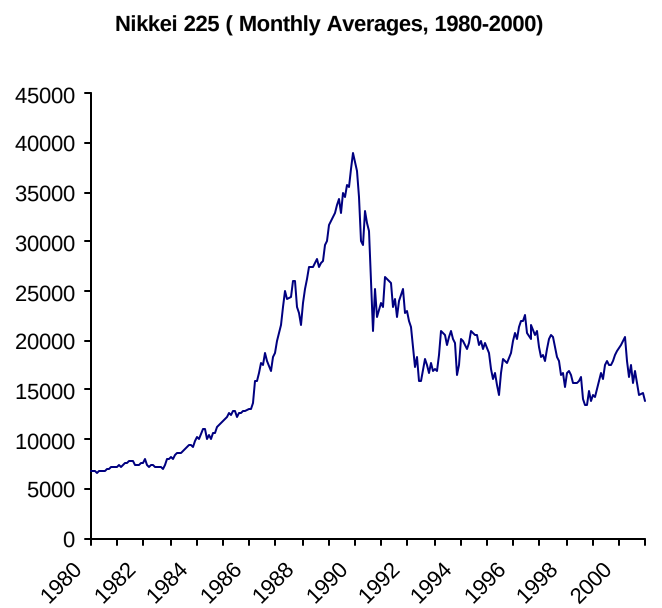
Figure 1.1 Key Economic Indicators for Japan.









Number of Business Establishments (in thousands)

1981	1986	1991	1996	1999
6291	6512	6559	6522	6203

Notes

1) GDP and Investment Data are from the National Accounts, 93SNA, population numbers are from IMF database.
2) TFP is the Solow Residual of Hayashi and Prescott (2002).
3) Nikkei 225 Index is publicly available from the Bank of Japan.
4) Number of Business Establishments is from Statistical Handbook of Japan, available on line at http://www.stat.go.jp/english/index.htm.

Table 2.1 Relative Weights of Industries, By Sector and Size of Capital

share of	all industry A	B	C	D	C+D	manufacturing A	B	C	D	C+D	non-manufacturing A	B	C	D	C+D
capital stock	1.00	0.69	0.09	0.22	**0.31**	0.41	0.34	0.03	0.05	**0.07**	0.59	0.35	0.06	0.18	**0.24**
operating profits	1.00	0.49	0.12	0.38	**0.51**	0.36	0.22	0.04	0.10	**0.15**	0.64	0.27	0.08	0.28	**0.36**
current profits	1.00	0.49	0.12	0.39	**0.51**	0.42	0.26	0.05	0.10	**0.15**	0.58	0.22	0.07	0.29	**0.36**
sales	1.00	0.40	0.16	0.44	**0.60**	0.30	0.17	0.04	0.09	**0.13**	0.70	0.24	0.12	0.35	**0.46**
Industry's contribution to GDP	1.00					0.26	0.11	see note1		**0.15**	0.74				

Size of capital: A is all sizes, B is 1 billion yen or over, C is 100 million yen to 1 billion yen, D is 10 to 100 million yen
Main figures are 1990-2002(II quarter) averages.
Note 1: break down of manufacturing sector on this line is on two groups:
with employees above 300, and the rest. The former is in column B.

Table 2.2 Bank Dependence By Sector and Size of Capital

	all industry A	B	C	D	manufacturing A	B	C	D	non-manufacturing A	B	C	D
long term bank borrowing/ total liabilities	0.26	0.21	0.25	0.31	0.20	0.12	0.21	0.34	0.28	0.25	0.27	0.30
	0.25	*0.18*	*0.21*	*0.34*	*0.19*	*0.12*	*0.19*	*0.32*	*0.28*	*0.22*	*0.22*	*0.34*
total bank borrowing/ total liabilities	0.45	0.38	0.48	0.51	0.37	0.28	0.41	0.52	0.48	0.44	0.50	0.50
	0.42	*0.34*	*0.43*	*0.50*	*0.34*	*0.26*	*0.39*	*0.49*	*0.44*	*0.37*	*0.44*	*0.50*
long term bank borrowing/ long term liabilities	0.60	0.45	0.68	0.74	0.51	0.31	0.63	0.82	0.63	0.51	0.69	0.72
	0.55	*0.39*	*0.58*	*0.72*	*0.47*	*0.30*	*0.56*	*0.75*	*0.58*	*0.43*	*0.59*	*0.71*

Size of capital: A is all sizes, B is 1 billion yen or over, C is 100 million yen to 1 billion yen, D is 10 to 100 million yen.
Main figures are 1990-2002(II quarter) averages, small italics are levels as of August 2002.

Manufacturing:	Non-manufacturing:
Food	Construction
Publishing and printing	Wholesales and retails
Chemicals	Real estate
Metal products	Transport and communications
General machinery	Electricity
Electrical machinery	Services
Transportation equipment	

Source: White Paper on Small and Medium Enterprises.
Ministry of Economy, Trade, and Industry.

FIGURE 3.1 THE EFFECT OF BAD LOANS.

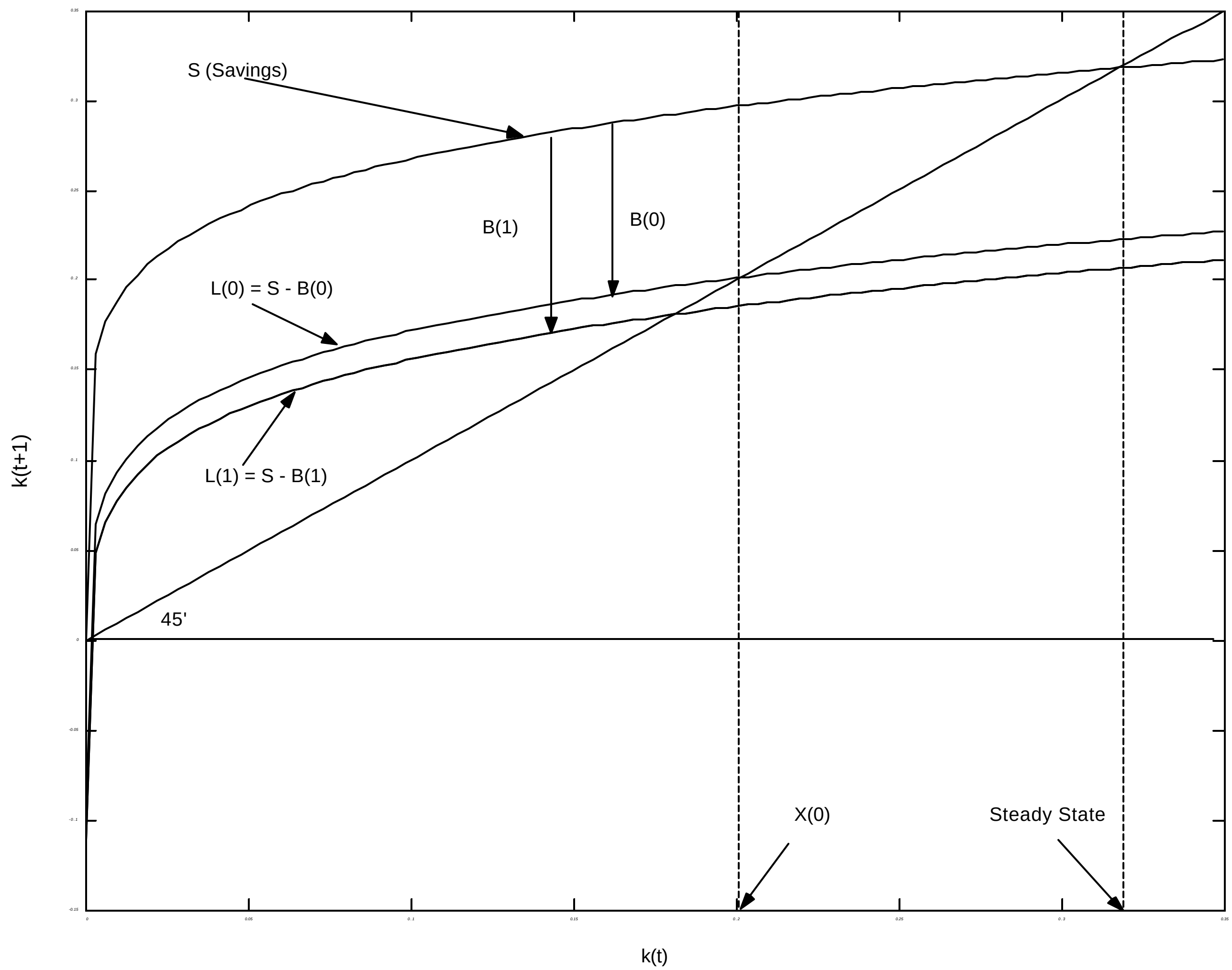


FIGURE 3.2 DELAYED BAILOUT

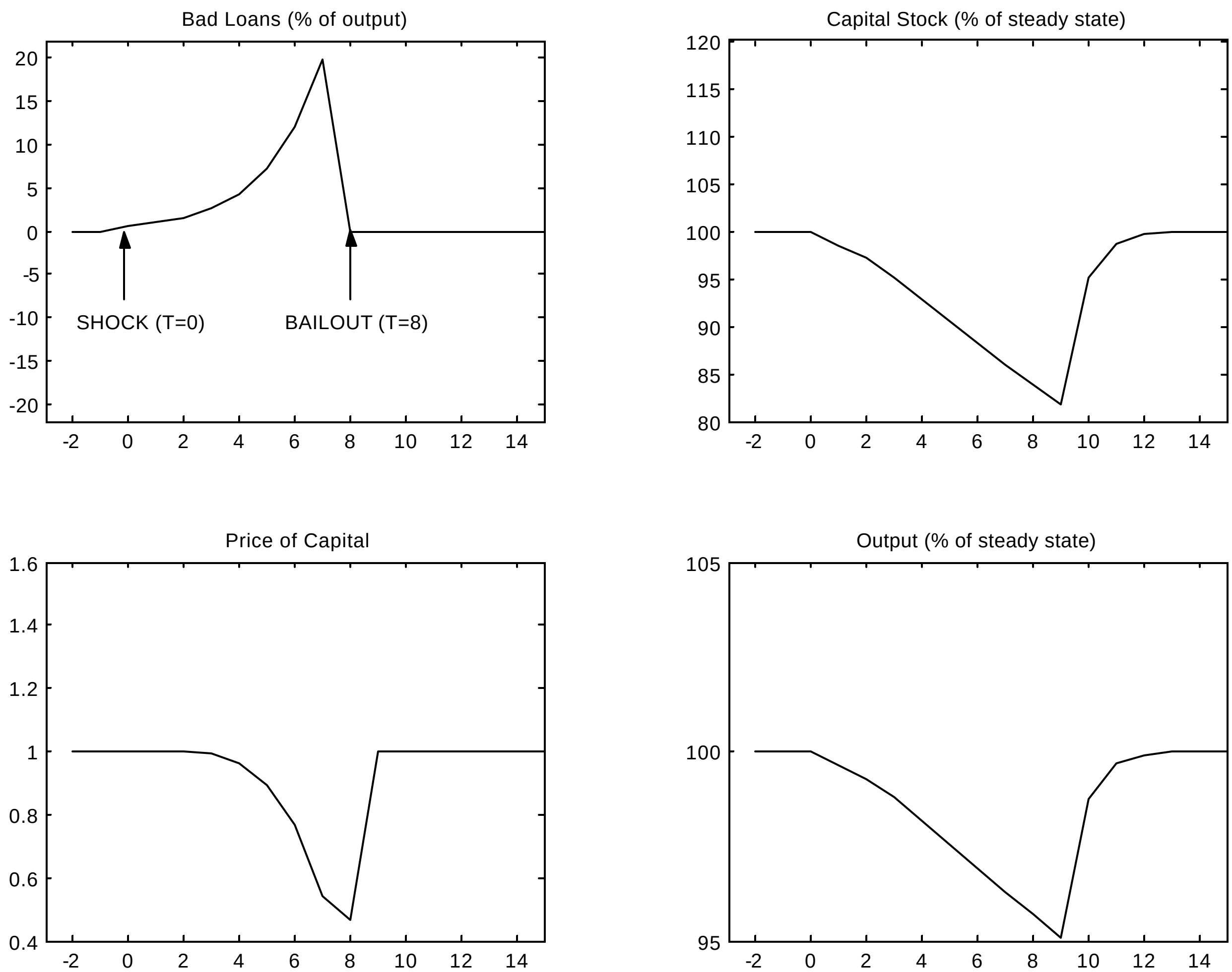
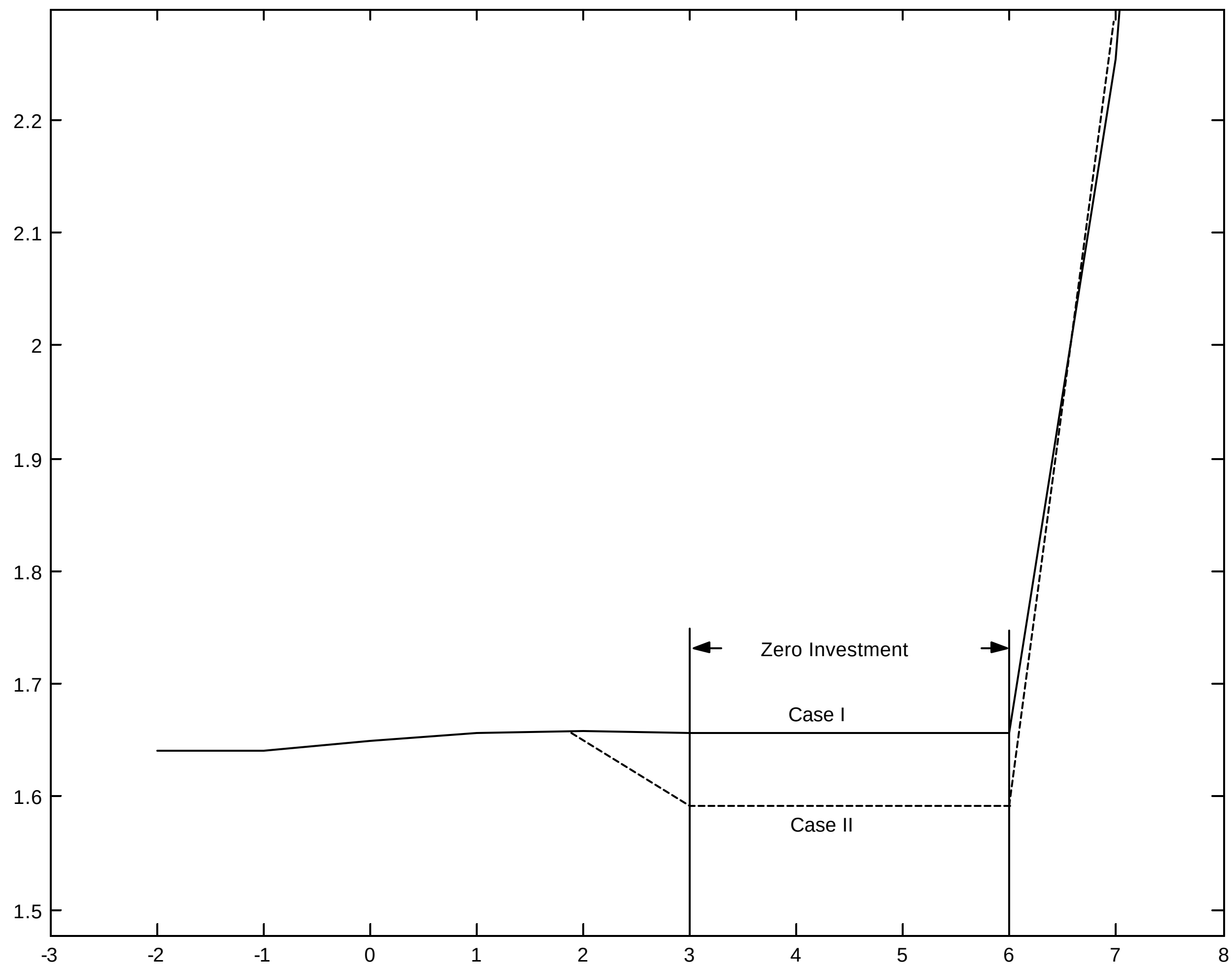


FIGURE 3.3 DELAYED BAILOUT: INTEREST RATE (log utility)



CASE I: When investment is zero, interest rate is higher than in the steady state.
CASE II: When investment is zero, interest rate is lower than in the steady state.

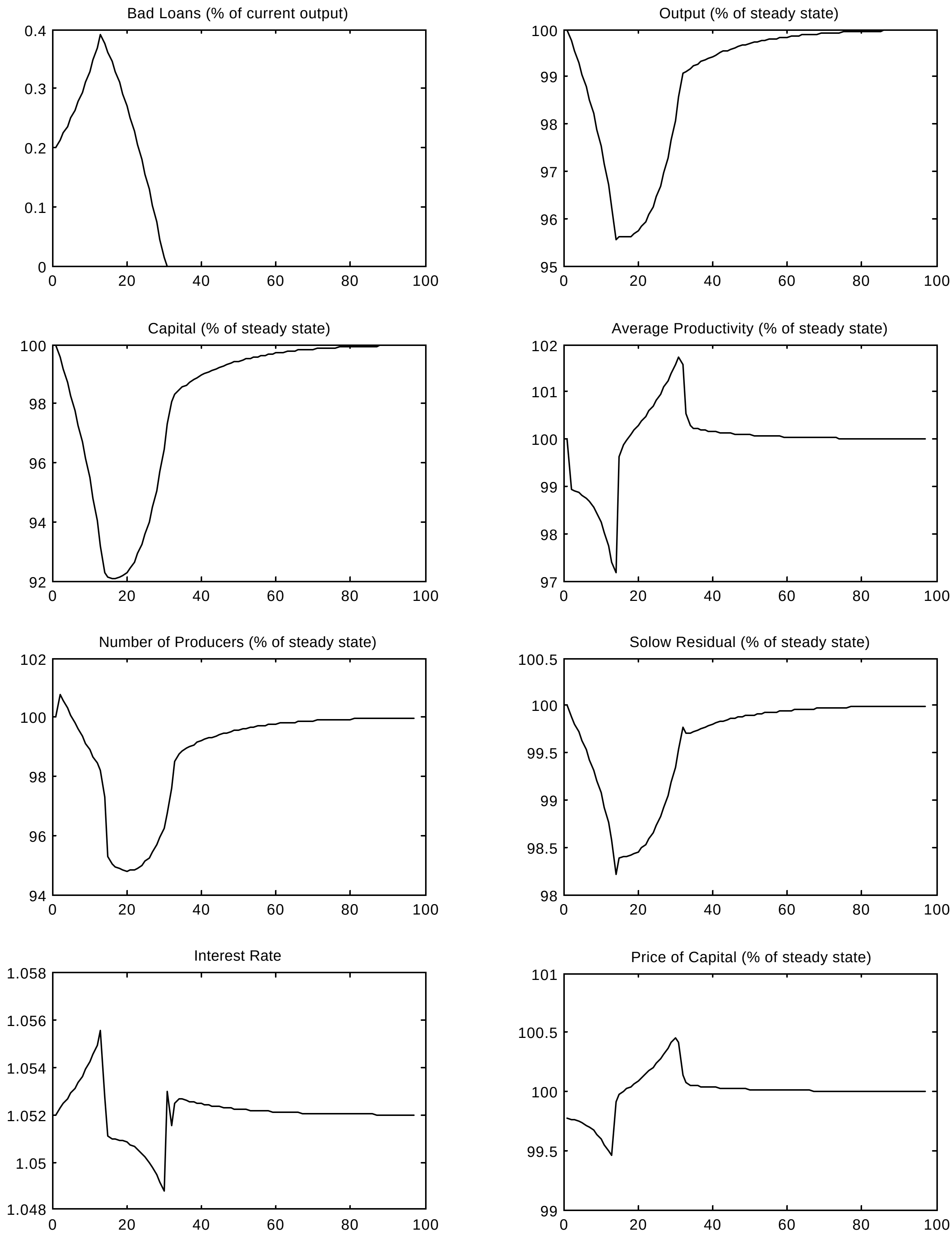


FIGURE 5.1 DELAYED BAILOUT

Table 5.1-*A* B_{T-1} =24% of GDP.

Bailout	Bailout[1]		Average Decline[2] in		*p*.	B_0
Policy	Starts	Ends	Capital	Output		Transfer[3]
P1	13	21	0.43	0.25	.024	
P2	13	21	0.41	0.24	.024	
P3	13	23	0.46	0.27	.024	
P4	13	22	0.36	**0.21**	.024	
P1	13	21	0.50	0.29	.10	
P2	13	21	0.48	0.28	.10	
P3	13	23	0.52	0.31	.10	
P4	13	22	0.44	0.26	.10	
P1	13	21	0.54	0.31	.024	No
P2	13	21	0.52	0.30	.024	No
P3	13	22	0.57	0.33	.024	No
P4	13	21	0.47	0.28	.024	No
P1	13	22	0.60	0.34	.10	No
P2	13	22	0.58	0.34	.10	No
P3	13	23	0.62	**0.36**	.10	No
P4	13	21	0.54	0.32	.10	No

Table 5.1-*B* B_{T-1} =37% of GDP.

Bailout	Bailout[1]		Average Decline[2] in		*p*.	B_0
Policy	Starts	Ends	Capital	Output		Transfer[3]
P1	13	29	.59	.34	.024	
P2	13	30	.57	.33	.024	
P3	13	35	.62	.36	.024	
P4	13	31	.52	**.30**	.024	
P1	13	29	.72	.42	.10	
P2	13	30	.70	.41	.10	
P3	13	34	.75	.43	.10	
P4	13	32	.66	.38	.10	
P1	13	29	.70	.40	.024	No
P2	13	30	.67	.39	.024	No
P3	13	36	.72	.42	.024	No
P4	13	30	.61	.36	.024	No
P1	13	29	.82	.47	.10	No
P2	13	30	.80	.46	.10	No
P3	13	34	.84	**.49**	.10	No
P4	13	31	.74	.43	.10	No

Notes

1. Periods after shock.
2. Average yearly decline, in percent.
3. ‘No’ indicates that the B_0 vanishes from the economy in the period of the shock.

Table 5.1-*C* B_{T-1} =43% of GDP.

Bailout	Bailout[1]		Average Decline[2] in		*p*.	B_0
Policy	Starts	Ends	Capital	Output		Transfer[3]
P1	13	32	.67	.37	.024	
P2	13	34	.62	.36	.024	
P3	13	39	.67	.39	.024	
P4	13	36	.56	**.33**	.024	
P1	13	33	.81	.46	.10	
P2	13	34	.79	.46	.10	
P3	13	38	.83	.48	.10	
P4	13	35	.74	.43	.10	
P1	13	34	.73	.43	.024	No
P2	13	35	.72	.42	.024	No
P3	13	39	.77	.45	.024	No
P4	13	35	.66	.38	.024	No
P1	13	34	.89	.52	.10	No
P2	13	35	.88	.51	.10	No
P3	13	39	.92	**.53**	.10	No
P4	13	36	.83	.48	.10	No

Notes

1. Periods after shock.
2. Average yearly decline, in percent.
3. 'No' indicates that the B_0 vanishes from the economy in the period of the shock.

FIGURE 6.1 DELAYED BAILOUT, OPEN ECONOMY

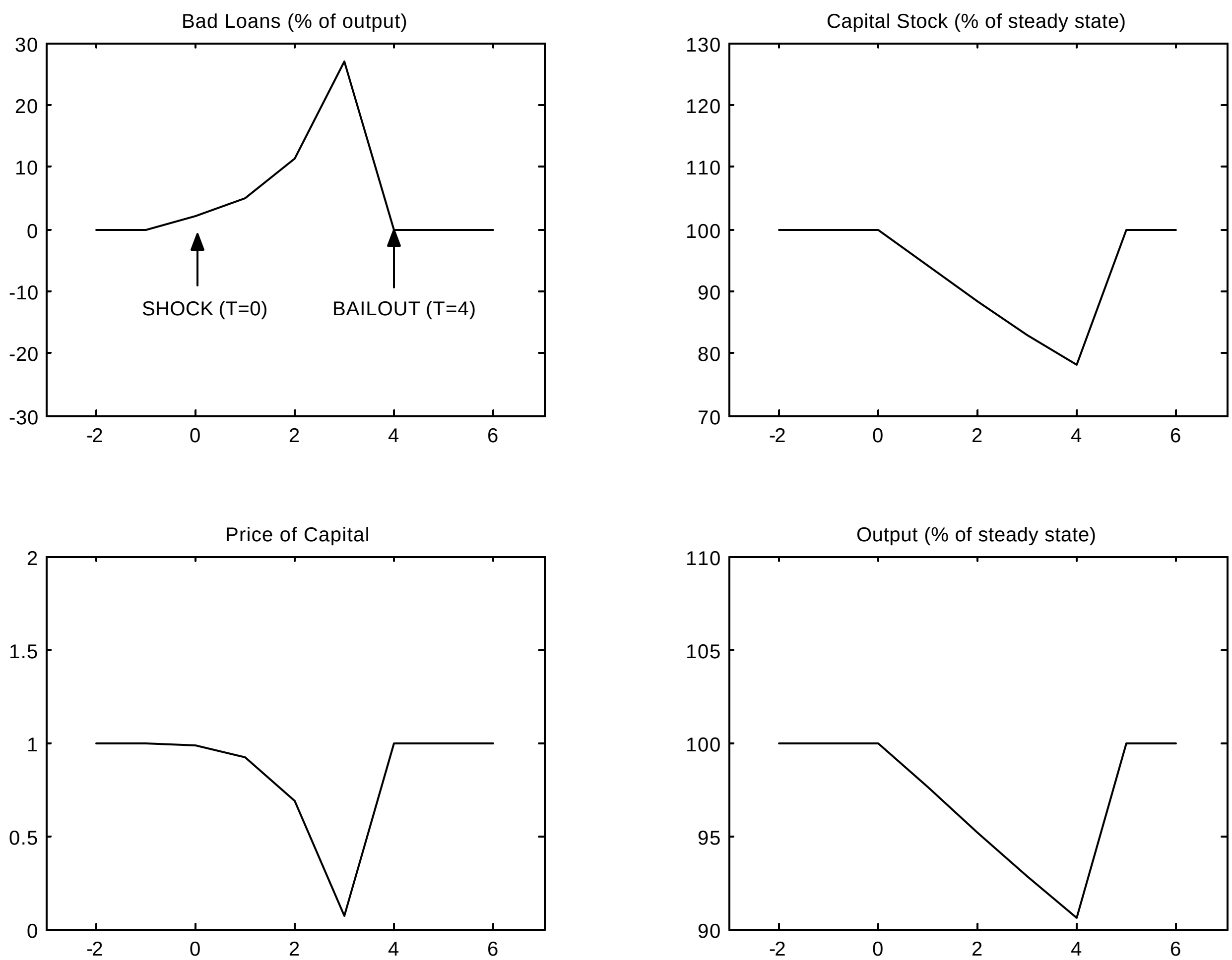


FIGURE 6.2 DELAYED BAILOUT, OPEN ECONOMY