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Undercapitalized Banks, Uncertain Government Policies, and Declines in Total Factor Productivity

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(PRELIMINARY AND INCOMPLETE)

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Abstract

Recently a number of countries have experienced a prolonged slowdown in aggregate economic activity accompanied by a significant deterioration of the banks' net worth. This paper studies the optimal bank behavior when they are severely undercapitalized but continue to operate due to lax government policies. In particular, we show that when the government policies generate uncertainties regarding (i) the exact timing at which the government intervention will occur, and (ii) the fraction of the banks that will be forced to shut down, then banks change their lending behavior. These changes are largely responsible for the prolonged recession, which occurs in the aftermath of the banking crisis. The mechanism through which this effect occurs is as follows. In the model economy, firms need 'time to build' in order to achieve the maximum return on investment they undertake. Due to the uncertainty regarding the probability of survival, the banks' discount rate increases dramatically. This implies that the banks do not wish to finance long-term investment, forcing firms to switch to the short-term projects. These projects do not require 'time to build', but are less productive. As the quality of investment falls, the total factor productivity (TFP) falls, contributing to the fall in aggregate output. Such a joint decline in the TFP and aggregate output in the aftermath of the banking crisis is a salient feature of the Japan's and Mexico's recent experiences.

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1 Introduction

Recently number of countries have experienced prolonged slowdown in aggregate economic activity accompanied by a significant deterioration of the net worth of a major part of the banking industry. In most cases, it has been argued that the recession is caused by the meltdown of the financial sector. Among others, the most striking example is Japan in 1992-2003 (Figure 1 illustrates the behavior of Japan's economy in the 1990s). Typically, the deterioration of the banks' net worth has been caused by the problem of the so called 'bad loans' (non-performing loans). These are loans extended to entities which are de-facto in bankruptcy, loans which have been renegotiated, or loans which are past due. For example, in Japan's case, the amount of these loans is estimated to be anywhere between 24-47% of GDP.[1] The recovery rate on these loans is about 12% of the original amount.[2]

A hypothesis commonly proposed in Japan's case is that the slowdown is due to an inefficient allocation of resources. For example, Hubbard (2002) states that "the real problem is that capital is not being allocated to its most productive uses", while 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). 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.[3] Because of this, zombie firms continue to operate, yet the question why new efficient firms (or investment) does not eventually crowd out zombie firms remains open.

Finally, Hayashi and Prescott (2002) claim that Japan's stagnation is a consequence of an exogenous decline in the growth rate of total factor productivity.[4] They note that the growth rate of total factor productivity has declined, and that this decline has been large enough to explain a significant part of the slowdown. This argument highlights the importance of finding the cause of the fall in the growth rate of total factor productivity.

In this paper we argue that the crisis in the banking sector and the type of policies pursued by Japan's regulators can generate substantial fall in the total factor productivity. In particular we show that the non-performing loans problem along with lax and uncertain government policies induce a shift in the lending pattern of the banks, which is ultimately responsible for the fall in the total factor productivity, and therefore, for the fall in output as well.

[1] For recent account of non-performing loans see Kashayap (2002a).

[2] See Barseghyan (2002).

[3] 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.

[4] According to their calculations in Japan during the 1990s 1% fall in growth rate of output was accompanied by 1% fall in the growth rate of output.

We start with a premise that banks have a monopolistic power in the loan markets and can choose to finance investment projects which differ both by their duration and profitability. Projects in this economy have the following key property. In order for a project to have the maximum net present value, it requires a specific "time to build". That is, a particular number of periods has to pass after the initial investment takes place before the project becomes operational.

Next, we focus on the changes in the optimal bank behavior after the occurrence of the non performing loans and how these changes affect overall macroeconomic performance. In particular, we focus on the case where the banks are severely undercapitalized, but can continue to operate due to lax government policies. The key assumptions regarding the policy implemented by the government are as follows:

- The exact timing at which the government will restructure the banking sector and restore the capital adequacy requirement is uncertain.

- The probability of a bank being shut down by the government increases with its level of under capitalization.[5]

We show that this set of policies effectively increases the banks' discount rate. That is, the banks shift to the financing of only short term projects. The reason for this shift is that the banks recognize that they may not be operating long enough to benefit from longer-term projects.[6] They rather finance projects which pay immediately and use the proceeds to improve their balance sheets. The balance sheet's improvement effectively decreases the probability of the bank being shut down by the government, and therefore increases the value of the bank.

We interpret projects financed by the banks as actual firms. While these firms, as in most of standard models, need capital and labor in order to produce, their productivity (TFP) is determined by the quality of the project. In this paper, we associate quality with the actual time to build of the project. That is, higher quality projects require a longer time to build. With this structure of production in place, the shift towards short term projects induced by the government policy leads to a decline in the economy wide total factor productivity. The latter decline contributes significantly to the fall in the growth rate of the economy.[7]

Most of alternative research, as for example Kashyap (2002a) and Caballero, Hoshi and Kashyap (2003), emphasizes moral hazard as the main mechanism through which the large amounts of non-performing loans

[5] These types of polices are a characteristic feature in most of the economies in the aftermath of the banking sector crisis. This has been the case so far, for example, in Japan.

[6] It is implicit in our analysis that longer term projects are more profitable than short term ones. However, the liquidation value of the long-term projects for the banks is very low.

[7] In a recent work Barseghyan (2002) highlights a different mechanism through which the problem of non-performing loans reduces aggregate economic activity. In that model the delay in the government intervention results in averting resources away from investment.

held by the banks affect the economy.[8] As it was mentioned above, the moral hazard mechanisms cannot explain why the new productive investment does not take place. In contrast, in our model there is a shift in the type of new investment: from productive to (relatively) unproductive. Thus, overall, total factor productivity is on decline, drugging down the growth of output.

The rest of this paper is constructed as follows. In Section 2 we present the model economy. In Section 3 we describe the dynamics of the economy after a bad loan shock. Section 4 provides conclusions and details some of the future work on this project.

2 The Model Economy

We consider a small open AK economy populated by the households, firms, banks, and the government.

2.1 Households

Households in this economy are infinitely lived agents who maximize their expected life time utility. Their preferences and budget constraint are defined as follows:

$$\begin{aligned}&\max \textstyle\sum_{\tilde{t}=t}^{\infty} \beta^t U(c_t)\\ &\text{s.t.}\\ &c_t + S_{t+1} = R_t S_t,\end{aligned}$$

where c_t is period's t consumption, S_{t+1} is period's, t savings and R_t is the interest rate. We assume that the households have a perfect access to the world capital markets. The households can save through domestic banks and through world capital markets. Because depositors are protected by full deposit insurance, the interest rate domestic banks pay is equal to the world interest rate. For this reason, households are indifferent between allocating their savings at home or abroad.[9] We assume that the world interest rate is constant and equal to the inverse of the discount rate $\beta : R^D = 1/\beta$.

2.2 Firms

In order to operate the firms need to rent a production location from the bank. Once a location is rented the firm can produce according to the following technology:

$$y^i = A^i K$$

where y^i is the firm's output, and $A^i, i = \{L, H\}$ is the productivity parameter which depends on the type of location the firm has rented. Regardless of the project's type, in order to be able to produce, firms need

[8] See for example,

[9] Note, that the households do not directly own domestic banks. As we will show later, this is without loss of generality.

to pay a one period ahead installation cost of $P(K)$ for K units of capital they install. Consequently, the maximization problem of the firm is given by

$$\pi_t^i = A^i K_t - (R^D - 1)K_t - R^D P(K_t) - R^i$$

where R is the world interest rate, and R^i is the rent paid to the bank

The first order conditions of the firm are given by

$$[A^i - r] = R^D P'(K_t).$$

where $r = R^D - 1$. We assume that

$$\begin{aligned} P'(K_t) &> 0, \\ P''(K_t) &> 0. \end{aligned}$$

This implies that the optimal amount of capital installed for H projects is higher than the amount installed for L projects.

2.3 Banks

There is a continuum of measure one banks, which are infinitely lived. We assume that the banks are owned by net present value maximizing foreign financial intermediaries. Banks are competitive in the deposit market, but enjoy a monopoly power in the loan market at the locations they operate.[10]

Each period the banks perform the following actions:

- Collect new deposits;
- Collect payments on loans made in the previous period;
- Receive a capital injection from the shareholders (if any);
- Pay dividends;
- Receive government transfers (if any);
- Pay off previous period depositors;
- Make loans to entrepreneurs.

[10] We assume that there exist a high enough entry cost to the banking industry, so that their monopoly power is uncontested.

The banks' loan portfolio consists of two types of loans. Type H loans[11] made in period t mature in period $t+2$ and pay a return R^H_{t+2}. Type L loans made in period t mature in period $t+1$ and pay a return R^L_{t+1}.

The banks face the following two constraints:

1. Resource constraint:

$$L^S_t + L^H_t + div_t + R^D D_{t-1} \leq D_t + R^S_t L^S_{t-1} + R^H_t L^H_{t-2} + E^\Delta_t - C(L^S_t + L^H_t) + T_t$$

where

L^S_t	one period loans made in period t
L^H_t	two period loans made in period t
D_t	deposits in the period t
E^Δ_t	equity injection in the period t
div_t	dividends paid in the period t
R^D	interest on deposits paid in period t
R^S_t	interest on one period loans paid in period t
R^H_t	interest on two period loans paid in period t
$C(L)$	is the cost of making L loans [12]
T_t	is the government transfer in period t

2. Capital Adequacy Requirement

$$\frac{L^S_t + L^H_t + R^D L^H_{t-1}}{D_t} \geq q,$$

where q is a constant chosen by the government.[13]

At this step it is useful to define the bank's net worth:

$$NW_t \equiv L^S_t + L^H_t + R^D L^H_{t-1} - D_t.$$

That, is the worth of the bank NW_t is the difference between its assets and liabilities. Also, the profits of the bank are given by

$$\pi_t \equiv R^H_t L^H_{t-2} + R^S_t L^S_{t-1} - R^D D_{t-1} - C(L^S_t + L^H_t).$$

[11] To ease the notational burden we indentify the number of locations of a particular type: H or S , as the amount of loans of that type the banks have. The cost of creating one unit of these loans (i.e. locations) is 1, the return from this asset is R^i_{t+j}, $i = H, S$, $j = 2$ if $i = H$, and $j = 1$ if $i = S$.

[12] We assume that there is no difference in the cost of making a short-term and long-term loans.

[13] Note, that the type H loans which have been made one period earlier are counted towards assets at a cost, that is the deposit rate rate R^D_{t-1}.

We assume that prior to the bad loan shock to be described later the banks do not face any uncertainty. Further, let A^H and A^S be such that

$$\frac{R^H}{R^D} > R^S.$$

This implies that the banks finance solely the projects of type H, since the latter have higher net present value. Further, the optimal amounts of loans are given by:

$$L_{ss}^H = \arg\max R^H L^H - \left[R^D\right]^2 \left[C(L^H) + L^H\right]$$

Note this is a steady state value of loans. Because there is no uncertainty the banks are indifferent between financing their operation through equity or debt. We assume that prior to the bad loan shock the banks position is such that the capital adequacy requirement constraint holds with equality

$$\begin{aligned} D_{ss} &= \frac{1}{q}(1+R^D)L_{ss}^H \\ NW_{ss} &= \frac{q-1}{q}(1+R^D)L_{ss}^H \end{aligned}$$

2.4 The Steady State of the Economy

Given the steady state of the banks, we can describe the economy's steady state. L_{ss}^H locations are operating in the economy and at each location the optimal amount of capital employed is given by

$$K_{ss} = P'^{-1}\left(\frac{A^H - r}{R^D}\right)$$

Thus, net output in steady state is given by

$$Y_{ss} = L_{ss}^H \left(K_{ss} - P(K_{ss})\right)$$

Since the households face a constant interest rate, their consumption decision is completely determined by the world interest rate and initial level of savings S_0. For example, with logarithmic utility function their steady state consumption is given by

$$C_{ss} = \frac{(1-\beta)}{\beta} S_{ss}$$

We assume that S_{ss} is such that the net foreign foreign asset position of the country is zero.

2.5 The Banks after the Bad Loan Shock

Initially, the economy is at its steady state. At time zero a shock occurs which lowers the gross amount collected on previously made loans by $-X$.

The government's response to this shock is to relax capital adequacy requirement.[14] In particular the banks are allowed to count towards assets a κ fraction of the value of the losses the banks incurred.

$$\frac{L_t + \kappa \left[R^D\right]^t X}{D_t} \geq q.$$

Without loss of generality we assume that the banks are not allowed to pay dividends while taking advantage of the new capital adequacy requirement.

Denote by V_t^B the value of the bank which is being shut down

$$V_t^B = \max\{0, R_t^H L_{t-2}^H + R_t^S L_{t-1}^S - R^D D_{t-1}\}$$

That is a bank can salvage any assets remaining after the depositors are fully repaid.

We assume that the timing of the government's intervention is uncertain. Once the intervention takes place each bank faces a probability of being shut down which increases with its level of under capitalization. Let λ_{t+1} denote the probability that a bank will be shut down at period $(t+1)$. Similarly, let $ind_t = \{0, 1\}$ indicate whether the government has intervened or not. Then it follows that the bank's maximization problem can be written as follows,

$$V_t(\omega_t) = \max_{\hat{\omega}_{t+1}} \{div_t - E_t^{\Delta} + \frac{1}{R^D}[\lambda_{t+1}(\omega_{t+1})V_{t+1}^B + (1 - \lambda_{t+1}(\omega_{t+1}))V_{t+1}(\omega_{t+1})], V_t^B\}; \tag{2.1}$$

s.t.

$$L_t^S + L_t^H + div_t + R^D D_{t-1} = D_t + R_t^S L_{t-1}^S + R_t^H L_{t-2}^H + E_t^{\Delta} - C(L_t^S + L_t^H) + T_t \tag{2.2}$$

$$\frac{L_t + \kappa \left[R^D\right]^t X}{D_t} \geq q; \text{ if } \frac{L_t}{D_t} < q, \text{ then } div_t = 0 \tag{2.3}$$

where $\omega_{t+1} = (\hat{\omega}_{t+1}, \omega_{t+1}^g)$, is the state of the economy

$$\begin{aligned} \hat{\omega}_{t+1} &= (L_t^S, L_t^H, div_t, D_t, E_t^{\Delta}), \\ \omega_{t+1}^g &= (ind_t, T_t) \end{aligned}$$

2.6 The Government

The government's actions are considered to be exogenous. We assume that probability of being shut down for an individual bank is given by

$$\lambda_{t+1}(\omega_{t+1}) = \lambda_{t+1}^I \lambda_{t+1}^B (\hat{\omega}_{t+1}).$$

[14] The rationale for this assumption is as follows. We think the government cannot completely abandon the capital adequacy requirement due to standard moral hazard considerations. Yet, maintaining the capital adequacy requirement on the original level is not feasible because no bank can meet such a requirement after the bad loan shock. Thus, the only way the government can make the banks operational without exuberating the moral hazard problem is to relax in some way the capital adequacy requirement.

where λ^I_{t+1} is the probability that the intervention occurs and $\lambda^B_{t+1}(\hat{\omega}_{t+1})$ is the probability of an individual bank with a state $\hat{\omega}_{t+1}$ The transfer amount T_t to the banks which will not be shut down is financed through lump sum taxes τ_t:

$$(1 - \lambda_{t+1}(\omega_{t+1}))T_t = \tau_t.$$

2.7 Equilibrium

The equilibrium is defined as sequences of prices (R^S_t, R^H_t, R^D), quantities $\{L^S_t, L^H_t, div_t, D_t, E^\Delta_t, K^S_{t+1}, K^H_{t+1}, C_t, S_t, \}$, and a government policy $\{ind_t, T_t, \lambda^I_{t+1}, \lambda^B_{t+1}(\cdot)\}$ such that,

- the government policy is feasible: $\tau_t \leq S_t$ for all t;

and given the government policy:

- (C_t, S_t) sequences solve the households' problem in each period;
- $(R^S_t, R^H_t, L^S_t, L^H_t, div_t, D_t, E^\Delta_t)$ solve the banks' problem in each period;
- (K^S_{t+1}, K^H_{t+1}) solve the firms' problem in each period;
- markets clear in each period.

3 The Dynamics of the Economy after a Bad Loan Shock

The main finding of the paper evolve around the question: 'What happens after the bad loan shock under the following government policies?

- The probability of the government's intervention λ_{t+1} is positive in every period.
- The probability of being shut down faced by an individual bank $\lambda^B_{t+1}(\hat{\omega}_{t+1})$ depends only on the degree of capitalization of the bank:

  $$\lambda^B_{t+1}(\hat{\omega}_{t+1}) = \lambda^B_{t+1}(\frac{L_t}{D_t}),$$

  where $\lambda^B_{t+1}(\cdot)$ is increasing and concave.

We show that for a range of parameters λ^I_{t+1}, and λ^B_{t+1} and the level of the bad loan shock X the banks' optimal behavior is as follows:

- There is no capital injection E^Δ_{t+1};
- The banks finance only short term projects.

In order to highlight the intuition behind this result, let us focus on the banks maximization problem:

$$V_t(\omega_t) = \max_{\hat{\omega}_{t+1}}\{div_t - E_t^{\Delta} + \frac{1}{R^D}[\lambda_{t+1}(\omega_{t+1})V_{t+1}^B + (1-\lambda_{t+1}(\omega_{t+1}))V_{t+1}(\omega_{t+1})], V_t^B\};$$

s.t.

$$L_t^S + L_t^H + div_t + R^D D_{t-1} = D_t + R_t^S L_{t-1}^S + R_t^H L_{t-2}^H + E_t^{\Delta} - C(L_t^S + L_t^H) + T_t$$

$$\frac{L_t + \kappa\left[R^D\right]^t X}{D_t} \geq q; \text{If } \frac{L_t}{D_t} < q, \text{ then } div_t = 0$$

The first order conditions for the problem above can be written as:

$$L_t^S \;:\; -A_t\left[1 + C_t'\right] - B_t - \frac{R_t^S}{R^D}\left[\lambda_{t+1}' V_{t+1}\right] + \frac{1}{R^D}\left(1 - \lambda_{t+1}\right)\frac{\partial V_{t+1}}{\partial L_t^S} \leq 0 \tag{3.1}$$

$$L_t^H \;:\; -A_t\left[1 + C_t'\right] - B_t - \left[\lambda_{t+1}' V_{t+1}\right] + \frac{1}{R^D}\left(1 - \lambda_{t+1}\right)\frac{\partial V_{t+1}}{\partial L_t^H} \leq 0 \tag{3.2}$$

$$D_t \;:\; A_t + qB_t + \left[\lambda_{t+1}' V_{t+1}\right] + \frac{1}{R^D}\left(1 - \lambda_{t+1}\right)\frac{\partial V_{t+1}}{\partial D_t} \leq 0 \tag{3.3}$$

$$E_t^{\Delta} \;:\; -1 + A_t \leq 0 \tag{3.4}$$

where A_t and B_t denote the Lagrange multipliers for the resource constraint and the capital adequacy ratio at time t respectively. [15]

From the first order conditions for the banks' problem one can see that $E_t^{\Delta} = 0$ as long as

$$A_t < 1$$

The last condition simply implies that the increase in the net present value of the bank from a capital injection is lower then the current dollar value of the capital injection itself. Yet, one can also see from (3.1)-(3.4) that the banks finance only short term projects as long as (3.1) holds with equality and condition (3.2) is satisfied as an inequality.

The reason for such a shift is as follows. Despite the fact the bank's chances for survival do not warrant capital injection, the bank's survival probability rises as the degree of under capitalization falls. Therefore, the banks have an incentive to 'gamble' for resurrection by improving their next period capitalization ratio by as much as it is possible without injecting any capital of their own. For this phenomenon to occur it is crucial that the loans which are outstanding count towards assets *only* at a cost for making such loans. This assumption, which is commonly used in the banking literature argument[16], is justified as follows: the bank's

[15] As a technical note let us note that the value of the bank after it has been recapitalized, is given by

$$V_T = R_T^S L_{T-1}^S - R^D D_{T-1} + T_T + \left(\frac{1}{R^D}\right)^2 V_{ss}$$

where V_{ss} is the value of the bank at the steady state. This allows for the FOC of the bank to be computed explicitly.

[16] See for example Devatripont and Tirole (1993), or Freixas and Rochet (1997).

monitoring cannot be replicated by any other agent in the economy. Therefore, the market value of the loan is lower then its value for the bank.

Figure 2 illustrates the behavior of various aggregate variables for the scenario above. Right after the bad loan shock the banks stop financing long-term loans and shift completely to short-term ones. Moreover, the total amount of loans falls. The reason for latter effects is the severe under capitalization of the banks. Absent capital adequacy requirement, the banks would immediately increase the amount of deposits to make more loans. Yet, even with the new relaxed capital adequacy requirement their capital has deteriorated so much that total amount of loans they can afford to extend goes down.

The fall in loans continues despite the slow rise in the amount of deposits. These seemingly controversial result is due to the new capital adequacy requirement: the amount of the losses counted towards the assets rises with the deposit rate R^D, allowing the total amount of assets on the bank's balance sheet $L_t + \kappa \left[R^D\right]^t X$ to rise despite the fall in L_t.

Output falls due to two reasons. First, the overall number of firms that are operating is on decline because of a fall in the total amount of loans. Second, the total factor productivity of the firms falls by the ratio $(A^H - A^S)/A^H$, because of the shift in the lending pattern of the banks.

4 Conclusions

This paper attempts to identify channels through which the banking crisis affects the performance of the economy. In particular, we focus on the effects of the banking crisis on the lending patterns of the banks. We show that when undercapitalized banks face uncertain government policies, their effective discount factor increases. The latter effect forces the banks to finance only short term investment, which is not the most efficient (i.e. the most productive) from the social point of view. In particular, such investment leads to a lower total factor productivity, thereby contributing to the fall in level and/or the growth rate of total output.

The policy implications of the paper of the paper reinforce earlier findings (see Barseghyan (2002), Caballero, Hoshi, and Kashyap (2003)): while the paper does not argue in favor or against the existence of the deposit insurance, it provides a rationale for an *immediate* government's intervention and restructuring of the banking sector.

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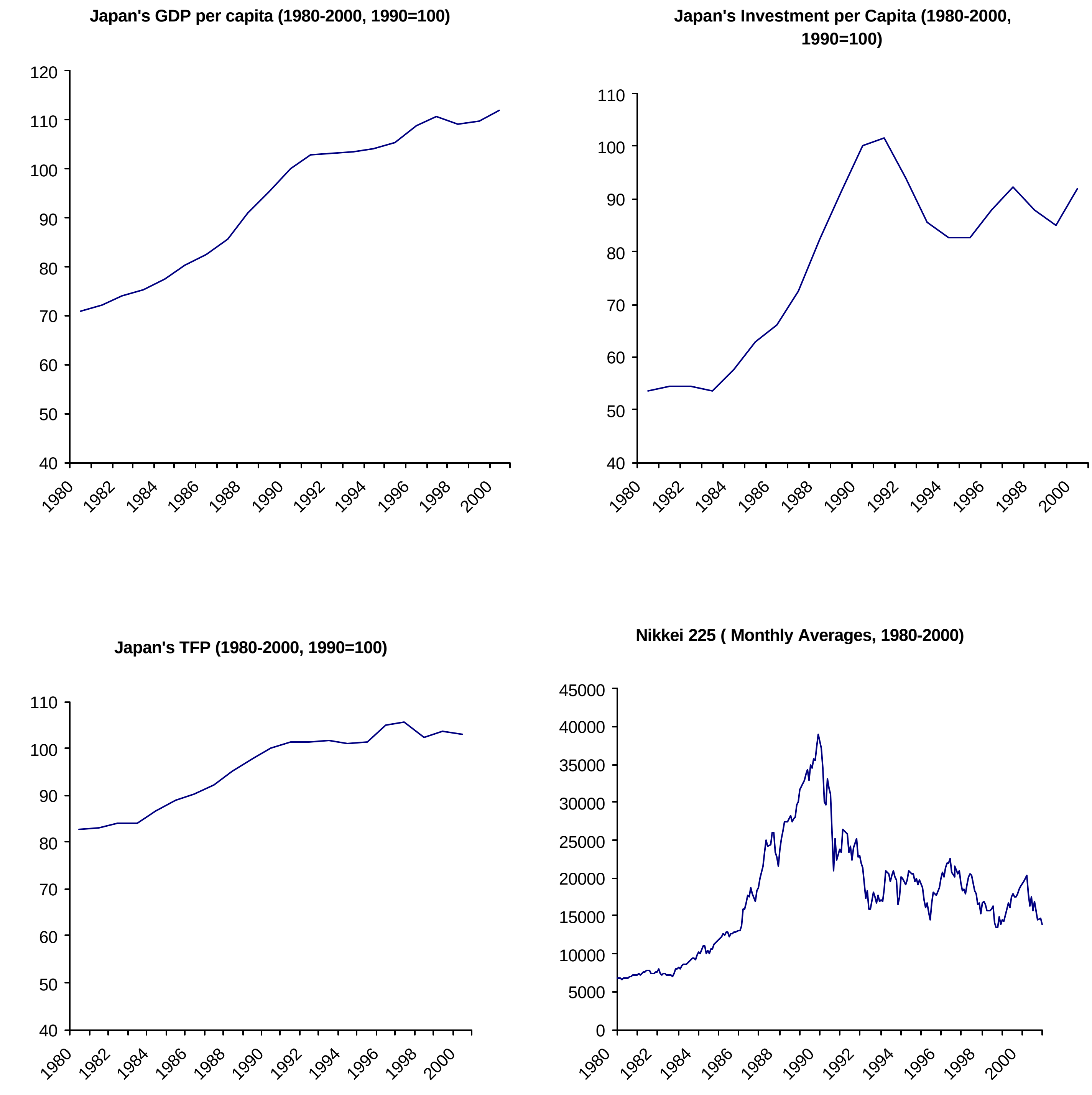
Figure 1.1 Key Economic Indicators for Japan.



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.

Figure 2. The Response of the Economy to the Bad Loan Shock