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Banking in General Equilibrium with an Application to Japan.

R. Anton Braun
University of Tokyo

Max Gillman
Central European University

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University of Tokyo
Max Gillman
Central European University

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Abstract

Japan has now experienced over a decade of slow growth and deflation. This period has also been associated with protracted problems in the banking sector. A wide range of measures have been tried in to restore health in the banking sector including recapitalization, the extension of 100% guarantees to all deposits, and central bank purchases of shares held by banks. It has also argued that ending deflation is an important ingredient in restoring banking sector health. This paper develops a general equilibrium of the banking sector. In our model the banking sector produces an intermediate good that is used to produce investment goods and a variable fraction of consumption goods. We then assess the implications of alternative policies designed to assist the banking sector in terms of their implications for welfare and the size and profitability of the banking sector.

1. Introduction

Japan has experienced over a decade of low growth. In addition, CPI inflation has declined from 3% in 1990 to a level of -0.7% in 2003 and nominal interest rates are now about zero. This period of slow growth and deflation has also been accompanied by persistent problems in the Japanese banking sector. Loans have fallen by 18 percent between 1997 and 2003, deposits have stagnated and employment in the banking sector has fallen by over 17 percent. These declines produced a number of important government initiatives designed to assist the banking sector. The Japanese government has extended 100% guarantees to bank deposits, offered loan guarantees, re-capitalized the banking system, and the Bank of Japan has purchased private equity shares from banks in an effort to improve bank balance sheets. The persistent nature of the problems in Japan's banking sector has also increased pressure on the Bank of Japan to end deflation in the expectation that higher inflation will widen spreads on lending rates and thereby increase profitability.

This paper develops a dynamic general equilibrium model with a banking sector that can be used for assessing the effects of these policies on welfare and the size and profitability of the banking sector. Our model builds on the previous models of Gillman (1993), Aiyagari, Braun and Eckstein (1998) and Erosa (2001). Our general equilibrium model has the following structure. Money enters via a cash-in-advance constraint and separate sectors produce goods and banking services. Goods are produced using capital and labor. The banking sector also uses capital and labor to produce credit services that facilitate both exchange and investment. We model the industrial organization of the banking sector in two alternative ways for robustness. In one version of the model,

banks are perfectly competitive and profits arise through a strategic complementarity with the output of the goods sector. In the other version of the model, banks are monopolistically competitive.

We then calibrate the model to Japanese data and use the model to compare and contrast the effects of alternative policies designed to assist the banking sector. We find that recapitalizations can restore profitability to the banking sector but have no effect on the size of the banking sector- employment and provision of credit services still fall. In the model with monopolistic competition this policy produces higher welfare than a passive policy that allows profitability to be restored due to exit and higher markups. Deposit guarantees, in contrast, have positive effects on the size of the sector no effect on profitability and negative welfare effects. The revenue benefits generated by deposit guarantees gets passed through and results in higher input prices. A higher average inflation rate increases demand for banking services by households and but reduces demand for interemporal credit services. The former effect is more pronounced than the latter effect and profitability and employment in the banking sector increase with the inflation rate. However, this policy has negative effects implications for welfare.

The model extends the specification of the credit services sector developed in Gillman (1993), Aiyagari Braun and Eckstein (1998) and Erosa (2001) by using a single consumption good as in Gillman and Kejak (2002). [*more references to other literature to be added.*]

2. The Model

In this section we develop a general model that nests as special cases both perfectly and monopolistically competitive structures of the banking sector. The household decision problem is as follows.

2.1 Household decision problem

Household preferences are defined over consumption and leisure with the following utility function

$$\sum_{t=0}^{\infty} \beta^t u(c_t, l_t) \tag{2.1}$$

Period budget constraint:

$$\begin{aligned} &\left(bP_{1t} + (1-b)P_{2t}\right)\left(k_{t+1} - (1-\delta)k_t\right) + P_{2t}\left(1-a_t\right)c_t + P_{1t}a_t c_t + M_{t+1} + \frac{B_{t+1}}{1+R_{t+1}} = \\ &P_{1t}\left(1-\tau_{nt}\right)w_t n_t + P_{1t}\{r_t - \tau_{kt}(r_t - \delta)\}k_t + M_t + B_t + P_{1t}pr_t \end{aligned} \tag{2.2}$$

where, $a_t \in \left[0,1\right]$ is the fraction of consumption goods purchased with cash, $b \in \left[0,1\right]$ is the fraction of investment goods purchased with cash, B_{t+1} are new purchases of nominal bonds in period *t* and pr_t are profits. The fraction of consumption goods purchased with cash a_t varies depending on the relative exchange cost of cash versus

credit. The fraction of investment purchased with cash is given parametrically to households.

Households face the following cash in advance constraint:

$$bP_{1t}\left(k_{t+1}-(1-\delta)k_t\right)+P_{1t}a_t c_t = M_t \tag{2.3}$$

The right hand side is the amount of cash that the household has after it leaves the financial market.

Households divide their time endowment between labor market activities and leisure:

$$n_t + l_t = 1\,. \tag{2.4}$$

Definition 1: Households' problem.

The household's problem is to maximize (2.1), subject to equations (2.2)- (2.4) by choice of the sequences $\{c_t, k_{t+1}, h_{t+1}, a_t, n_t, n_{ht}, l_t, M_{t+1}, B_{t+1}\}_{t=0}^{\infty}$ given sequences of prices, profits and government policy variables $\left\{P_{1t}, P_{2t}, r_t, w_t, pr_t, \tau_{mt}, \tau_{kt}, v_t\right\}_{t=0}^{\infty}$ and given the initial conditions $k(0)$, $h(0)$, $B(0)$ and $M(0)$.

Properties of household optimization

First order necessary conditions (notice that (2.4) has been substituted into the objective):

c: $$u_{1t} - \lambda_t \left[P_{2t}\left(1 - a_t\right) + P_{1t} a_t \right] - \mu_t P_{1t} a_t = 0 \tag{2.5}$$

n: $$-u_{2t} + \lambda_t P_{1t}\left(1 - \tau_{nt}\right) w_t h_t = 0 \tag{2.6}$$

M_{t+1}: $$-\lambda_t + \beta\lambda_{t+1} + \beta\mu_{t+1} = 0 \tag{2.7}$$

B_{t+1}: $$-\frac{\lambda_t}{1 + R_{t+1}} + \beta\left[\lambda_{t+1}\right] = 0 \tag{2.8}$$

k_{t+1}: $$\begin{aligned} &-\mu_t b P_{1t} + \mu_{t+1} P_{1t+1} \beta b(1-\delta) - \lambda_t \left[bP_{1t} + (1-b)P_{2t} \right] \\ &+\beta\lambda_{t+1} \left\{ \left[bP_{1t+1} + (1-b)P_{2t+1} \right](1-\delta) + P_{1t+1}\left[r_{t+1} - \tau_{kt+1}(r_{t+1} - \delta) \right] \right\} \\ &= 0 \end{aligned} \tag{2.9}$$

a: $$\lambda_t \left[P_{2t} - P_{1t} \right] - P_{1t}\mu_t = 0 \tag{2.10}$$

Next observe that

$$\frac{\mu_t}{\lambda_t} = \frac{P_{2t} - P_{1t}}{P_{1t}} = R_t \tag{2.11}$$

These first order conditions imply the following no-arbitrage restrictions:

$$u_{1t} = \lambda_t P_{1t}\left(1 + R_t\right) \tag{2.12}$$

$$\frac{u_{1t}}{u_{2t}} = \frac{1 + R_t}{\left(1 - \tau_{nt}\right) w_t h_t} \tag{2.13}$$

This equation relates the marginal rate of substitution between leisure and consumption to the relative price of leisure and consumption. In this economy inflation acts as a tax on labor supply.

$$\frac{\beta u_{1t+1} P_{1t}}{u_{1t} P_{1t+1}}\left[1 + R_t\right] = 1 \tag{2.14}$$

Define the inflation rate: $1 + \pi\left(t+1\right) \equiv P_1(t+1) / P_1(t)$ then the above equation is the standard intertemporal first order condition.

$$\frac{\beta u_{1t+1}}{u_{1t}}\left[(1-\delta) + \frac{\left[r_{t+1} - \tau_{kt+1}(r_{t+1} - \delta)\right]}{1 + R_{t+1}}\right] = 1 \tag{2.15}$$

Combining (2.14) and (2.15) we have:

$$1 + R_t = \left[(1-\delta) + \frac{\left[r_{t+1} - \tau_{kt+1}(r_{t+1} - \delta)\right]}{1 + R_{t+1}}\right] \tag{2.16}$$

Notice that equations (2.11), (2.13)-(2.16) and (2.2)-(2.4) constitute 8 equations in the 8 unknown household choice variables.

Technology & Feasibility

The production side of the economy consists of three sectors- a goods sector that produces a single storable good, a banking sector that produces credit services and a credit goods sector that combines goods with credit services to produce credit goods.

Goods are produced using the following Cobb-Douglas production technology.

$$y_{gt} = k_{gt}^{\theta} n_{gt}^{1-\theta} A_{gt} \tag{2.17}$$

Production in the banking sector by the i^{th} producer is specified in a general way to allow for the possibility of fixed costs associated with losses from existing outstanding loans $\phi_i K$, increasing returns to scale governed by the parameter η and/or a strategic complementarity, z_t:

$$s_{it} = \begin{cases} \left(k_{s,it}^{\gamma_2} n_{s,it}^{\gamma_2} z_{s,it}^{1-\gamma_1-\gamma_2}\right)^{\eta} A_{s,it} - \phi_i K, & if \left(k_{s,it}^{\gamma_2} n_{s,it}^{\gamma_2} z_{s,it}^{1-\gamma_1-\gamma_2}\right)^{\eta} A_{s,it} > \phi_i K \\ 0 \quad , & otherwise \end{cases} \tag{2.18}$$

Credit goods production combines credit services with goods using a Leontief production technology:

$$y_{2t} = \min\left(y_{g,2t}, s_t / q_t\right) \tag{2.19}$$

where,

$$s_t = \left[\int_0^1 s_{it}^{\rho} di\right]^{1/\rho} \tag{2.20}$$

We think of credit goods production as being the activity performed, for instance, by a car dealer when an individual uses the dealer to arrange financing at the time of purchase. Below in some of the simulations we will assume that credit goods production is subject to a productive externality. This turns out to be equivalent to monetary economies analyzed by Gillman (1993)or Aiyagari, Braun and Eckstein (1998) in which there are a continuum of credit goods that differ in terms of the amount of credit services they require.

The feasibility constraint for the goods sector is:

$$y_{gt} \geq c_t a_t + y_{g2t} + b(k_{t+1} - (1-\delta)k_t)\,. \tag{2.21}$$

The Credit goods feasibility constraint is:

$$y_{2t} \geq (1-a_t)c_t + (1-b)\left[k_{t+1} - (1-\delta)k_t\right] + g_t \tag{2.22}$$

Capital is constrained by the following restriction

$$k_{gt} + k_{st} \leq k_t\,. \tag{2.23}$$

And the labor feasibility restriction is:

$$n_t = n_{gt} + n_{st} \tag{2.24}$$

Market Structure

Goods producers are perfectly competitive. They chose their inputs according to the following marginal product pricing rules:

$$w_t = A_{gt} f_{2t} \tag{2.25}$$

$$r_t = A_{gt} f_{1t} . \tag{2.26}$$

Credit goods producers also behave competitively. They will choose their inputs in the following way:

$$\left(\frac{S_t}{S_{it}} \right)^{1-\rho} = \frac{P_{s,it}}{P_{st}} \tag{2.27}$$

where,

$$P_{st} = \left[\int_0^1 P_{s,it}^{\frac{\rho}{1-\rho}} \right]^{\frac{\rho-1}{\rho}} \tag{2.28}$$

and,

$$S_t / q_t = y_{g,2t} . \tag{2.29}$$

The zero profit condition for credit goods production implies the following restriction on prices:

$$P_{2t} = P_{1t} + P_{st} q_t . \tag{2.30}$$

We will consider two distinct industrial organization structures for the banking sector. First, we will consider a situation in which banks are monopolistic competitors. The rationale for such an assumption can be found, for instance, in Hellwig(1977) who describes the comparative advantage that an old lender has relative to new lenders due to the fixed costs incurred in collecting information about the quality of the recipient of credit. A special case of this industrial organization structure is a perfectly competitive market sector where profits are generated by a productive externality z as in Romer (1986). In the empirical analysis below we will compare and contrast both structures. The solution to a bank's optimization problem is found in two steps.

The first step is to derive a cost function by solving the following cost minimization problem:

$$\min_{k_{s,i}, n_{s,i}} r_t k_{s,it} + w_t n_{s,it} \tag{2.31}$$

subject to (2.18).

The solution to this problem is a cost function:

$$C(r_t, w_t, s_i, A_{s,it}), z_t) = \left[\left(\frac{\gamma_1}{\gamma_2} \right)^{\frac{\gamma_2}{\gamma_1+\gamma_2}} + \left(\frac{\gamma_1}{\gamma_2} \right)^{-\frac{\gamma_1}{\gamma_1+\gamma_2}} \right] r_t^{\frac{\gamma_1}{\gamma_1+\gamma_2}} w_t^{\frac{\gamma_2}{\gamma_1+\gamma_2}} \left(\frac{\left(S_{it} + \phi_t K_t\right)}{z_t^{1-\gamma_2-\gamma_2} A_{s,it}} \right)^{\frac{1}{\eta(\gamma_1+\gamma_2)}} \quad .(2.32)$$

The second step is to express profits in the following way:

$$pr_{s,it} \equiv \frac{P_{s,it}}{P_{st}} P_{st} S_{it} - P_{1t} C\left(r_t, w_t, s_{it}, A_{s,it}, z_t\right) \tag{2.33}$$

and then use (2.27) to substitute in the inverse demand function:

$$pr_{s,it} \equiv \left(\frac{S_{it}}{S_t} \right)^{\rho-1} P_{st} S_{it} - P_{1t} C\left(r_t, w_t, S_{it}, A_{s,it}, z_t\right). \tag{2.34}$$

The first order condition is:

$$\rho \left(\frac{S_{it}}{S_t} \right)^{\rho-1} \frac{P_{st}}{P_{1t}} = \rho \frac{P_{s,it}}{P_{1t}} = MC_t \tag{2.35}$$

where MC_t is the derivative of the cost function with respect to $s_i(t)$. Finally, we also have the following restrictions linking wages and rental rates in the goods production and credit production sectors.

$$w_t = \rho \frac{P_{st}}{P_{1t}} \{\gamma_2 \eta\} k_{s,it}^{\gamma_1 \eta} n_{s,it}^{\gamma_2 \eta - 1} A_{s,it} z_t^{\eta(1-\gamma_1-\gamma_2)} \tag{2.36}$$

$$r_t = \rho \frac{P_{st}}{P_{1t}} \{\gamma_1 \eta\} k_{s,it}^{\gamma_1 \eta - 1} n_{s,it}^{\gamma_2 \eta} A_{s,it} z_t^{\eta(1-\gamma_1-\gamma_2)} \tag{2.37}$$

Notice next that real profits are then given by:

$$pr_{st} = \frac{P_{st}}{P_{1t}} \left\{ \left(S_t + \phi K_t\right) \left[1 - \eta\rho(\gamma_1 + \gamma_2)\right] - \phi K_t \right\}. \tag{2.38}$$

If we choose the fixed cost parameter ϕ so that the banking sector has zero long-run profits this implies from equation (2.38) that ϕ satisfies the following restriction:

$$\frac{S_t}{K_t}\left(\frac{1}{\rho\eta(\gamma_1+\gamma_2)}-1\right)=\phi \tag{2.39}$$

Notice that under the assumption of constant returns to scale in the banking sector we have:

$$\frac{S_{it}}{K_t}\left(\frac{1-\rho}{\rho}\right)=\phi \tag{2.40}$$

Notice also that if there is no fixed cost and constant returns to scale in capital and labor economic profits are zero. However, perfect competition is also consistent with non-zero profits in the presence of a productive externality in *z*. Below we will report some simulation results for the case with perfect competition where profits arise due to a strategic complementarity of banking with goods production.

The government budget constraint is given by:

$$P_{1t}\tau_{nt}w_t h_t n_t + P_{1t}\tau_{kt}\left(r_t-\delta\right)k_t + M_{t+1} - M_t + \frac{B_{t+1}}{1+R_{t+1}} - B_t = P_{2t}g_t \tag{2.41}$$

According to this budget constraint government purchases are credit goods and money enters and leaves the economy via open market purchases and sales of nominal bonds.

Given the above definitions GDP for this economy is defined as:

$$
\begin{aligned}
gdp_t &= y_{gt} - y_{g,2t} + \frac{P_{2t}}{P_{1t}} y_{2t} \\
&= \frac{P_{2t}}{P_{1t}} \Big[(1-b)\Big(k_{t+1} - (1-\delta)k_t\Big) + (1-a_t)c_t + g_t \Big] + a_t c_t + b\Big(k_{t+1} - (1-\delta)k_t\Big) \quad (2.42) \\
&= w_t n_t h_t + r_t k_t + pr_t
\end{aligned}
$$

Definition 2: Monopolistically Competitive Equilibrium

Given a sequence of government policies M_0, $\{M_{t+1}, \tau_{kt}, \tau_{nt}\}_{t=0}^{\infty}$, a competitive equilibrium is a sequence of allocations and prices that satisfies household optimization as given in definition 1, firm optimization as given by equations (2.25) -(2.37), feasibility (2.21)-(2.24), and the government budget constraint given by (2.41).

3. Characterization of Equilibrium (Steadystate analysis)

General market clearing imposes the following steadystate restrictions on prices and allocations:

Steadystate Equilibrium

$$\pi = \beta(1+R) - 1 \qquad (3.1)$$

$$(1-\delta)+\frac{(r-\tau_k(r-\delta))}{1+R}=(1+R)/(1+\pi)$$

or

$$1+R=(1+\pi)\left[(1-\delta)+\frac{(r-\tau_k(r-\delta))}{1+R}\right] \tag{3.2}$$

$$N=N_g+N_s \tag{3.3}$$

$$l=1-N \tag{3.4}$$

$$Y_g=A_gK_g^{\theta}N_g^{1-\theta} \tag{3.5}$$

$$K_g=\left\{r/(A_g\theta N_g^{1-\theta})\right\}^{\frac{1}{\theta-1}} \tag{3.6}$$

$$w=(1-\theta)A_gK_g^{\theta}N_g^{-\theta} \tag{3.7}$$

$$N_s=1-\frac{\alpha C\left(1+R\right)}{w}-N_g \tag{3.8}$$

$$1=\frac{\theta}{1-\theta}\frac{\gamma_2}{\gamma_1}\frac{N_g}{K_g}\frac{K_s}{N_s} \tag{3.9}$$

$$S=A_s(Z^{1-\gamma_1-\gamma_2}K_s^{\gamma_1}N_s^{\gamma_2})^{\eta}-\phi K \tag{3.10}$$

$$Y_{g2}=S/q \tag{3.11}$$

$$Y_2=\min(Y_{g2},S/q) \tag{3.12}$$

$$a=\frac{Y_g-Y_{g2}-b\delta K}{Y_2-\delta K-G+Y_g-Y_{g2}} \tag{3.13}$$

$$C=\frac{Y_g-Y_{g,2}-b\delta K}{a} \tag{3.14}$$

$$\frac{M_t}{P_{1t}}=aC+b\delta K \tag{3.15}$$

$$R/q = \frac{w}{\rho\eta\gamma_2 A_s Z^{\eta(1-\gamma_1-\gamma_2)} K_s^{\eta\gamma_1} N_s^{\eta\gamma_2-1}} \tag{3.16}$$

Consider next two policies designed to support the credit services sector. The first is a transfer, ψ, . that affects the fraction of loan losses:

$$pr_t = \frac{P_{st}}{P_{1t}}\left\{(S_t+\phi)\left[1-\eta\rho(\gamma_1+\gamma_2)\right]-(\phi-\psi)K_t\right\} \tag{3.17}$$

This type of policy captures measures such as purchases of bad loans at less than market rates, and/or government guarantees on loans.

Consider also a proportionate subsidy to the banking sector, τ_s:

$$pr_t = (1+\tau_s)\frac{P_{st}}{P_{1t}}\left\{(S_t+\phi)\left[1-\eta\rho(\gamma_1+\gamma_2)\right]-\phi K_t\right\} \tag{3.18}$$

This subsidy is reflects, for instance, the extension of 100% government guarantees of deposits to the banking sector that were made in Japan in the mid 1990's. This guarantee acts to raise the amount of banking services provided at any given level of capital and labor inputs.

The firm's problem under this type of subsidy changes in the following way.

$$(1+\tau_s)\rho\left(\frac{S_{it}}{S_t}\right)^{\rho-1}\frac{P_{st}}{P_{1t}} = \rho\frac{P_{s,it}}{P_{1t}} = MC_t \tag{3.19}$$

$$w_t = (1+\tau_s)\rho\frac{P_{st}}{P_{1t}}\{\gamma_2\eta\}k_{s,it}^{\gamma_1\eta}n_{s,it}^{\gamma_2\eta-1}A_{s,i}(t)z_t^{\eta(1-\gamma_1-\gamma_2)} \tag{3.20}$$

$$r_t = (1+\tau_s)\rho \frac{P_{st}}{P_{1t}} \{(\gamma_1 \eta) k_{s,it}^{\gamma_1 \eta - 1} n_{s,it}^{\gamma_2 \eta}\} A_{s,it} z_t^{\eta(1-\gamma_1-\gamma_2)} \tag{3.21}$$

If the technology factor in credit goods production is held constant and there are no external effects to credit services production the following results can be derived.

Lemma 1 If $\gamma_1 + \gamma_2 < 1$ and q and z are constant then an increase in τ_s increases output and profits in the banking sector.

Proof: Note that (3.17) can be rewritten as:

$$R/q = \frac{(1-\theta) A_g \left(\frac{\theta \gamma_2}{(1-\theta)\gamma_1} \right)^{\theta}}{(1+\tau_s)\rho \gamma_2 \eta \mathrm{A}_s Z^{\eta(1-\gamma_1-\gamma_2)}} \left(\frac{K_s}{N_s} \right)^{\theta - \gamma_1 \eta} N_s^{1-\eta(\gamma_1+\gamma_2)}. \tag{3.22}$$

The result follows immediately by noting that the real interest rate from equation (3.2) is invariant to changes in τ_s and thus that the capital labor ratio in either sector is also invariant to changes in τ_s. Finally note that from equation (2.38) that an increase in credit services output implies profits must also rise.

Lemma 2 If $\gamma_1 + \gamma_2 < 1$ and $\theta - \gamma_1 > 0$ then an increase in R increases production net of fixed costs in the banking sector.

Proof: Equation (3.1) and (3.2) imply:

$$\frac{1}{\beta} = \left[(1-\delta) + \frac{r}{(1-b)R+1} \right] \tag{3.23}$$

or that the real interest rate is increasing in the nominal interest rate. This in turn implies from (3.2) that the capital labor ratios fall in both sectors. Then the result follows from inspection of equation (3.22).

Since inflation acts as a tax on labor supply and investment in this economy it will also likely be the case that the aggregate capital stock will fall. Then from equation (2.38) profits in banking sector will also rise.

Lemma 3 Suppose that ϕ is a fixed cost (replace ϕK_t with ϕ) . Then an increase in ϕ has no effect on equilibrium consumption, investment, labor input or relative prices. This follows directly from inspection of equations (3.13) and (3.14).

Lemma 4 An increase in government purchases lowers consumption and leaves other variables unchanged.

Proof: The proof proceeds in a similar way to the previous proofs.

In the more general situation where either the technology in the credit goods production sector or credit services sector faces and externality it is no longer possible to establish analytic results.

4. Calibration and results

In this section we report results from some computational experiments in which we calibrate the model to the Japanese economy as of 1990 and then consider the implications of a decline in the inflation rate to its 2000 level.

In order to facilitate comparison with other work, the calibration of Hayashi and Prescott (2002) is used as a reference point for calibrating the capital share parameter in the goods production sector, the depreciation rate of capital, the tax rate on capital income and the share of government purchases. The values for these parameters are reported in Table 1 below. The value for α, the leisure parameter is calibrated to data from 1983-1990 using equation (2.13). The household parameter *b* which governs the share of investment goods that are cash goods is set initially to zero. This implies that all investment goods require banking services and creates a role for the banking sector in low inflation environments. The inflation rate is set to the 1990 CPI inflation rate of 0.03%. The remaining details of the calibration are specific to the assumptions about the industrial organization structure of the banking sector. We consider two distinct structures. The first is monopolistic competition. Under this market structure, the capital share parameter in the banking sector, γ_1, is set to 0.36, the same value used in the goods sector, the labor share, γ_2, is set to 0.36 and η, the increasing returns to scale parameter is set to a value of 1.4. This is in the range of values used in by Hornstein (1993) (1.5) and Rotemburg and Woodford (1995) (1.4). The fixed cost parameter ϕ is set to 0.0005. This corresponds to a loss rate of .1% on outstanding bank loans. In 1990 loans by commercial banks were about the same size as GDP. From Hayashi and Prescott the capital output ratio is about 2. Thus loans are about half the size of the capital stock. The markup, ρ, is calibrated so that long-run profits are zero. This produces a value of ρ of 1.93 or about the value estimated previously by Hall (19??). Finally, we assume that the technology parameter for credit goods production q is given by:

$$q = -\upsilon \ln(m_t / c_t) \tag{4.1}$$

This is the same functional form used by Aiyagari, Braun and Eckstein (1998) and can be motivated by a situation in which there are a continuum of credit goods that differ in the amount of credit services inputs they require. We set υ to 0.1. This is the same value estimated by Aiyagari, Braun and Eckstein (1998). The complete calibration of the monopolistic competitive model is reported below in column 1 of Table 1.

This calibration has several implications that can be used to assess the model. First it implies that the share of employment of banking in total employment is 2.1%. For purposes of comparison the share of financial services and life insurance employment in GDP was 3.5% in 1990. Second, the model implies that, a, the share of consumption that is purchased as a cash good is: 0.92.

Table 1

Model Parameters

	Monopolistic competition	Perfect Competition
θ	0.36	0.36
γ1	0.36	0.36
γ2	0.64	0.64
η	1.40	1.40
ρ	0.52	0.52
b	0.00	0.00
υ	0.10	0.10
α	2.40	2.40
ϕ	0.0005	0.0005

To investigate the robustness of our conclusions to the market structure for the banking sector we also report results for the case where the banking sector is perfectly competitive and profits arise due to a strategic complementarity with goods production. Specifically it is assumed that $z_t = y_{gt}$. And the capital and labor share parameters are

set to a value of 0.1 and the markup is set to a value of 1.0. The complete calibration results for this specification are reported in column 2 of Table 1.

Monopolistic Competition

Table 2 reports the results for the monopolistic competition specification from simulating a drop in the steadystate inflation rate from $\pi = 0.03$ to a value of –0.007 the value of CPI growth in 2000. The results in column 1 correspond to the (counterfactual) case where there is no policy response and no adjustment of either markups of the fixed cost to return long-run profits to zero. Observe that this decline in the steadystate inflation has dramatic effects on the size and profitability of the banking sector. Employment in banking drops by 41% and profits fall by 948%. These declines indicate that a decline from low inflation to negative inflation produces substantial dis-intermediation. Even though by construction the banking sector is required for the provision of intertemporal credit, the demand for exchange credit to finance cash purchases is very low in a deflationary environment.

This model also has implications for the level of loan losses. It implies that they will rise as the inflation rate falls. To understand this result, note that in this economy the real interest rate depends on the inflation rate and a decline in the inflation rate also lowers the real interest rate in increases the steadystate capital stock output ratio and steadystate investment. This implies that losses on outstanding loans increase.

Somewhat surprisingly welfare also falls. This is due to the fact that in the monopolistic economy inflation interacts with the productive inefficiency of this IO structure in a nontrivial way. This effect has been documented elsewhere in the literature (see e.g. Woodford (2002)). To control for this effect one can set long-term profits to zero in the new steadystate. There are two ways to make long run profits zero. The first is to follow

Rotemberg and Woodford(1995) and set the markup equal to the increasing returns parameter $\rho = \mu$. (They assume $\gamma_1 + \gamma_1 = 1$.). They set the value of the markup to 1.4 (In our case $\rho = 1/1.4$).

An alternative approach is that of Hornstein(1993) who adjusts the fixed cost coefficient to ensure that long-term profits are zero (see (2.39) above)

Results for these two cases are reported in columns 2 and 3 of Table 2. Column 2 corresponds to the case where the markup is adjusted to bring profits back to zero. Column 3 corresponds to the case where the fixed cost term is lowered. Setting long-run profits to zero reduces banking employment further but welfare now rises.

It is worth noting that the column 3 results can be given two interpretations. One interpretation is that this is what would happen over time due to entry and exit from the banking sector. Banks with high non-performing loan ratios would exit. Alternatively, this can be interpreted as a policy intervention that is designed to reduce loan losses. For instance, government purchases of bad loans or other policies that effectively lower the value of ϕ act help stem banking sector loses. Independent of the interpretation, the model captures in a simple way why ridding banks of non-performing loans has been a focal point of recent policy debates. Moreover, the model predicts that independent of how the adjustment occurs employment in the banking sector will fall.

Table 2					
Simulation Results of a reduction in inflation from 3% to -.7%					
Monopolistic Competition Specification					
Percentage change relative to 1990 baseline (except reeal interest rate)					
Variable	Baseline	zero long-run profits restored by increasing the markup	zero long-run profits restored by lowering ratio of bad loans	Effect of a deposit guarantee	Effects of higher government spending
consumption	5.39	5.60	5.78	5.21	3.70
employment	2.50	2.30	2.12	2.68	4.15
investment	14.55	14.32	14.12	14.74	16.39
banking employment	-40.55	-54.43	-66.32	-28.91	-38.84
profits	-947.79	0.00	0.00	-1211.21	-944.76
Welfare	-0.24	0.07	0.32	-0.49	-2.64

As described above, the model can also be used to investigate the impact of a subsidy to the banking sector such as the extension of a 100% guarantee on deposits. Results from this type of policy intervention are reported in Column 4 of Table 2. The subsidy is calibrated in a way so that the benefits of this subsidy are equivalent to a 100 basis point increase in the nominal interest rate. This type of policy intervention has a positive effect on banking employment. Now employment falls by 30% as compared to 41% under the basline scenario. However, this policy has only has a negligible impact on profits. Most of the benefits of the higher subsidy get passed through to the two factors in the form of higher input prices. If instead the subsidy is set at a level that is equivalent to a 200 basis point increase in the nominal interest rate, employment only drops by 16%.

Finally, we also consider the impact of higher government purchases on the banking sector. Government purchases are by assumption a credit good in this economy and higher government purchases require more banking services. The effect of an increase in the share of government purchases in output from 0.13 to 0.15 is considered in column 5 of Table 2. This is the magnitude of increase in government purchases between 1990 and 2000. Even though government purchases are credit goods the

measured increase government purchases only have a negligible impact on banking employment and profits relative to the baseline case. Banking employment falls by 39% now as compared to 41% for the baseline case and the decline in profits is now 945% as versus 948%.

Table 3
Simulation Results of a reduction in inflation from 3% to -.7%
Perfect Competition Specification
Percentage change relative to 1990 baseline (except real interest rate)

Variable	Baseline	Effect of a deposit guarante τ=0.6	Effects of higher government spending g/y=0.14
consumption	5.28	5.14	4.40
employment	3.60	2.77	3.49
investment	14.38	14.61	15.30
banking employment	-310.19	80.01	-75.40
profits	-74.63	-54.30	-74.40
Welfare	1.60	-0.23	1.70

Perfect Competition

The perfect competition case is described in Table 3. The baseline parameters are

$\tau_s = 0, \tau_k = 0.48, \beta = 0.976, \delta = 0.089, \theta = 0.36, \gamma_1 = \gamma_2 = 0.1, \alpha = 2.4, \phi = 0 \rho = 1, \varepsilon = 1,$

g=0.13, b=0.0, q=1, $A_g = 1, A_s = 1.4$, and nu=0 (to be included in revised first table).

The results show in the first column that there is a comparable change in consumption, total employment, and investment, relative to the monopolistic competition model, when the inflation rate falls from 0.03 to –0.007. The main difference here is that banking employment falls by more and profits by less as compared to the monopolistic competition case.

The experiment of a subsidy to the economy that is also experiencing Japan's –0.007 inflation rate of 2000, produces an increase in employment in the banking sector; this stands in contrast to the monopolistic competitive model, while other results are more similar. The increase in government spending also produces similar results so the only big difference is in the banking employment and profits. It appears that the banking employment is more sensitive to changes in the effective price of the credit in the perfect competition model than in the monopolistic competition.
(While the monopolistic competition model requires zero profits to be reestablished, the perfect competition model is not so constrained and this leads to the …)

5. Concluding Remarks

In this paper we have described a dynamic economy in which the banking sector provides two services intertemporal credit which facilitates saving and investment activities and exchange credit which facilitates transactions. In this economy money is a substitute for exchange credit. In equilibrium the relative price of credit services is the nominal interest rate and there is an important link between the conduct of monetary policy and the size and profitability of the banking sector. We have found that a move from moderate inflation to deflation can have a big effect on households' demand of exchange services from the banking sector. This fall in demand in turn reduces bank employment and profitability of the banking sector when there are increasing returns and/or even small fixed costs associated with lending. These effects are of a sufficient magnitude that they provide a powerful stimulus for a government policy response. We

have investigated a variety of possible government responses and found that policies such as deposit guarantees are the most effective in stemming employment losses in the banking sector. Other policies that help banks cut losses on outstanding loans improve banking profitability but imply even larger reallocations of labor to other sectors.

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