Financial Intermediation with Heterogeneous Projects: An Application to the Japanese Credit Crunch*

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Abstract

Japan has gone through a long period of stagnation in the 1990s. We use a model of financial intermediation and endogenous occupational choice to understand this stagnation. In this model, investment projects are partly financed by loans and banks screen candidates by looking at their wealth. Due to various idiosyncratic risks, total wealth is heterogeneous across households. Calibrating the model to Japan, we conclude that the successive lowering of interest rates by the Bank of Japan was doomed to be ineffective, and that cash injections into the banking sector have little impact. Modifications to the regulation of the lending practices are, however, very potent in getting the country out of a credit crunch.

Keywords: Japan, Credit crunch, Basle accord, heterogeneous agents, bank regulation

JEL classification: E44, E22, G28, E58

errors or omissions are those of the authors.
1 Introduction

Japan has gone through a long stagnation during the 1990s. The average growth rate has been around 1% (-0.7% for 1997–1998). With only a few exceptions, business investment has been declining over the entire period. Several empirical studies, such as Motonishi and Yoshikawa (1999) and Woo (1999), identify a credit crunch during the 1997–1998 period, that is banks have been reallocating their assets from loans to risk-free fixed-income securities, as defined by Green and Oh (1991). Furthermore, Bayoumi (1999) argues that financial disruption has been at the origin of this extended slump. In order to get out of the credit crunch and the stagnation, several measures have been taken by the Bank of Japan and the Japanese government. In this paper, we use a novel model of financial intermediation and endogenous occupational choice to study how such a credit crunch may arise. After confirming some empirical regularities, we examine the effectiveness of the actions by the Bank of Japan and the Japanese government.

According to Motonishi and Yoshikawa (1999), investment (or the lack of it) is identified to be the major factor of the 1991–1994 recession, the 1995–96 recovery, and also the 1997–1998 recession. The poor performance of corporate investment can be blamed for the slow-down in investment, but this is not the whole picture. The banks suffering from bad loans became reluctant grant new loans, which further depressed investment. It was found that the fall in investment during the 1992–1994 recession was basically caused by worsening real profitability. However, a credit crunch followed in 1997. Given the fact that there was no intention to tighten monetary policy stance by the Bank of Japan, it can reasonably be
argued that the credit crunch was caused by the conservative lending action taken by banks. According to Motonishi and Yoshikawa (1999), the financial distress caused a 3.8% decline in investment growth while the real factor caused a 15.5% decline in investment growth in 1998. They also find evidence that small firms suffered the reduction of lending but not large firms. The results are consistent with Woo’s (1999) empirical study which suggests that a credit crunch was found in the 1997 bank data, but not for most of the 1990’s.

What could cause the change in the banks’ lending attitude? At least three hypotheses have been suggested: (1) risk-based capital requirement following the 1988 Basle Accord at the Bank for International Settlements; (2) voluntary risk reduction by bank managers; and (3) higher regulatory scrutiny by bank regulators.\(^1\) These three hypotheses are not exclusive and during a credit crunch state, every hypothesis could hold. Ito and Sasaki (1998) examine how the risk-based capital standards, the so-called Basle Accord, influenced the behavior of 87 major Japanese banks between 1990 and 1993. They find that banks with lower capital ratios tended to issue more subordinated debts and to reduce lending.

The Bank of Japan has been implementing very accommodative monetary policy to promote economic recovery. The monetary policy instrument, the call rate, virtually was set at its practical floor, zero. Besides, the Japanese government

\(^1\)Wagster (1999) studies the 1989–1992 credit crunch in the United States, Canada and the United Kingdom and shows that none of the three hypotheses can be eliminated as explanations for the U.S. credit crunch. For Canada, the results conform to the risk-based capital requirement and higher regulatory scrutiny hypotheses. For U.K., the higher regulatory scrutiny is the explanation for the crunch.
injected capital in several commercial banks and also relaxed capital adequacy requirement by changes in accounting practices. The question we ask here is how effective these measures can be.

To answer this question, we consider a model of financial intermediation which could generate a credit crunch scenario, in a sense that banks reduce their risky asset ratio while they could still be solvent if they were lending more. The reasons behind this behavior may be either risk-management policies (regulation internal to the bank) or capital regulatory rules (regulation external to the bank). In particular, we assume the banks constrain their lending behavior to a particular ratio, expected losses from loans to deposit. This ratio is calibrated according to a benchmark state, 1982–1989. During the reduced profitability period, 1997–1998, this ratio was binding and forced banks to lend less, a situation resulting a credit crunch. We then look at several policies that could be (and to some extend have been) implemented. We find that reducing interest rates or cash injections in the banking sectors are largely ineffective, and even counterproductive, confirmations of the liquidity trap reported by Krugman (1998) and Bernanke (1999). Allowing the banks to relax the lending rules is, however, a powerful measure to annihilate the credit crunch.

The model used here is innovative because it takes into account the savings decisions of households and it lets them choose whether to become entrepreneurs. These two elements are crucial in understanding the financing of banks and can explain the liquidity trap we observe. This is a departure from most of the extant literature. Also we find that credit frictions appear even though no information
problems like moral hazard, adverse selection or agency costs are present. Finally, we introduce heterogeneity across households, both workers and entrepreneurs, in order to capture the fact that small firms get squeezed more often in credit crunches. It allows us as well to model better the risk of bankruptcy.

In Section 2, we describe the model. The model is then calibrated in Section 3 to the “normal state” of the economy in 1982–1989. A credit crunch state is generated by adapting the calibration to the Japanese economy in 1997–98 in Section 4. Several policy options are considered in Section 5. Section 6 concludes.

2 The Model Economy

2.1 An Overview

There are three types of agents in the model economy: banks that collect deposits, make loans and invest in risk-free fixed-income securities, say treasury bonds; households who strive to become entrepreneurs by accumulating assets; and a central bank that regulates the banking sector.

Households are all endowed by two investment projects that require external financing, which they try to get approved by the bank. Having limited funds, the bank picks those agents that have the largest collateral, in others words, from the richest households. Given this rule, households try to accumulate assets to make the cut, as entrepreneurial income is expected to be higher than work income. Being an entrepreneur, however, is very risky: you may lose all your assets if the project fails. Besides entrepreneurial reasons, households want to accumu-
late assets also because they are hit by idiosyncratic unemployment shocks that are imperfectly insured, and because they face mandatory retirement. Assets are deposited at the bank. These various incentives to save and idiosyncratic shocks lead to a plausible distribution of wealth across households.

The banks choose the interest rate on loans and the cut-off point between entrepreneurs whose loans are approved and workers with rejected loans following several constraints: a) the banks must make a profit (the banks’ participation constraints); b) households must be willing to ask for loans (the households’ participation constraints); c) deposits must at least cover loans; d) losses from loans should not exceed a specific share of deposits. This last constraint is a proxy for the internal rules imposed on credit officers (“Value at Risk”) and the external rules implemented throughout the major banking systems by the Basle Accord (“capital adequacy requirement”). Any deposits unused for loans are invested in government bonds.

Effectively, this lending rule corresponds to rationing of credit. Banks would not make a loss if they were to approve more loans, but risk management imposes such a constraint. Our modeling of financial intermediation matches several features of the data: (a) a loan requires a collateral; (b) when credit conditions are tightened, more small projects than large ones are rejected; (c) most households have little wealth, which is only invested in bank deposits or similar financial vehicles.

Finally, the central bank picks the policy parameters: the rate on government bonds (and deposits) by means of an implicit monetary policy, and the level of
riskiness allowed in the loan sector. The bank may also inject cash in the banking system by increasing the amount of deposits.

A credit crunch may happen when the banks face more losses from their loans because of more frequent bankruptcies. If deposits do not increase, the banks have to reduce loans in order to satisfy their lending rule. This may mean that a larger share of assets are funneled to government bonds.

2.2 The Detailed Model

Formally, this model economy can be described in the following way. Households have infinite horizons, but face mandatory retirement every period with probability \( \tau \) and then death with probability \( \delta \). Before retirement, households are either “workers” or “entrepreneurs”, depending on their level of assets and the cut-off point \( m^* \) determined by the banks. A worker may be unemployed with a probability \( u \) and employed with probability \( 1 - u \). Each period, a worker earns an income of 1, while the unemployed receives unemployment benefits \( \theta < 1 \). A retired household received the same \( \theta \). All types of households decide on their level of consumption and the amount of deposits they wish to hold. The rate of return on deposits is \( R^d \).

Entrepreneurs have two investment projects that are jointly approved by the banks. All projects are of size \( x_i = \phi m_i / 2 \), where \( m_i \) is the amount of wealth the household has accumulated. As \( \phi > 1 \), bank financing is necessary at an interest rate of \( R^f \). The returns \( r_i \) on the projects are stochastic and may lead to bankruptcy of a project. Households are, however, liable for only half of their
assets in each project. In the event that both projects go bankrupt, a minimal level of consumption of \( \theta \) cannot be seized by the bank.\(^2\)

The dynamic programs of employed workers (W), unemployed workers (U), entrepreneurs (E) and retirees (R) are:

\[
V_W(m) = \max_{\{c, m'\}} \{ U(l_W, c) + \beta[(1 - \tau)(1 - u)V_W(m') + uV_U(m') + E_rV_E(m', r') + \tau V_R(m')] \}
\]

S. T.
\[
c + m' = (1 + R^d)m + 1,
\]

\[
V_U(m) = \max_{\{c, m'\}} \{ U(1, c) + \beta[(1 - \tau)(1 - u)V_W(m') + uV_U(m') + E_rV_E(m', r') + \tau V_R(m')] \}
\]

S. T.
\[
c + m' = (1 + R^d)m + \theta,
\]

\[
V_E(m, r) = \max_{\{c, m'\}} \{ U(l_E, c) + \beta[(1 - \tau)(1 - u)V_W(m') + uV_U(m') + E_rV_E(m', r') + \tau V_R(m')] \},
\]

S. T.
\[
c = \max\{\theta, m + 1 + \sum_{j=1}^{2}(1 + r^j - R^l)x^j + R^l m - m'\},
\]

\[
\sum_{j=1}^{2} x^j = \phi m,
\]

\[
V_R(m) = \max_{\{c, m'\}} \{ U(1, c) + \beta[(1 - \delta)V_R(m')] \},
\]

S. T.
\[
c + m' = (1 + R^d)m + \theta.
\]

A participation constraint has to be met, namely that households qualifying

\(^2\)We need entrepreneurs to be able to diversify in two projects to get plausible solutions of the model. Indeed, having a single project would be too risky and nobody would want to be an entrepreneur.
for loans indeed want to be entrepreneurs:
\[ E_r V_E(m, r) \geq (1 - u) V_W(m) + u V_U(m) \quad \forall m \geq m^*. \]

The banks are all identical and competitive and can therefore be modeled as a representative bank. This bank accepts deposits from households paying them the rate \( R^d \). Those deposits are partly invested in government bonds, earning the same \( R^d \), or in loans at the rate \( R^l \). Being competitive, and assuming free entry, the bank has zero profits. Of course, \( R^l > R^d \) since the bank has to bear several costs: (a) liquidation costs in case of bankruptcy, amounting to a share \( \mu \) of principal and interest; (b) a minimal consumption of \( \theta \) has to be granted to households when both projects are bankrupt. In addition, the expected losses from the loans cannot exceed a fraction \( \alpha \) of the deposits, and, finally, the bank cannot lend more that what it has. Thus, the three constraints of the bank are:

\[
\int_{m_t^* < m_t} R^d_t m_t = E_r \left\{ \int_{m_t^* > m^*} R^l_t (x_t^i - m_t^*)/2 - \int_{m_t^* > m^*} L_t^i \right\} + R^d_t \max \left\{ 0, \int_{m_t^* < m_t} m_t - \int_{m_t^* > m^*} (x_t^i - m_t^*/2) \right\},
\]
where \( L_t^i = \max \left\{ 0, (1 + \mu) \left[ (1 + R^l_t)(x_t^i - m_t^*)/2 - x_t^i(1 + r_t^i) \right] + g_t^i \right\} \)

\[
E_r \left\{ \int_{m_t^* > m^*} L_t^i \right\} \leq \alpha \int_{m_t^* < m_t} m_t, \\
\int_{m_t^* > m^*} (x_t^i - m_t^*)/2 \leq \int_{m_t^* < m_t} m_t.
\]

where \( g_t^i \) represents additional costs stemming from having to grant minimal consumption.

Clearly, \( m^* \) is a critical decision variable for the banks. Indeed, if the probability of bankruptcies increases, the banks are tied by \( \alpha \), which means they must
somehow decrease approvals of loans. Our modeling choice is to have the banks screen agents by wealth because the model then captures the fact that small firms are more squeezed than large ones. There is no indication that this is an optimal decision rule. Optimizing would have required additional elements in the model which either would have complicated it considerably (search, asymmetric information) or would have made calibration hazardous (fixed auditing cost, minimum project size).  

Other modeling choices could have been made. We encourage strongly research in this line.

Finally, the central bank has three roles: it determines monetary policy, summarized by the interest rate on government bonds, $R^d$; it regulates the lending of banks by setting $\alpha$; and it can help banks by providing them with extra deposits.

Let $z$ be the set of parameters describing this model economy. The steady state equilibrium is then a loan interest rate $R^l(z)$, a loan threshold $m^*(z)$, a law of motion for the distribution of the households $\lambda' = g(\lambda; z)$ and households’ decision rules $m^W(m; z)$, $m^U(m; z)$, $m^E(m; z)$ and $m^R(m; z)$ such that:

1. each household solves its optimization problem;

2. the banks meet all their constraints;

3. the households’ participation constraint is satisfied.

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3In fact, one could imagine in this model that banks could insure entrepreneurs fully on their risk to returns. As we do not think such contracts are the norm, we prefer sticking to simple loan contracts.
2.3 Computational Issues

Since agents are heterogeneous in their types \((W, U, E, R)\), assets \((m)\), as well as the project returns \((r)\), we need to discretize the state space and solve this model economy numerically. The calibration is described in the next section. The computational procedure is the following:

1. define grids over household types, assets and project returns;
2. guess \(R^d\) and \(m^*\);
3. compute value functions iteratively;
4. use decision rules and laws of motion to determine the invariant distribution \(\lambda\);
5. check constraints of the bank and the participation constraints of the households. If not met, go back to 2. If the bank still does not balance revenue and expenses, modify \(R^d\) and go back to 2;
6. check boundaries of grids. If any one is hit, go back to 1;
7. compute aggregate statistics.

Note that there are no aggregate shocks in this model economy. The reason is that it is extremely difficult to implement them computationally. Indeed, the distribution of assets and the other measures of heterogeneity would not be invariant anymore and would require state variables with many dimensions. With future developments in computing power and solution techniques, a similar problem with aggregate shocks may become solvable.
Yet, we do not believe that studying steady states is a completely unreasonable assumption here. Indeed, Japan has been in a prolonged slump that has lasted as long as a full cycle in other countries. In a certain sense, this economy has settled into a new steady state.

3 A Calibration to Japan

We calibrate the model to the average Japanese economy in the years 1982 to 1989, that is a full cycle where there was no suspicion of a credit crunch. We follow the literature for several parameters. We choose the utility function to be

\[ U(c) = \frac{(l_r^e c^{\phi})^{1-\rho} - 1}{1 - \rho}, \]

and set \( \rho \) and \( \sigma \) to 2.5 and 0.67, respectively, their standard values in the literature. \( l_E, l_W, l_U \) and \( l_R \) are set to be consistent with standard models with explicit leisure specification, i.e. \( l_E = l_W = l_U = 0.55 \) and \( l_R = 1 \), which implies that working hours of employed workers and entrepreneurs and the search effort of the unemployed are 0.45. Given that we have a period length of one year in mind, \( \beta = 0.96 \).

The unemployment insurance benefit \( \theta \) covers 15% of wage rates, which were normalized to one. During the benchmark period, the unemployment rate is 2.60%. We measure the average D/E ratio at 2.67. The retirement and death probabilities are set to be 0.03 and 0.10, respectively, implying that the expected number of working years of a worker is 33 and the after-retirement life expectancy of a retiree is 10 years.
The distribution of returns ($r$) is not available. We derive it from the data on lending rates ($R_l$), the average returns on equity ($ROE$), the average debt-equity ratio ($D/E$), and the ratio of loan loss reserves and loans ($\gamma$). The returns and the lending rates are assumed to be normally distributed and independent, i.e. $R_l \sim N(\mu^R, \sigma^2_R)$ and $r \sim N(\mu^r, \sigma^2_r)$. From the observed lending rates, we can estimate the mean $\mu^R$ and $\sigma_R$ with a fitting method. Given the average $ROE$, $D/E$, and the average lending rate $R_l$, the mean of returns, $\mu^r$, can be calculated by $r = \frac{ROE + (1 + R_l)D/E}{1 + D/E} - 1$. To get the standard deviation, $\sigma_r$, we use data on loan loss reserves. Here we define the net income debt ratio as $n_r$, where $n_r = (1 + r)(1 + 1/(D/E)) - (1 + R_l)$. The mean of $n_r$ is $(1 + \mu^r)(1 + 1/(D/E)) - (1 + \mu^R)$ with a variance of $(1 + 1/(D/E))^2\sigma^2_r + \sigma^2_R$. If $n_r < 0$, the loan incurs a loss. The probability of a loan loss can be calculated by $P^{loss} = P[n_r < 0]$, where $P$ is the probability distribution of $n_r$. Note that $P^{loss}$ is a function of $\mu^r, \mu^R, \sigma_R$ and $\sigma_r$. The only unknown argument in $P^{loss}$ is $\sigma_r$. Now we assume that the banks’ loan loss reserves are realized (or an upper bound). Hence by equating the loss/loan ratio $\gamma$ to $P^{loss}$, $\sigma_r$ can be calculated.

Once we have the mean and standard deviation estimates of the return distribution on projects, we approximate the continuous normal distribution by a discrete distribution with three returns on projects, negative, close-to-mean and high. The discretization of the continuous distribution is to simplify the computation. The negative return is selected to allow a possibility to get a loan loss for the banks in equilibrium. The three returns and the corresponding probabilities are calculated based on a truncated normal distribution.
According to our calculation, in the benchmark period, the returns of projects are \( r = \{-29.36\%, 8.67\%, 44.60\%\} \) with probabilities \( \{0.0062, 0.9833, 0.0105\} \). The real returns are calculated by subtracting the inflation rate during the period, 1.57%.

The average real lending rate is 4.52% over the period. The deposit rate and the asset for the minimum qualified firm \( m^* \) are chosen such that banks balance their income and disbursements, while the bond/deposit ratio is as close as possible to the average of the bond-holding ratios over the reference period, 17%. As a consequence of these constraints, the deposit rate is endogenously determined to be 4.43% while \( m^* \) is 16.4, and the bond/deposit ratio is 18.4% (see Table 1). In the benchmark steady state, the proportion of workers is 0.71 while there are 6% of entrepreneurs and 23% of retirees. The benchmark economy has a Gini coefficient for wealth of 0.47, which compares to 0.62 in actual data as reported by Takayama and Arita (1994). Also, this means that the distribution of assets is not clustered around \( m^* \) or 0, as it would be the case without retirement in the model, for example.

Banks incur some losses in this benchmark economy as negative returns lead some household bankruptcy. The loss/deposit ratio \( \alpha \) is found to be 0.067%. We use this ratio as a benchmark for the banks’ lending policy in the following experiments. It turns out that during periods with reduced returns, \( \alpha \) becomes binding, forcing the banks’ lending behavior to turn more conservative, resulting in a credit crunch.
4 Generating a Credit Crunch

The empirical literature identifies 1997–1998 to be a period of credit crunch in Japan. During the period, the unemployment rate is 3.75%, which is higher than in the benchmark period, 2.60%. The average D/E ratio is 2.69, which is slightly higher in than the benchmark period, 2.67.\(^4\) The unemployment benefit (pension benefit), the retirement and death probabilities are set to be the same as the benchmark period.

To compute the returns on the projects during this period, we employ the same method as in the benchmark case. The returns are \{-35.39\%, 3.94\%, 45.15\%\} with probabilities \{0.0138, 0.9770, 0.009\}. The return distributions show a reduced profitability during the credit crunch compared to the benchmark period.

The new steady state equilibrium is determined by finding the values of \(m^*\) and \(R^d\) such that the bank’s loss/deposit ratio \(\alpha\) matches the benchmark case, 0.067\%, banks equilibrate revenues and expenses, and the participation constraint holds.

In this new equilibrium, we find that the minimum qualified firm has assets of \(m^* = 17.0\), slightly more than in the benchmark case, 16.4. This suggests that some reduction in loans to smaller firms has occurred, as Gertler and Gilchrist (1994) and Li (1997) have noticed in the data. Total loans are reduced by more than 60\% in the credit crunch state compared to the benchmark state. The lending

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\(^4\)In Yuan and Zimmermann (1999), we show, albeit for a different country, that of the three changes in the exogenous parameters, the change in the return distribution is the one that generates most of the credit crunch, by far. The increase in labor uncertainty leads to more deposits, which counterbalances partly the credit crunch.
rate is calculated to be 4.70%, which is slightly higher than the benchmark lending rate, 4.52%. By looking at the distribution of bank assets, we see a big increase in the ratio of bank deposits allocated to bonds. The ratio increases to 71.6% compared to the benchmark result of 18.4%. The restriction on the loss/deposit ratio $\alpha$ effectively mimics the conservative bank lending behavior. This avoids explicitly modeling changes in bank risk-aversion in lending under different economic states.

The sharp reduction in loans implies that more people become workers (from 71% to 75%) and less people become entrepreneurs (from 6% to 2%). The Gini coefficient decreases to 0.42 compared to the benchmark case, 0.47, and the average utility is decreased from -0.263 to -0.283 during this credit crunch state.

In this state of the economy, bankruptcies happen more often because of reduced returns of projects and higher lending rates. Banks are tied by their loan strategy, and as losses increases as a share of loans, they have to reduce the amount of loans. As $m^*$ is increased, some entrepreneurs become workers, thereby driving down the amount of loans and increasing deposits. The decrease in loans is partially offset by the increase in size of the remaining loans. This process continues until the banks find the $m^*$ that yields the original loss/deposit ratio $\alpha$. Along the way, banks also have to modify the loan rate to recover the higher costs per loan due to losses.

We interpret these results as evidence of a credit crunch. Indeed, we observe a massive reallocation from private loans to government bonds while the banks’ profit situation is unchanged. Indeed, without constraints on $\alpha$ this reallocation
would not have taken place.⁵

5 Policy Responses to a Credit Crunch

Given that the model economy experiences a credit crunch, what can a central bank in this model do? One option is to lower interest rates, and this is what the Bank of Japan has been actively pursuing with its “zero interest rate” policy. In our model economy, such a policy is reflected by an exogenous reduction in the deposit rate $R^d$, which is also the rate on government bonds.

We show in Table 2 the impact of a 100 basis point reduction in $R^d$. It turns out that this is a very bad policy in the following sense: it discourages households from depositing money at the bank, which makes it impossible for the banks to meet the targeted loss/deposits ratio $\alpha$ of 0.067%. This means that banks give no loans and the whole banking system closes down.⁶ In the table, we show the configuration with the lowest attainable $\alpha$, 0.191%, still at three times its allowed target.

One may want to look at the opposite policy, an increase in $R^d$. While the banking sector remains active, the policy does not eliminate the credit crunch (the share of assets invested in bonds is almost identical) but the total amount of

⁵Yuan and Zimmermann (forthcoming) has several robustness experiments on a similar model applied to Canada that highlight this.

⁶It should be noted that shutting down the banks is a solution in all experiments. Here it is the only one we could find. Although we have no uniqueness theorem to support it, we could not find any other equilibria than those presented in the tables and the “zero” equilibrium.
loans increases a little as households are encouraged to deposit more at the banks. Surprisingly, average utility is even higher than in the benchmark case: indeed, workers save so much given the high return on deposits that they can enjoy a higher average level of consumption.

The obvious policy to eliminate the crunch is then to relax $\alpha$, that is to allow the banks to take more risk on their portfolio, either through an explicit relaxation of the regulation or through loan guarantees. The experiment we call “lenient lending” purports to find what new $\alpha$ and lending rate $R_l$ it takes to find the same bonds/deposits ratio as in the benchmark, thereby annihilating the credit crunch. Such a policy is possible, all that is needed is to allow the banks to take three times as much losses from loans on their portfolio. But as they are still making a (small) profit, they are willing to go along.

As $\alpha$ is relaxed, the banks lower $m^*$ to allow more households to get loans. The additional losses can be financed by the loan rate which is higher than the bond rate. The loan rate can even be reduced slightly by three basis points. Even though the top depositors are now using their funds for their projects, a household strives to accumulate more deposits as it is easier to become an entrepreneur, a state that has a higher return than that of a depositor. Indeed, while the expected project return is below the deposit rate, the return on own funds is much higher.

While the Basle accord imposes regulators of each participating country to apply uniform standards on loan risk in banks, the introduction in some countries has led to a tightening of standards that may have led to credit crunches, as Wagster (1999) suggests. This can be corroborated by this model: a reduction in $\alpha$
leads to a credit crunch. The Bank of Japan may have realized this as it modified some accounting rules to allow banks to take more loan risk while still meeting the Basle accord criteria, i.e. it changed the formula of $\alpha$ to make it less binding or, equivalently, increased $\alpha$. Yet, this does not seem to have been sufficient. Indeed, look at the case with a reduction in $R^d$: we had to triple $\alpha$, but with the strong interest rate reduction the Bank of Japan has pursued (more than the 100 basis points we assumed here), the increase in $\alpha$ would be even larger.

A further policy applied in Japan was to use public funds to provide cash directly to the banks. In our economy, we model this as an addition to deposits in the banks. We calibrate this injection to 10% of deposits or 30% of output, which we consider to be an upper bound. Indeed, the additional liquidity injected in the Japanese economy peaked at 0.2% of GDP in 1998, plus 1.9% of GDP in direct capital injections directly to the banking sector (OECD 1999). This policy does not seem to be effective. Indeed, while the additional cash allows the banks to make more loans while still meeting the loss/deposits criterion, the quantitative impact is modest. The reduction in the cut-off point $m^*$ is minimal, from 17 to 16.95, increasing loans by only 6%. In fact, a significant portion of the injection goes straight into government bonds, surely not the purpose of such a policy. Indeed, the conditions of the banks have not changed much, so they continue to invest about 72% of deposits in bonds.

The final experiment combines the cash injection with a lowering of the interest rate. Indeed, the cash injection corresponds to an increase in the money supply that usually results in a reduction of interest rates. Quantifying this reduction is
no simple task. For this experiment we use the result of Chinn and Dooley (1997) estimate the semi-elasticity of money demand to be -0.39 in Japan. Given that this estimate is rather high, we can consider this experiment as an upper bound (the preceding one being the lower bound with a semi-elasticity of zero). This means that the injection of 10% of new deposits combines with a 4 basis points reduction in $R^d$. It turns out there is not much of a change compared to the case without an interest rate change. This experiment also highlights the existence of a liquidity trap: Injections have no impact because the banks view cash and bonds as perfect substitutes. Contrarily to Krugman (1998) this happens in our model economy even though interest rates are not at zero. Bernanke (1999) also finds evidence of a liquidity trap as the Bank of Japan nominal instrument rate is zero and the accelerated growth of base money since 1995 has not lead to similar increases in broad money: bank prefer holding excess reserves rather than lend. Cho and Kang (1999) have also found, empirically, that banks approve more loans after a monetary expansion, but not in periods of financial distress.

These results are driven by two very important components of the model economy. First, the lending rule $\alpha$ is the most binding constraint of the banks. Second, households’ decisions regarding asset accumulation are sensitive to interest rates and to the tightness of credit. We find that it is essential to understand credit crunches in a general equilibrium, as all three sides of the market, savers, intermediaries and entrepreneurs, are interdependent.

\footnote{Incidentally, this is the exactly same number that Chari, Kehoe and McGrattan (1998) find for the United States, although defined on somewhat different variables.}
6 Conclusions

We have studied the recent credit crunch in Japan using a dynamic general equilibrium model with heterogeneous agents where it is determined endogenously whether or not households become entrepreneurs. This model is of particular interest in the case of Japan, where the credit crunch has been prolonged, combined to an investment slump lingering for six years. To replicate the credit crunch, we included in the model a simple lending rule for the banks to mimic the regulations imposed by the Basle Accord on risk-based capital requirements. According to this rule, banks cannot generate more expected losses from their loans than a predetermined share of their assets. Another important and innovative feature of the model is that deposits in the banks are determined endogenously by the saving decisions of households.

We found that such lending regulation constrains the banks very much. First, lower returns on investment projects, as experienced in 1997–1998, imply higher expected losses from bankruptcies, which in turn imply that banks need to cut down strongly on loan approvals. We find a severe credit crunch, as banks now reinvest over 70% of deposits into “unproductive” government bonds, instead of the 18% in normal times.

We then looked at various policies the Bank of Japan and the Japanese government have used. Reducing interest rates proves ineffective because (a) households do not want to accumulate deposits and (b) the loan industry shuts down. Injecting cash in the banking system has little impact as banks remain locked by their lending rules, thereby creating a liquidity trap. Relaxing the loan regulation works
wonders, however. The banks can make more loans while still being able to balance expenses and revenues, and the economy returns close to the normal situation despite the lower returns on investments.

The lending regulation as implemented by the Basle Accord are currently being debated and revised. This paper shows that some flexibility in this regulation is beneficial, especially as the other tools of the central bank are ineffective in alleviating a credit crunch.
References


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Table 1: Steady State Analysis, Japan
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Table 2: Policy Analysis, Japan