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# THE CREDIT CHANNEL IN JAPAN: RESOLVING THE SUPPLY VERSUS DEMAND PUZZLE

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**Abstract**

A long-standing macroeconomic issue is how monetary policy affects the real economy. Previous VAR research has found that bank loans typically contracted following a monetary tightening. This is consistent with the credit view: a monetary tightening decreases aggregate demand by shifting the loan supply curve left. However, the finding is consistent with another interpretation: a monetary tightening operates through the conventional money channel and decreases the demand for loans. This observational equivalence is called the "supply-versus-demand puzzle." This paper shows that embedding the loan price in a macroeconomic VAR model reduces the puzzle to the simultaneous equation bias. As a proxy for the loan price, the survey-based data is utilised. The main finding is that the loan supply curve shifts left after a monetary tightening. The effectiveness of monetary policy is also confirmed. From these results, this paper concludes that monetary policy operates through the credit channel in Japan.

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# 1 Introduction

Under the assumption that bank loans and bonds are imperfect substitutes for some borrowers, Bernanke and Blinder (1988) show that draining bank reserves reduces the amount of loanable funds and forces bank-dependent borrowers to cut their expenditures on investment. This transmission mechanism of monetary policy is called the "bank lending channel." Bernanke and Gertler (1989) show that a monetary tightening worsens enterprises' balance sheets and induces lenders to shift funds from risky loans to safe bonds, which decreases aggregate demand by forcing the enterprises to cut their investment plans. This transmission mechanism is called the "balance sheet channel," and these different channels of monetary policy are collectively called the "credit channel." This paper aims to show that the credit channel of monetary transmission is operative in Japan.

To study the monetary transmission mechanism, it is essential to investigate the dynamic interaction among macroeconomic variables, and this paper adopts a structural VAR approach. The main focus is on an empirical resolution of the "supply-versus-demand puzzle" (Bernanke 1993, p. 57) using Japanese data. The puzzle is as follows. Suppose that one estimates the impulse response function of bank loans to a negative innovation in monetary policy, finding that bank loans contract. Such a finding is consistent with the credit view that a monetary tightening shifts the loan supply curve left, but it is also possible that the fall of bank loans is due to a leftward shift of the demand curve for loans. The impulse response function

of loans to an innovation in monetary policy does not, of itself, indicate whether the fall of bank loans is largely due to the leftward shift of the loan supply curve or the leftward shift of the loan demand curve.

This paper offers a way to identify shifts in supply and demand in the credit market by utilising survey-based data to proxy for the price of additional bank credit. As explained in the next section, embedding both the price and quantity of bank credit in a macroeconomic VAR reduces the supply-versus-demand puzzle to a standard identification problem. The third section of the paper provides a brief description of the VAR model that is used to investigate the credit channel of monetary transmission. This section also includes a discussion of the construction of our price of credit variable. Results are presented in the fourth section, and the main novelty of the paper is that we are able to establish that, in Japan, a monetary tightening is followed by a leftward shift of the loan supply curve. The fifth section concludes.

# 2 The Supply versus Demand Puzzle

## 2.1 Extant Studies

In search of evidence for the credit view, researchers have investigated the behaviour of credit aggregate following a monetary tightening. In an influential paper, Bernanke and Blinder (1992) estimate a VAR model for the U.S. economy from 1959 to 1978, which includes the federal funds rate, the unemployment rate, the

consumer price index, and three bank balance-sheet variables (deposits, securities, and loans). They analyse the impulse response functions of these variables to an innovation to the funds rate, finding that an unanticipated hike in the funds rate is followed by a decline in loans and a rise of the unemployment rate. With a longer sample of 1959 to 1990, their findings are reproduced by Kashyap and Stein (1994). Using Japanese data, Ueda (1993) obtains similar results.

The finding that a decline in bank loans follows a monetary tightening is certainly consistent with the credit view: a monetary tightening has an impact on real economy by shifting the bank loan supply curve left. A problem is that similar results can be obtained even if the credit channel is not operative. Suppose that a monetary tightening depressed aggregate demand through the conventional money channel. Then, the consequent decrease of the demand for loans would lead to a decline in bank lending. The decline in bank lending, of itself, does not indicate whether the loan supply curve shifts left or the loan demand curve shifts left. This observational equivalence is the supply-versus-demand puzzle.

Kashyap, Stein, and Wilcox (1993) try to deal with the supply-versus-demand puzzle by looking at the behaviour of commercial paper and business bank loans in the wake of tight money. For this purpose, they define the "mix" as the ratio of business bank loans to the sum of business bank loans and commercial paper. Their intuition is as follows. A leftward shift of the supply curve of bank loans will force borrowers to substitute away from bank loans into commercial paper, so that the mix will drop. Using the U.S. data, they find that the mix drops following a monetary

contraction. The fall of the mix does not necessarily mean a leftward shift of the supply curve of bank loans, however. It is possible, for instance, that the demand for commercial paper increased relative to the demand for bank loans.[1] If there are certain sorts of heterogeneities in credit demand, their approach is subject to the same identification problem as the bank loan market - the supply-versus-demand puzzle - which is the subject of this paper.

## 2.2 An Alternative Approach

This paper provides an alternative approach to resolve the supply-versus-demand puzzle. An important assumption is that an observable quantity of bank loans is the equilibrium value given by the intersection of the demand and supply curves in the bank loan market. Apart from errors in measurement, a change in the quantity may be associated with a shift of the demand curve, a shift of the supply curve, or both. A decline in the quantity, for example, is not necessarily caused by a leftward shift of the supply curve. Observing the price will, however, help us to identify the shifts of the supply and demand curves behind the change in the quantity.[2]

The approach can be well illustrated using a simple demand-supply model. Suppose that an exogenous shock occurred. Such a shock will shift the supply curve and/or the demand curve, so that the price (P) and/or the quantity (Q) will change.

[1] See Gertler and Gilchrist (1993) and Oliner and Rudebusch (1996) for the ambiguities concerning the interpretation of the Kashyap, Stein, and Wilcox (1993) results.

[2] A difficulty lies in measuring the price of bank loans. The construction of the price of bank loans will be discussed in section 3.2.

As depicted in Figure 1, there are four possible changes:

- Case I: Q increases, while P does not fall,
- Case II: P rises, while Q does not increase,
- Case III: Q decreases, while P does not rise,
- Case IV: P falls, while Q does not decrease.

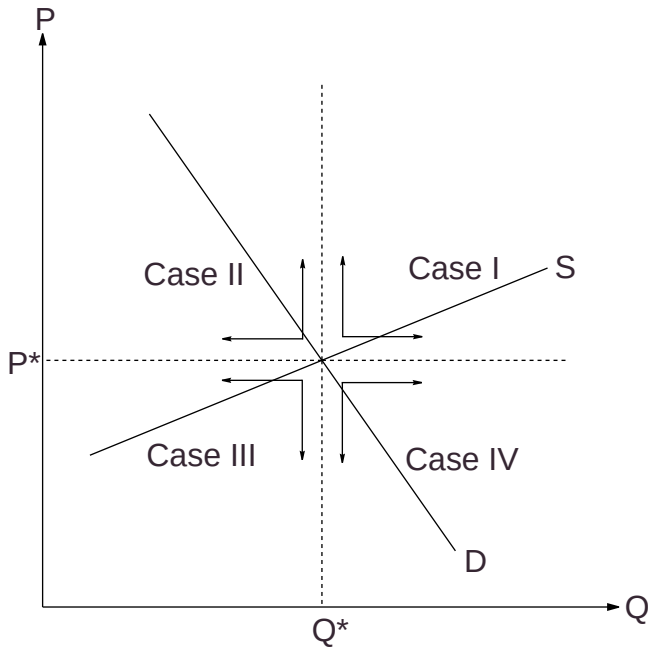


Figure 1: Possible changes in price and quantity of a commodity

Case I occurs only if the demand curve shifts right. It is not clear, however, whether the supply curve shifts right or left. Suppose that the demand curve shifts from D to D′ in Figure 2. As long as the supply curve shifts within a range between S′ and S″, both P and Q increase. If the supply curve shifts to S′, P does not change.

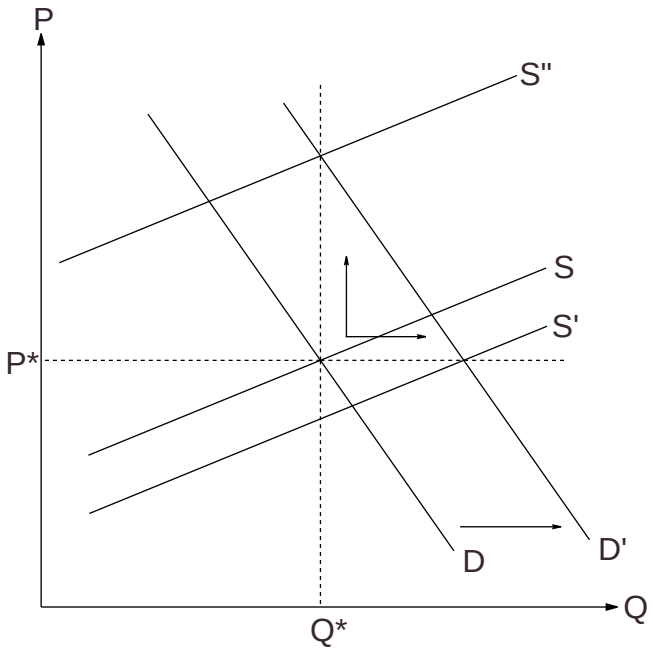


Figure 2: Case I: Q increases, while P does not fall.

Similarly, Case II occurs only if the supply curve shifts left. Suppose that the supply curve shifts to S′ in Figure 3. As long as the demand curve shifts to a range between D′ and D″, P rises and Q decreases. If the demand curve shifts to D′, Q does not change. In Case II, it is not clear how the demand curve shifts. Case III and IV can be depicted as mirror images of Figure 2 and 3, respectively. While Case III occurs if the demand curve shifts left, Case IV occurs if the supply curve shifts right.

In the context of testing the credit view, Case II is of prime interest. If we find Case II statistically significant in the bank loan market after a monetary tightening, we may conclude that the supply curve of loans shifts left, so that the credit view is supported. Similarly, we can reject the credit view if we find Case IV significant. In Case I and III, however, we cannot draw any conclusion about the position of the

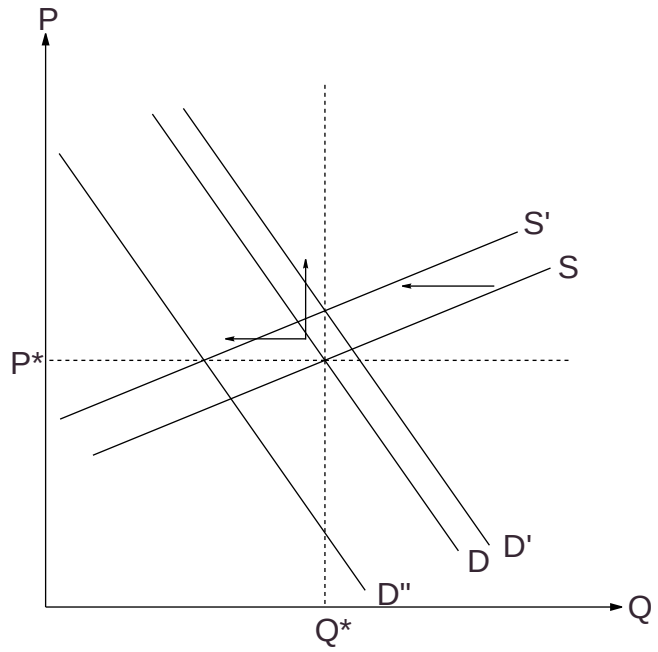


Figure 3: Case II: P rises, while Q does not increase.

supply curve.[3] Thus, the probability that we cannot accept the credit view when it is true may be high. Nevertheless, the approach identifies a shift of the supply curve of loans, depending on the results. Based on the above argument, the hypothesis will be formalised in a testable form in the fourth section.

[3]In Case I or III, a concrete conclusion about the money view can be drawn. One should note that the money view and the credit view are not exclusive each other. Rejection of the money view does not mean acceptance of the credit view, and acceptance of the money view does not mean rejection of the credit view.

# 3 Model and Estimation

## 3.1 Structural Model

This subsection describes the construction of our structural VAR model to test the credit view. When constructing a model, the first task is to decide which variables should be modelled. Taking into account the basic credit channel story, it is obvious that the dynamic interaction among three markets (goods, money, and loans) needs to be investigated.[4] Hence, the minimal set of variables to model are three quantities and three prices of these markets: aggregate real output (Y), the general price level (P), money (M), a short-term interest rate (R), bank loans (L), and a measure of the price of bank loans (LP).

In the structural VAR model, each of the six variables is linked. The model is typically written in vector form as

$$\mathbf{B}_0\mathbf{y}_t = -\mathbf{\Gamma}\mathbf{x}_t + \mathbf{u}_t, \tag{1}$$

where

$$\mathbf{y}'_t = (\mathrm{P}_t,\ \mathrm{Y}_t,\ \mathrm{M}_t,\ \mathrm{R}_t,\ \mathrm{L}_t,\ \mathrm{LP}_t), \tag{2}$$

$$-\mathbf{\Gamma} \equiv [\mathbf{k},\ \mathbf{B}_1,\ \mathbf{B}_2,\ \cdots,\ \mathbf{B}_p], \tag{3}$$

$$\mathbf{x}'_t \equiv [1,\ \mathbf{y}'_{t-1},\ \mathbf{y}'_{t-2},\ \cdots,\ \mathbf{y}'_{t-p}], \tag{4}$$

and $\mathbf{u}$ is a vector of structural shocks. We assume that these shocks are serially

[4] For instance, the theoretical model of Bernanke and Blinder (1988), which is the building block of the lending view, consists of the three markets: goods, money and credit.

uncorrelated and uncorrelatd with each other. That is,

$$E(\mathbf{u}_t\mathbf{u}_\tau) = \begin{cases} \mathbf{D} & \text{for } t = \tau \\ \mathbf{0} & \text{otherwise,} \end{cases} \tag{5}$$

where $\mathbf{D}$ is a diagonal matrix.

In the literature, the equation associated with the short-term interest rate, R, is usually interpreted as representing the response of the monetary authority to current and past developments in economy, and a shock to R is regarded as an innovation to monetary policy. This paper follows the convention. As the debate between Rudebusch (1998) and Sims (1998) shows, however, the common practice is contentious. For a shock in R to be a good indicator of monetary policy, it must be that the central bank supplies reserves elastically at the targeted level of R. Not until the late 1990s did the Bank of Japan (BOJ) disclose how it implemented monetary policy.[5] Nevertheless, there have been economists who have argued that the BOJ always attempted to control the overnight call rate (see, for example, Okina 1993, Ueda 1993, and Yoshikawa 1995). Okina (1993) emphasizes the institutional fact that the Japanese reserve accounting system is a lagged reserve system.[6] Under such a reserve system, the demand for reserves is predetermined each month. Since

[5]The Bank of Japan now officially announces that the overnight call rate is its operating target. See minutes of the Monetary Policy Meeting, which are available in English on the web of the Bank of Japan at http:\\www.boj.or.jp.

[6]In Japan, banks are required to maintain reserves, which are the product of the reserve ratio and average deposits outstanding in each calendar month, during the period from the 16th of that month to the 15th of the next month.

the Japanese banks hold almost no excess reserves, the BOJ faces a nearly vertical demand curve for reserves in the short-run. To avoid excessive fluctuations in the short-term interest rate, the BOJ must supply reserves passively at the targeted rate. Thus, it seems plausible to interpret a shock to R as an innovation to monetary policy.

## 3.2 Data Selection

The next task is to choose data to proxy the six variables in the model. The consumer price index and the seasonally adjusted index of industrial production are chosen for the price level (P) and real output (Y), respectively. For the short-term interest rate (R), the uncollateralised overnight call rate should be ideally chosen, since this is what the Bank of Japan (BOJ) now announces as its operating target. Not until July 1985, however, did the uncollateralised call market come into operation. To obtain a longer sample period, we use the collateralised overnight call rate, which the BOJ reputedly targeted before the money market reform of November 1988. For money (M), the monetary base is selected. As its quantity is directly affected by the BOJ's open market transactions, the monetary base seems more closely related with the call rate than are other monetary aggregates.[7] For the volume of bank loans (L), data series for "new loans for equipment funds" are found in TANKAN, the BOJ's quarterly economic survey of enterprises. For consistency with the output series,

[7]McCallum (1999) argues that the monetary base is an essential variable for evaluating the Japanese monetary policy.

which is the index of industrial production, the subset of the data, which refers to loans to manufacturing, is selected. Importantly, this series measures the flow of bank loans but not the stock.

Now turn to the data for the cost of bank credit. Data on "average contracted interest rates on new loans and discounts" are available from 1980, but there is a break in the series from October 1993 onwards when overdrafts are included.[8] An alternative series based on the diffusion index (DI) of "financial institutions' lending attitude" is available from 1970 onwards, and it is this series which is used here. The DI on lending attitude is released in the BOJ's TANKAN, in which firms are asked whether the financial institutions' lending attitude is "accommodative," "not so severe," or "severe." The BOJ calculates the DI by industry by subtracting the percentage of the firms answering "severe" from the percentage of those answering "accommodative." A lower value of the DI may be interpreted as indicating a tighter bank loan market. Suppose that an appropriate price of bank loans exists. If the price rises (due to a decrease of the supply of loans, an increase of the demand for loans, or both), more firms will perceive the loan market as tight. Therefore, it seems that the DI is correlated with the price of bank loans.

A potential problem of the DI arises from the fact that, while the firms are asked

[8]The change in the definition of loans and discounts also affects "new loans for equipment funds" by which we choose to measure the volume of bank loans (L). Consequently, the sample period of L is either from 1970:Q1 to 1993:Q1 or from 1993:Q4 onward. (The BOJ has released the figures of new loans for equipment funds since 1970.)

to choose one answer from "accommodative," "not so severe," and "severe", the DI does not contain information provided by those answering "not so severe." Suppose that 45 % of the firms answer "accommodative" and 55 % answer "severe." In this case, the DI is calculated as $-10$. The same value can be obtained, for example, if 10 % of the firms answer "severe" and no firm answers "accommodative." Despite the same value of the DI, bank loan market conditions obviously differ from each other in these cases. In this way, any particular value of the DI is consistent with an infinite number of different survey results. Fortunately, however, we do not have to worry about such a problem. As Figure 4 shows, there are nearly one-to-one relationships from the DI to the percentages of the firms choosing "accommodative" and "severe." Thus, it seems that the DI unambiguously provides information about the bank loan market.

As mentioned above, the full sample of the DI is longer by ten years than is that of the interest rate on new loans and discounts. In addition to providing a longer time series of consistent data, this series has the advantage of implicitly capturing non-price components of the cost of credit to borrowers (for example, collateral). Because of these advantages, this paper measures the price of bank loans by the DI rather than the interest rate on loans and discounts.[9] For consistency with the series for Y and L, the DI for manufacturing firms is chosen. In the following analysis, the DI is multiplied by $-1$ to measure the loan price (LP), so that a higher value

[9] As an alternative measure of the bank loan price, the interest rate on new loans and discounts will be used in section 4.3.

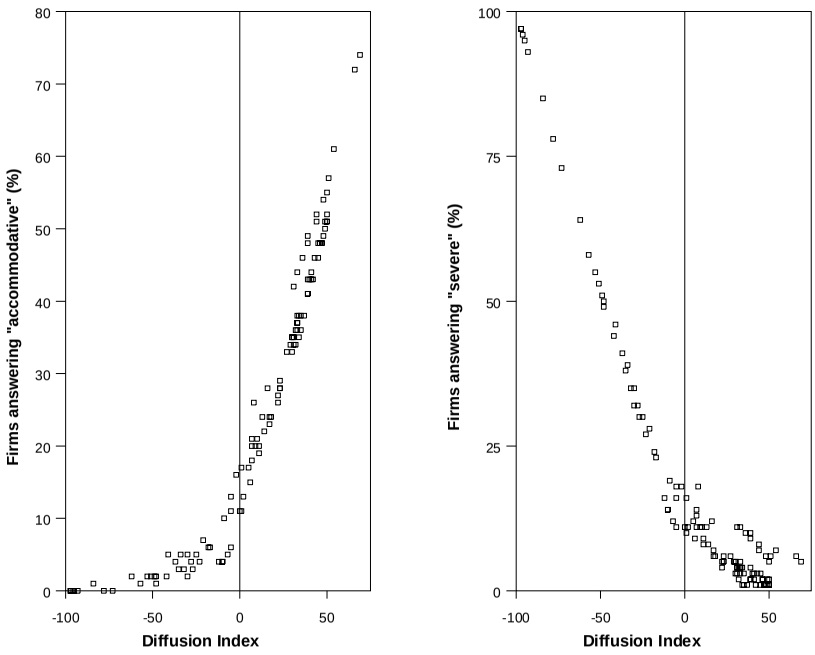


Figure 4: Diffusion Index and its Components (Sample: 1970:Q2 - 2000:Q1)

implies a higher price of loans.

## 3.3 Estimation

Estimating the structural model requires a set of identifying assumptions. For this purpose, a recursive structure is imposed upon the system. That is, $\mathbf{B}_0$ in (1) is restricted to be lower triangular. The causal ordering is given by (P, Y, M, R, L, LP).[10] Since a different ordering can have major consequences on the results, care must be taken (see, for example, Christiano, Eichenbaum, and Evans 1999). The rationale for the recursive structure is as follows. Since P is placed as the first variable, the other variables affect P only with a lag. This reflects the Keynesian

[10]For robustness checks, the model will be estimated under other causal orderings in section 4.3.

argument that prices slowly respond to economic developments. Y is placed before M and R under the assumption that money and the interest rate influence aggregate demand with a lag. This assumption is consistent with the monetarists' argument that monetary policy affects real economy only with a lag (so that fine-tuning is difficult). The position of M before R reflects the fact that the BOJ takes into account the current demand for the monetary base when it chooses the targeted level of the call rate. L and LP are placed after R because the BOJ obtains information about the bank loan market with a delay through its quarterly economic survey (TANKAN).

Imposing the recursive structure on the system, the parameters of (1) can be obtained by estimating the reduced form

$$\mathbf{y}_t = \mathbf{\Pi}'\mathbf{x}_t + \varepsilon_t, \tag{6}$$

where

$$\mathbf{\Pi}' = -\mathbf{B}_0^{-1}\mathbf{\Gamma}, \tag{7}$$

and

$$\varepsilon_t = \mathbf{B}_0^{-1}\mathbf{u}_t. \tag{8}$$

From the estimated parameters of (1), the impulse response functions of the variables to a shock in R will be calculated.

As the frequency of the data series for L and LP is quarterly, the other data series are converted from monthly to quarterly by taking the mean. All the variables except R and LP are measured as logarithms, while R is measured as a percent. Since only

the index of industrial production for Y is seasonally adjusted, additive dummies are included to remove the seasonal variations. Constant terms are also included. The number of lags is set to four. As a benchmark analysis, the six variable VAR is estimated for the period 1973:Q1-1993:Q1. The selection of the starting period reflects a belief that the Japanese economy experienced a structural change around the first oil embargo. The ending period is chosen as above due to the series breaks in L and LP.

# 4 Results

First, this section formalizes the hypothesis in a testable form. A distinctive implication of the credit view is that a monetary tightening shifts the loan supply curve left. As depicted in Figure 3, a rise of the loan price detects a leftward shift of the loan supply curve unless the loan quantity increases. Consequently, our statistical work focuses on responses of the quantity and price of bank loans to a contractionary monetary shock. In addition, the effectiveness of monetary policy obviously needs to be tested. Following a monetary tightening, the credit view is accepted if:

H1 The volume of bank loans (L) does not increase.

H2 The price of bank loans (LP) rises.

H3 Real output (Y) decreases.

Under the assumption that a short-term interest rate (R) is a good indicator of the

BOJ's monetary policy, H1 to H3 can be tested by the impulse response functions of L, LP, and Y to a shock in R.

## 4.1 Results of Benchmark Analysis

Figure 5 reports the results of our benchmark analysis. The solid lines display the estimated impulse response functions of the six variables to a one standard deviation shock to the call rate (R) representing an unexpected monetary tightening. Responses are shown over 16 quarters. The dashed lines denote two standard deviation bands of those impulse response functions. Assuming that $\varepsilon_t$ in (6) is a Gaussian vector white noise, the standard deviation bands are calculated by a Monte Carlo method with an uninformative prior.

The impulse responses of Y and L show that there are co-movements between industrial production (Y) and bank loans (L). Y begins to decrease in the sixth quarter after a monetary tightening, and the decrease becomes significant in the eighth quarter. This timing roughly corresponds to the timing of the contraction of L: L begins to decrease continuously in the eighth quarter, although the decrease is insignificant. The timing pattern does not indicate whether the contraction of bank loans causes the decline in output or the latter induces the former. In other words, the question is whether the fall of L is due to a leftward shift of the supply curve of loans or a leftward shift of the demand curve for loans. This is the supply-versus-demand puzzle. Notice that the loan price (LP) falls below the initial level with the same timing as the decline in L. This corresponds to Case III in section 2.2.

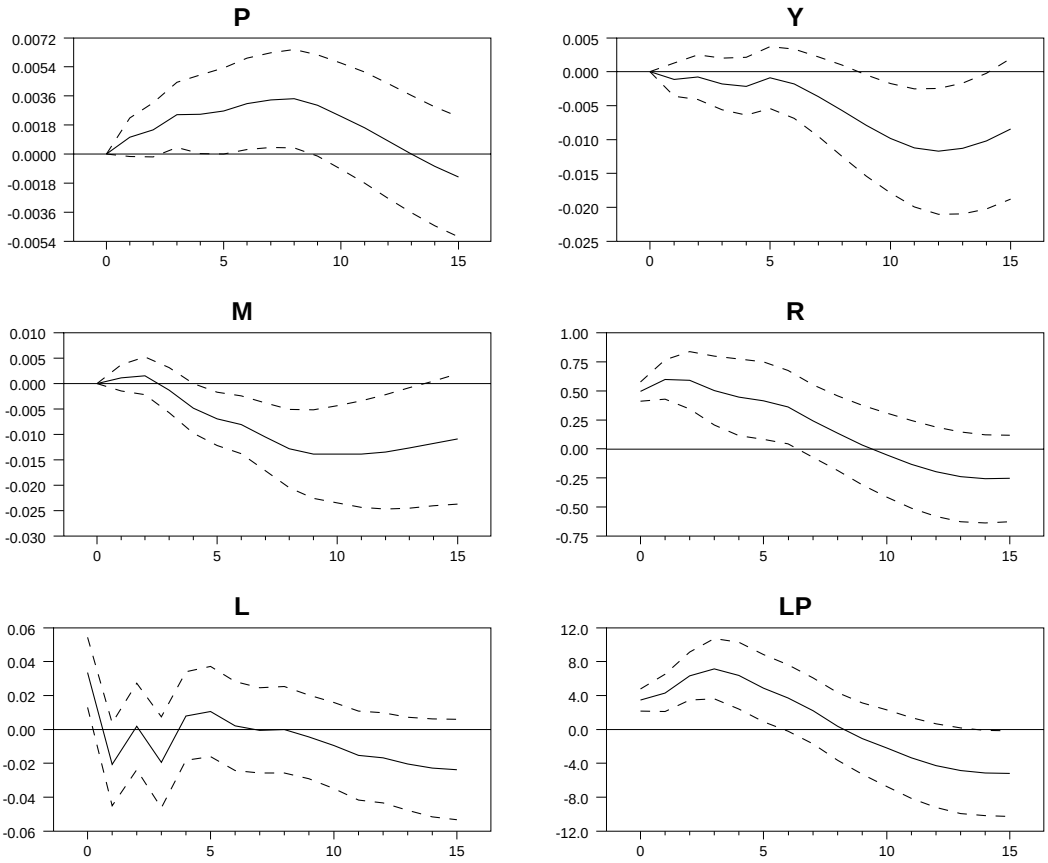


Figure 5: Impulse Responses to a Shock in R (Sample: 1973:Q1-1993:Q1)

(Benchmark Analysis)

Accordingly, we may conclude that the decline in bank lending, which occurs with the same timing as the decline in output, is due to a leftward shift of the loan demand curve.

Does the finding that the demand curve for bank loans eventually shifts right after a monetary tightening rule out the credit view? The answer is no. One must distinguish the short-run effects and the long-run effects of monetary policy on the bank loan markets. Not until the eighth quarter following a monetary contraction

did bank loans clearly show a tendency to decline. Without information provided by the behaviour of the bank loan price, one would conclude that monetary policy had an impact on the bank loan market with a considerable lag. As explained shortly, the results show that the supply curve of bank loans quickly shifts left in response to a monetary tightening.

Let us test whether a monetary tightening is followed by a leftward shift of the loan supply curve or not. In response to a positive shock in the call rate (R), bank loans (L) immediately increase and then contract. Apart from the temporary jump, L does not significantly increase. Thus, H1 is accepted except for the initial quarter. On the other hand, the response of the loan price (LP) is significantly positive in the first six quarters, so that H2 is accepted over this period. Given the acceptance of H1 and H2, the conclusions are that the loan supply curve shifts left, at latest, in the next quarter of a monetary contraction, and that it takes more than four quarters for the loan supply curve to move back to its original position.[11] Importantly, our results are free from the supply-versus-demand puzzle.[12]

The next task is to test the effectiveness of monetary policy. As shown in Figure 5, industrial production (Y) begins to decrease slowly but significantly in response to a positive shock to the cash rate (R). Obviously, H3 is accepted, which is

[11] In the initial quarter, the loan supply curve may shift left or right as depicted in Figure 2.

[12] In fact, similar results can be obtained even if the loan supply curve does not shift. Suppose that the loan supply curve is vertical. Then, a rightward shift of the demand curve for bank loans will raise LP and have no effect on L, so that H1 and H2 will be accepted. In this paper, however, we assume that the supply curve of loans is not vertical.

consistent with the effectiveness of monetary policy. The effects of monetary policy on real output seem sizable. The impulse response function of Y suggests that industrial production declines by approximately 1.2 % in three years following an unexpected 0.5 % hike in the overnight call rate. Notice that the significant decline in real output is preceded by the leftward shift of the supply curve of bank loans. Therefore, this paper concludes that the credit channel is operative in Japan.

## 4.2 Interpretation of Anomalous Results

The initial positive response of bank loans (L) might seem to be evidence for misspecification of the model. A temporary positive response and a subsequent sluggishness of bank loans to a contractionary monetary shock are commonly found in the U.S. literature (see, for example, Bernanke and Blinder 1992, Gertler and Gilchrist 1993, and Kashyap and Stein 1994). Bernanke and Blinder (1992) and Kashyap and Stein (1994) attribute such behaviour of loans to the contractual nature of loan agreements.[13] Their argument might apply to loans for equipment funds to manufacturing firms, by which L is measured, in the sense that a financial contract setting the lending terms is usually written in advance. This implies that the volume of bank loans to an individual firm may not be responsive to a monetary tightening in the short-run. It is not clear, however, whether the contractual nature of loan

[13]This argument is particularly true of loans under commitment. Morgan (1998) contrasts movements in loans under commitment with movements in loans without commitment in the U.S.A., finding that only loans without commitment decrease after a monetary contraction.

agreements can cause the sluggishness of loans at an aggregate level. Suppose that a contract specifying the loan volume was written in advance. Then, the individual firm's demand curve for loans would look like the demand curve for a discrete commodity, namely a vertical demand curve with a reservation price. If there are many firms with dispersed reservation prices, the aggregate demand curve for loans will not be vertical. So, instead of a specific nature of loans, we emphasize the countercyclical demand for business loans. Gertler and Gilchrist (1993) argue that, in the wake of tight money, firms increase their needs for loans to smooth the impact of declining sales. Figure 5 of this paper shows that, while L significantly increases in the initial quarter, the price of loans (LP) significantly rises. This corresponds to Case I depicted in Figure 2, which is supportive of a rightward shift of the demand curve for bank loans.

Another result that might seem puzzling is the sluggish response of money (M). One might argue that a shock to the call rate (R) should be associated with an immediate fall of M. M does not have to fall in response to a monetary tightening, however. The base money, by which M is measured, consists of bank reserves and currency in circulation. The demand for currency depends largely on the current economic activity in the short-run. As long as it takes time for monetary policy to have effects on real economy, the demand for currency may not be responsive to a change in the interest rate. As explained earlier, each month's demanded volume of reserves is predetermined by the preceding month's volume of deposits under the Japanese reserve accounting system, so that the demand for bank reserves may be

also insensitive to the interest rate in the short-run. Moreover, an interest rate hike will increase deposits, leading to an increase of the demand for reserves in future. Thus, the demand for the monetary base does not necessarily decrease or may even increase for a short time period after a monetary contraction. Such responses of the demand for the monetary base can explain the sluggishness of M in the wake of tight money.

The other anomalous result is the sustained positive responses of the price level (P) to a positive shock to the call rate (R). This is the well-known "price puzzle." Sims (1992) estimates VARs that include the interest rate, money, real output, and price level, finding that the price puzzle is evident in the U.S.A., the U.K., France, Germany, and Japan. He conjectures that the price puzzle appears when the VAR model omits the variable(s) from which the central bank attempts to anticipate inflationary pressures. It is known that including the commodity price index and/or the exchange rate sometimes resolves the price puzzle (see, for example, Sims 1992 and Christiano, Eichenbaum, and Evans 1996). With the commodity price index (CP) and the exchange rate (XR) added to the six variables, the VAR model is re-estimated.[14] The variables are ordered as (XR, CP, Y, P, M, R, L, LP). As Figure 6 shows, however, the price puzzle does not disappear. This is consistent with the Sims (1992) finding that including the commodity price and the exchange rate does not successfully change the results for Japan. Dungey and Fry (2000)

[14]The data series for CP and XR are the World export commodity price index and Yen per the U.S. dollar, respectively. Both are given by the IMF publication, *International Financial Statistics*.

estimate a three country VAR model (Australia, Japan, and the U.S.A.), obtaining similar results.

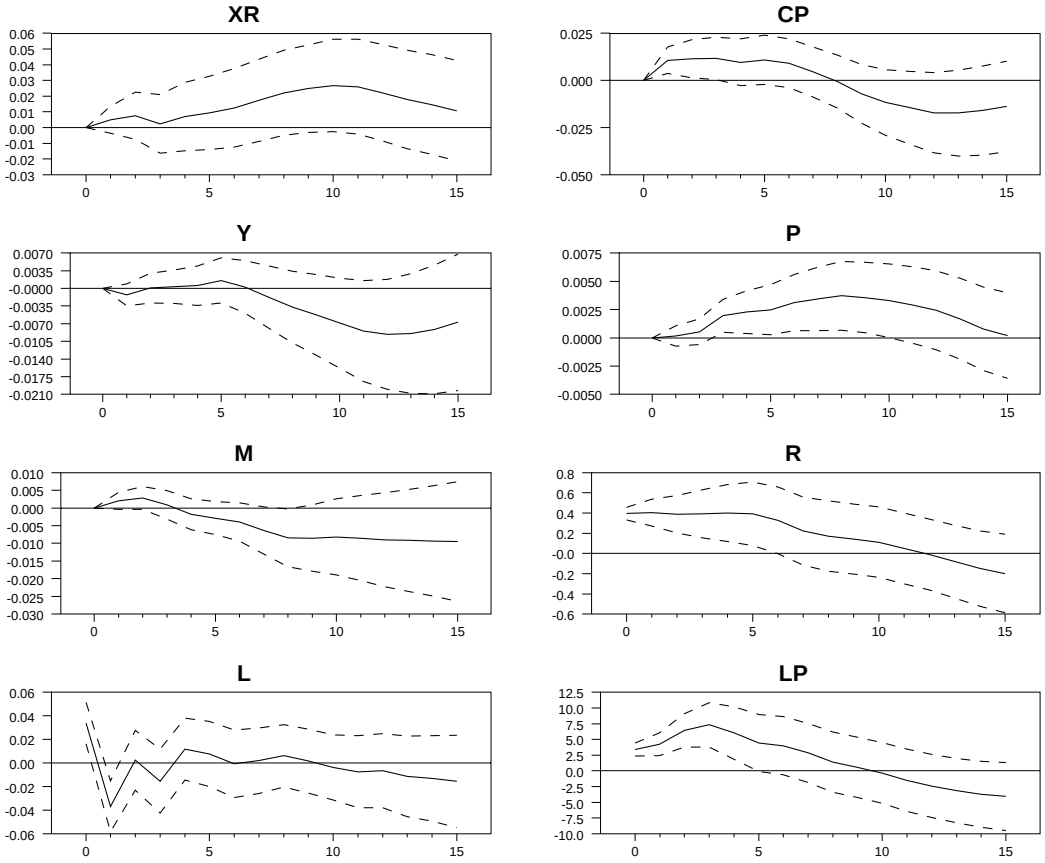


Figure 6: Impulse Responses to a Shock in R (Sample: 1973:Q1-1993:Q1)

(Including the Exchange Rate and the Commodity Price)

## 4.3 Robustness Checks

To assess the robustness of the benchmark results, the analyses were redone for an alternative measure of the price of bank loans, for different sample periods, and for other sets of identifying assumptions. This subsection briefly describes the results

of the robustness checks.

First, the VAR model was re-estimated with the proxy for the loan price (LP) replaced with the "average contracted interest rate on new loans and discounts." As mentioned earlier, the data are available only from 1980:Q1. Results are shown in Figure 7 where LR denotes the interest rate on loans and discounts. Obviously,

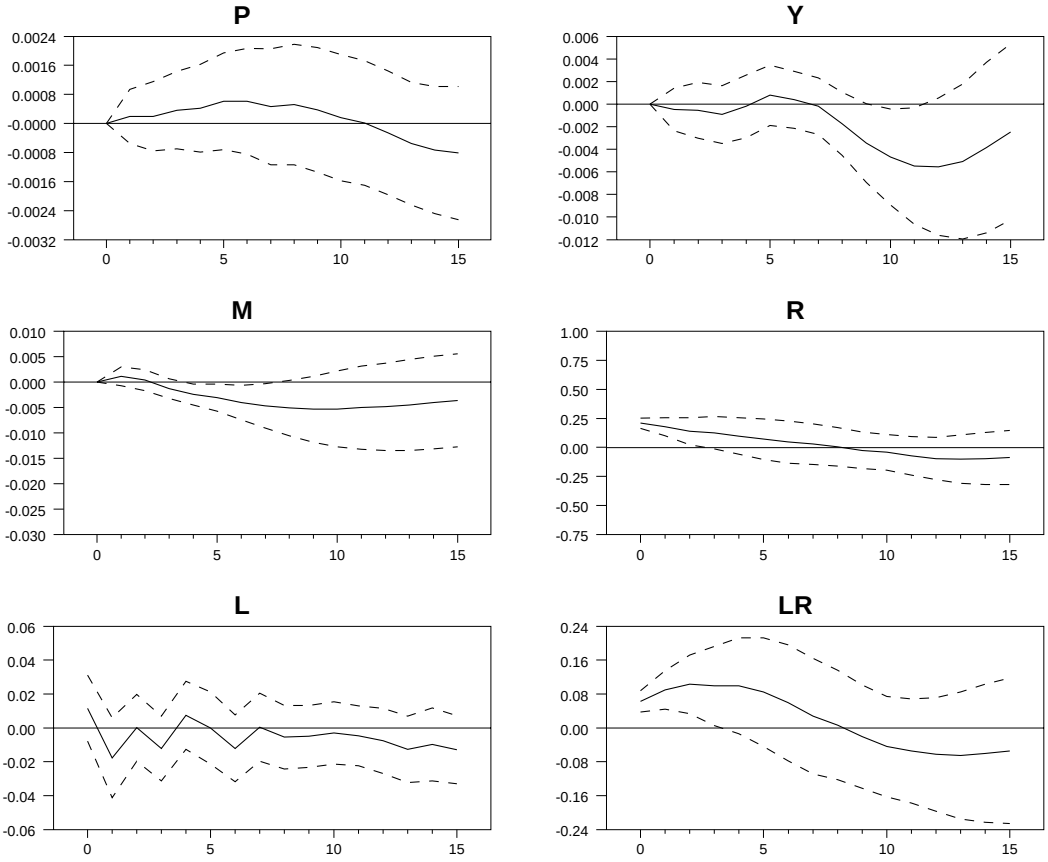


Figure 7: Impulse Responses to a Shock in R (Sample: 1980:Q1-1993:Q1)

(An Alternative Measure of the Loan Price)

H1 to H3 are again accepted. The alternative measure of the loan price does not

markedly affect the benchmark results.[15] As the initial response of bank loans (L) is no longer significant, we may conclude that a leftward shift of the supply curve of bank loans immediately follows a monetary tightening.

Second, the sub-sample stability was analysed. With the sub-samples of 1974:Q1-1993:Q1, 1975:Q1-1993:Q1, 1976:Q1-1993:Q1, and 1977:Q1-1993:Q1, results were quite similar to those of our benchmark analysis. Each estimation confirmed that a sustained leftward shift of the loan supply curve occurred, at latest, in the next quarter of a monetary contraction, and that industrial production fell by approximately 1.2 % in three years after an unexpected 0.5 % hike in the call rate. With the sub-samples of 1978:Q1-1993:Q1, 1979:Q1-1993:Q1, 1980:Q1-1993:Q1, and 1981:Q1-1993:Q1, results changed with respect to a shift of the loan supply curve. Figure 8 shows the results with the sample 1981:Q1-1993:Q1.[16] While the initial positive response of bank loans (L) disappears, these results now show a relatively slow response of the loan price (LP). This implies that the loan supply curve shifts left, at latest, in the third quarter following a monetary tightening. Nevertheless, H1 to H3 are accepted.[17]

[15]It may be noteworthy that the error bands of the impulse response functions of the price level (P) become wider. The price puzzle is no longer significant, although the response of P is still positive.

[16]This starting period is selected based on the Kasa and Popper (1997) argument that the BOJ began to use modern money market operations in 1981.

[17]The VAR model was also re-estimated with longer samples. With the sample of 1972:Q1-1993:Q1, for example, it was confirmed that a leftward shift of the loan supply curve followed a monetary contraction. The effectiveness of monetary policy (H3) was not accepted, however. This

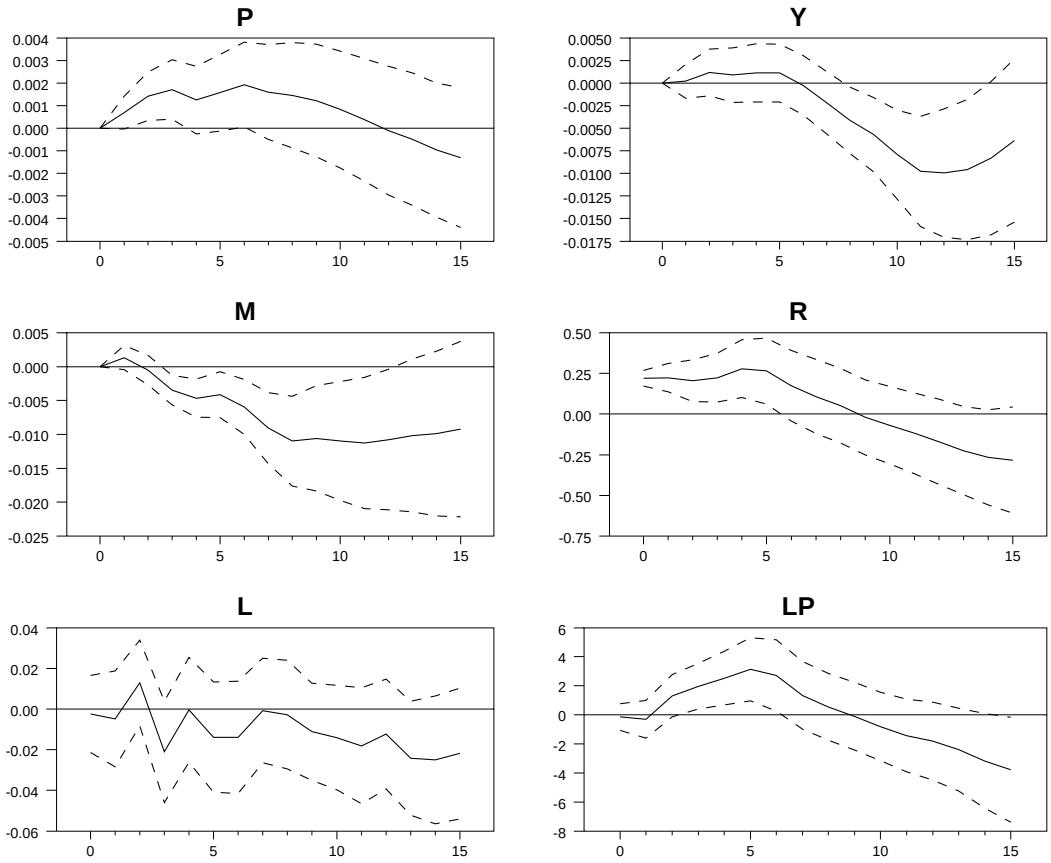


Figure 8: Impulse Responses to a Shock in R (Sample: 1981:Q1-1993:Q1)

(Sub-sample Analysis)

Finally, alternative recursive identifying assumptions were exmained. Sims (1998) suggests that the policy reaction function should exclude the current values of the variables that the authority observes with a delay. Assuming that the Bank of Japan (BOJ) observes the index of industrial production (Y) and the consumer price index (P) with a delay, the VAR model was re-estimated by ordering the variables

is presumably due to a structural break. Yoshikawa (1995), for example, argues that the Japanese economy experienced a structural change a few years before the oil embargo of 1973.

as (M, R, Y, P, L, LP).[18] As Figure 9 shows, ordering the variable in this way has almost no impact on the results of the benchmark analysis. The VAR model was

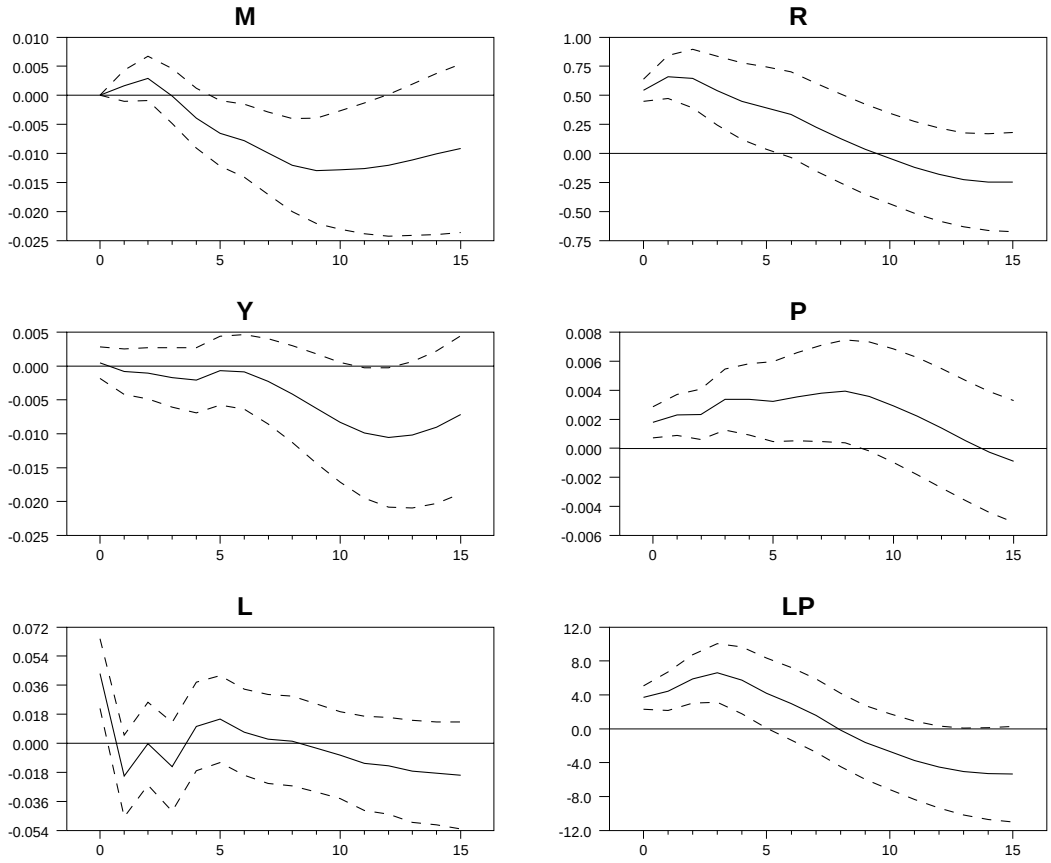


Figure 9: Impulse Responses to a Shock in R (Sample: 1973:Q1-1993:Q1)

(Reordering the Variables)

also re-estimated under a variety of orderings, and the results were quite robust to

[18]Neither the index of industrial production (IIP) nor the consumer price index (CPI) is published by the Bank of Japan. The Ministry of Economy, Trade and Industry and the Ministry of Public Management, Home Affairs, Posts and Telecommunications publish the IIP and the CPI, respectively.

the choice of the order.

# 5 Conclusion

Since the original work of Bernanke and Blinder (1992), the supply-versus-demand puzzle has been evident in similar empirical studies of the credit channel. A key to resolution of the puzzle lies in understanding its similarity to the simultaneous equation bias. An important assumption is that the quantity and price of bank loans are jointly determined and given by the intersection of the supply and demand curves. Using a simple demand-supply model, this paper showed how observing the behaviour of the quantity and price of bank loans could help to identify the shifts of the demand and supply curves in the bank loan market. As the price of loans, the diffusion index of "financial institutions' lending attitude" in the BOJ's quarterly economic survey of enterprises (TANKAN) was used.

To test the credit view, a six variable VAR model was estimated as a benchmark analysis. The six variables are prices and quantities in three markets: goods, money, and bank loans. One of the main results is that the loan supply curve shifts left, at latest, after one quarter following a monetary tightening. Importantly, our finding is free from the supply-versus-demand puzzle. Another significant finding is that a monetary tightening is followed by a sizable decrease of real output. In the estimation, industrial production decreases by approximately 1.2 % in three years following a 0.5 % hike in the call rate. These results clearly support the credit view

for Japan.

The VAR model was re-estimated, using an alternative measure of the loan price, namely the "average contracted interest rate on new loans and discounts." The sample of the interest rate is shorter by seven years than is the sample of the diffusion index. Nevertheless, the results are similar to those of the benchmark analysis. For further robustness checks, the analysis was conducted for different sample periods and for different sets of identifying assumptions. The results were robust to these perturbations, and this paper concludes that the credit channel of monetary transmission is operative in Japan.

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