Herd Behavior in the Japanese Loan Market:

Evidence from Bank Panel Data [1]

Hirofumi Uchida [2]
Kelley School of Business
Indiana University
and
Faculty of Economics
Wakayama University

Ryuichi Nakagawa
Faculty of Economics
Kansai University

April 20, 2004

[1]Comments by Takuya Noguchi are gratefully acknowledged. The first author thanks for the financial support from the Grant-in-Aid for Scientific Research (C) (No.15530214, 2003) of the Ministry of Education, Science, Sports and Culture, and Wakayama University Research Fund. This study had been conducted during the first author's visit at Kelley School of Business, Indiana University as a Fulbright visiting scholar. He would like to thank the hospitality from and intelectual interaction with Greg Udell (the host) and faculty members of the Finance Department, and financial support from the Fublight Grant.

[2]Corresponding author: Finance Department, Kelley School of Business, Indiana University, 1309 East Tenth Street, Bloomington, IN 47405, Phone: 812-855-5451, E-mail: huchida@indiana.edu.

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Abstract

This paper investigates whether Japanese banks had been following herd behavior in the domestic loan market from 1975 through 2002. Applying the technique developed by Lakonishok, Shleifer, and Vishny (LSV) (1992, J. of Fin. Econ.) to the data of loans outstanding to different types of borrowers, we obtain evidence indicative of the existence of herding. Consistent herding during the entire sample period is observed among regional banks, whereas city banks had been following a cyclical herd behavior with one peak around the bubble period in the late 1980s. Even after adjusting for herding resulting from rational or institutional factors, we still observe herding for regional banks in the entire period, whereas herding only in the bubble period remains for city banks. The results would indicate that regional banks had been consistently following irrational herd behavior, while city banks were frantic enough to herd only in the bubble period in the late 1980s.

Keywords: herd behavior, LSV herding measure, adjusted herding measure, banks, loan market, Japan

JEL classification number: C12, G14, G23

1 Introduction

Are Japanese banks rational? This question has been asked in different contexts, even after the argument of 'culturally different' Japanese firms being out of the economic principle of profit maximization became obsolete. One of the oft-quoted characteristics of Japanese banks regarding this question is herd behavior. Anecdotal evidence can easily be obtained from articles of the Nihon Keizai Shinbun (Nikkei), a Japanese newspaper comparable to the Wall Street Journal. From January 1, 1975 through December 31, 2002, database search through the Nikkei Telecom 21 Article Search Service yielded 1,287 articles in Nikkei containing the words "yokonarabi (herding)" and "ginko (banks)." We have had a lot of incidence of herding in, for example, setting deposit interest rates, business hours, and different fees in earlier years of this period. Herding about where and how much to lend is one of them. In later years of the period, on the contrary, we gradually observe a lot of incidence indicating the corruption of herding due to the hardening business condition for and increased competition among Japanese banks.

One of the phenomena which one would connect to herding must be the behavior of Japanese banks during the bubble period from the late 1980s. In that period, there was huge collective influx of loan funds into different industries. Such behavior by banks is regarded as herd behavior and often accused as a factor that accelerated the formation of the bubble.

We have other naive evidence of herding for Japanese banks. In the high growth period, the "convoy system" was paid attention to in which Japanese banks were claimed to be herding to keep the weakest member alive with the aid of regulation and protection by the Ministry of Finance. After the bubble period, a lot of Japanese banks have been uniformly suffering from bad loans and tried to contract their lending, which is blamed to be a cause of 'credit crunch.'

Anecdotal evidence like this is based on little empirical analysis. In fact, few empirical studies have been conducted about herd behavior of Japanese banks. Did herd behavior exist among Japanese banks first of all? What driving force was there to motivate such a behavior, if any? These important questions must be answered based on a formal empirical study. The aim of this paper is to investigate whether and why, if any, Japanese banks had been following herd behavior in these 30 years.

Our methodology is indebted to the study of herd behavior among fund managers. Lakonishok, Shleifer, and Vishny[17] (henceforth LSV) devised an innovative index to measure the extent to which fund managers follow herd behavior in investing in equity stocks. The measure, called the LSV

measure, captures the extent to which fund managers deviate from independent investment decision to collectively buy and sell specific stocks in the same direction. Due to its simplicity and great economic appeal, the measure received big popularity and was applied to investigate herd behavior in different contexts by a lot of studies that followed.[1]

We apply the measure to find out the existence or nonexistence of herd behavior among Japanese banks. The data to be used are of loans outstanding of individual banks to different industries which are available from the Nikkei NEEDS Company (Bank) Data File. It allows us to calculate the LSV measure for loans from about 140 commercial banks to 11 different industries during the period of 1975 through 2002. We calculated the measures separately for two types of commercial banks in Japan, regional banks and city banks.

The results demonstrate the existence of herd behavior among Japanese banks during the sample period. For regional banks, herding was observed consistently throughout the period. The herding had been significant both economically and statistically. In contrast, city banks had followed a cyclical herding pattern. Interestingly, herding is observed during the bubble period in the late 1980s and the stagnation period that follows. In these periods, herding among city banks was severer than regional banks. These results are consistent with our image of banks frantic enough to rush in lending to bubble industries. After 1997 when banks were facing severer competition, they cease to herd each other.

Even if herd behavior is detected by the LSV measure, however, it does not necessary imply irrational banks. The LSV measure just quantifies the extent of banks' collective deviation from each year's average lending policy. The deviation could result from rational behavior. As a matter of fact, theoretical studies have been clarified that variety of rational reasons could lead to herd behavior, although it is basically difficult to discern empirically what caused detected herd behavior.[2] The deviation could also result from

[1]For example, see Grinblatt, Titman, and Wermers[10], Wermers[22], Choe et al.[11], Borensztein and Gelos[4], Gelos and Wei[9], and Kim and Wei[16, 15].

[2]Herd behavior could result (i) among fund managers with a similar comparative advantage (Falkenstein[7]), (ii) when there is some kind of payoff externalities in following the herd (e.g. *bank run* in Diamond and Dybvig[6], *liquidity* in Devenow and Welch[5], and *information production* in Froot, Scharfstein, and Stein[8] and Hirshleifer, Subrahmanyam, and Titman[12]), (iii) from reputation concern (Scharfstein and Stein[20]), (iv) based on common information, and (v) through inference from behavior of other agents (Bikhchandani, Hirshleifer, and Welch[2] and Banerjee[1]). See Bikhchandani, Hirshleifer, and Welch[3], Devenow and Welch[5], and Nakagawa and Uchida[18] for survey.

It is difficult to empirically figure out what cause brought about herding, but we can at

institutional reasons. During the period from 1975 through 2002, Japanese banks had experienced the second oil crisis, financial liberalization, the bubble, and post bubble stagnation. Expanding or shrunk loan demand due to these drastic environmental changes could have made Japanese banks behave as if they had been following herd behavior.

In order to extract a purely irrational portion of herding, we regressed the extent of banks' collective deviation from the average lending policy on proxies for rational and institutional factors. By using the resulting residual, we created an *adjusted herding measure* which does not contain rational or institutional factors. The results show that even after adjusting for these factors, consistency for regional bank herding was still observed. For city banks, in contrast, most of the herding disappeared through this adjustment. However, a large extent of herd behavior was still observed in the bubble period of the late 1980s. As city banks have been dominant in the loan market in Japan, the results for this period might imply that their irrational behavior could have caused or accelerated the formation of the bubble.

The results obtained in this paper are consistent with the competitive nature of Japanese banks obtained in Uchida and Tsutsui[21]. Based on the theory of industrial organization, they estimate the degree of competition among Japanese banks. Their results show that regional banks had been consistently under less stringent competitive pressure than city banks throughout the period from 1974 to 2000. Together with the results obtained in this paper, we could conclude that banks under tight competition cannot afford to follow herd behavior.[3]

There is an attempt to clarify whether Japanese banks had been following herd behavior. Based upon Jain and Gupta[13], Nakagawa and Uchida[18]

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least exclude reasons (i) through (iii) as a cause of herding detected here. First, Japanese banks might have had respective comparative advantage in lending to firms with a specific size or a specific region. However they are unlikely to have one in lending to a specific industry. As our dataset contains each bank's loans outstanding only at the industry level, we can exclude explanation (i). Second, at an industry level, one bank's lending is not likely to positively affect other banks' lending, which excludes the explanation (ii). Finally, we could not infer any bank manager's ability based upon their performance of lending to a particular industry. This allows us to disregard explanation (iii).

[3] A less stringent competitive environment for regional banks might have been due to regional segmentation of their markets. One might then wonder that banks as regional monopolists would not follow herd behavior at all, which contradicts to the evidence obtained in this paper. However, Kano and Tsutsui[14] demonstrates that markets for regional banks were not segmented for regional banks. Together with the results of Uchida and Tsutsui[21], regional banks were under competition even if it was not very severe. The result of consistent herding is thus not contradictory.

try to detect the causality relationship between loans outstanding by different types of banks. They find the existence of the causality from city banks to regional banks, from long-term credit banks to city banks, and from trust banks to city banks. Their focus is thus on herd behavior between *different types of* Japanese banks, while we are interested in herd behavior *among the same type of* Japanese banks. The paper and the present one thus focus on different aspects of herd behavior. They are not substitutes but complements.

The contribution of the present paper is apparent from the fact that it presents the first evidence of herd behavior among banks. To our knowledge, the only empirical papers on bank herding are Jain and Gupta[13] and Nakagawa and Uchida[18] cited above. While they are interested in causality between amounts of loans aggregated by bank type, the use of the LSV measure enables us to detect herding at an individual bank level. So far, the measure has been applied exclusively to detect herding in financial markets. However, banks are as much likely to follow herd behavior as fund managers or investors in financial markets. A small number of banks and opaque nature of loans due to informational asymmetry and uncertainty would serve as a good field for herd behavior to take place among banks. The results do confirm this prediction.

Furthermore, the present paper contains some theoretical contribution over the existing studies since LSV. We have constructed a formal procedure to test the statistical significance of the herd behavior detected by the LSV measure. In the literature, some studies have paid little attention to the statistical testing, and the procedure presented in other studies is not reliable for a small sample analysis. The present paper formally investigates the testing procedure and proposes a Chi-squared statistic which is applicable to small sample analysis.

The rest of this paper is composed as follows. The next section explains data to be used. Section 3 introduces the LSV measure and reports the results. Our Chi-squared test is also explained in the section. In section 4, we proceed with the analysis of rationality in Japanese banks' herd behavior. Since the behavior of city banks in the late 1980s turns out to be of particular interest, we will focus on the period and conduct further analysis in section 5. The final section concludes the paper.

2 Data

The main data to be used in this paper are loans outstanding by industry, which are available from the Nikkei NEEDS Company (Bank) Data File. Loans to the following eleven industries by individual banks are respectively available: (1) manufacturing, (2) agriculture, forest and fisheries, (3) mining, (4) construction, (5) wholesale and retail trade, (6) finance and insurance, (7) real estate, (8) transport and communication (9) electricity, gas, heat supply and water, (10) services, and (11) individuals and others.[4]

We focus on two types of commercial banks in Japan. One is *city banks* which have a main branch in big cities and operate nationwide as well as multinationally. They are biggest banks in Japan and mainly deal with bigger businesses. Their lines of operation include not only commercial banking but also some securities activities and international banking. The other is *regional banks* which have main offices in local cities and operate mainly inside the prefectures they locate. They are small- or medium-sized banks and closely connected to local businesses and local governments. Note that there are banks called 'second regional banks' which have transformed themselves from mutual banks around 1992. As they have similar characteristics to regional banks, we treat them together as 'regional banks' in the present paper.

Table 1 presents descriptive statistics for city and regional banks. We confirm that the former is larger in size and smaller in number than the latter. Due to the small number of city banks, if we put the two samples together, the results are almost the same as those for regional banks only. We therefore conducted separate analysis for city and regional banks.

The data is available from fiscal year 1975 through 2002. This allows us to investigate herd behavior in several interesting periods. First of all, it includes the bubble period from the late 1980s through the beginning of 1990s in which land and stock prices inflated. As Table 1 demonstrates, loans surged in this period, which recalls the existence of herding. Second, the period of the bubble corruption is included in the sample. Herding among Japanese banks in this panic period might be as plausible as that among fund managers in the period of international currency crisis. Third, the period of financial liberalization in the 1980s is included. In this period, Japanese banks had lost their traditional borrowers who were freed from regulation and obtained other financing sources. Banks had to expand loans

[4] We excluded loans to local governments since they are determined mainly by demand side.

to borrowers with less information accumulation. Fourth, the sample period contains the stagnation period in the 1990s when the Japanese economy had been struggling to escape from its weak economic condition. Banks uniformly decreased loans in this period. Finally, the second oil crisis in 1979 is included in the period as well. We will interpret the results based on this historical background of interest.

3 Results from LSV herding measure

3.1 LSV herding measure

We detect herd behavior among Japanese banks using the herding measure invented by Lakonishok, Shleifer, and Vishny[17] (LSV). Suppose that at each year indexed by $t = 1975, ..., 2002$, banks have loans outstanding to industries $j = 1, ..., 11$. For notational simplicity, denote by i the index of each industry-year which is defined by a combination of one t and one j. The LSV herding measure is defined as follows.

$$LSV_i \equiv |P_i - P_t| - E|P_i - P_t|. \tag{1}$$

P_i is the proportion of banks who actually increased their loans outstanding in industry-year i (of industry j in year t), which is derived as,

$$P_i \equiv X_i/N_i,$$

where N_i and X_i are the numbers of banks who were active in the industry-year i, and who increased loans outstanding in the industry-year i, respectively.

P_t is the expected proportion of banks who increase their loans outstanding in year t, which is calculated as a mean of all the observed P_is in the year. This can be considered as banks' overall lending policy. If every bank *independently* increases (or decreases) its loans outstanding in industry-year i with probability P_t (or $1 - P_t$), the observed value of P_i would become close to P_t and the first term will become zero if there is a large number of banks. If, on the other hand, banks *collectively* increase or decrease loans in the industry-year, the observed value departs from P_t. The first term of (1) thus numerizes the extent to which banks' lending policies deviate on average from the overall policy.

The overall lending policy P_t thus represents the null hypothesis of no herding. Both non-independent corrective increase and decrease amount to a larger value of the first absolute value term and the measure itself. It is

this sense of herd behavior that the LSV measure tries to capture. As we are interested in the change in banks' lending behavior over the sample period, we obtain a sample mean of the LSV measure over 11 industries in each year and analyze the time series of the mean. For regional and city banks, we use P_t separately derived from the respective samples.[5]

Note that even if the null hypothesis holds and there exists no herding, the expectation of the first absolute term of LSV_i is positive. The last term $E|P_i - P_t|$ is subtracted so as to normalize the measure and make its mean zero under the null hypothesis of no herding.

3.2 Results

The sample means of the LSV measure obtained for 1975 through 2002 are represented in Table 2. They are also depicted in Figure 1. For regional banks, the results show the existence of consistent herding. The extent of herding had been even increasing from 2000. We observe about 10% of collective deviation from the year average lending policy. It is worth mentioning that this magnitude is bigger than that observed for mutual fund managers in existing studies. In Lakonishok, Shleifer, and Vishny[17], Wermers[22], and Grinblatt, Titman, and Wermers[10], for example, most of the figures are less than 5%.

The results for city banks make a good contrast. As shown in Figure 1, they seem to follow a cyclical herding pattern. Of particular interest is the result that herding is observed during the bubble period in the late 1980s and the collapse and stagnation period that followed. It is worth noting that in these periods, herding among city banks was severer than regional banks.

It is also interesting to observe a sudden drop of herding in 1990. Upon close inspection of the LSV measure for each industry in this year, it turned out that almost all the city banks increased loans outstanding to all the industries in this year, which makes P_t large and $|P_i - P_t|$ small. This unanimity may also be regarded as herd behavior in a sense different from what the LSV measure tries to capture. Although our interest in the present paper is herd behavior in the latter sense, further analysis about this unanimity would be an interesting future topic.

A big magnitude of herding can be found in 1979 as well when Japan was hit by the second oil crisis. Together with the results in the bubble period, these results are consistent with our image of banks frantic enough to herd in these 'abnormal' circumstances. However, we cannot conclude so

[5] We also conducted analyses by taking the average over the whole sample. The results were almost the same.

at this level of analysis because rational factors affecting herd behavior are not adjusted for, which is to be conducted in section 4.

As for the first half of the 1980s, the period of financial liberalization, we do not find serious herding. This is consistent with the results of Uchida and Tsutsui[21]. They found that the degree of competition for city banks became fierce after 1980. Until the late 1980s in which the bubble began to form, the shape of Figure 1 looks similar to their Figure 2 which depicts the degree of competition. The results of consistent herding among regional banks and less frequent herding in a smaller extent among city banks are also in line with the results obtained in Uchida and Tsutsui[21]. They report that regional banks were consistently under less stringent competitive pressure than city banks throughout the period.

Finally, in the late 1990s, city banks in Japan had gotten into the period of severe consolidation. As Table 1 shows, the number of city banks decreased due to big mergers. Consistent with this background, they ceased to herd after 1997.

3.3 Statistical testing of LSV measure

3.3.1 Conventional test and distribution of LSV measure

In this subsection, we take a side trip to investigate statistical significance of the herding detected by the LSV measure. We propose a Chi-squared test which is suitable for small sample analysis. In some existing studies thus far, careful treatment of statistical testing has been out of concern and the focus was only on economic significance or the magnitude of the measure.[6] In other studies which do mention about statistical significance of the measure, the standard t test has been conventionally applied. Lakonishok, Shleifer, and Vishny[17], Kim and Wei[16, 15], Borensztein and Gelos[4], and Choe et al.[11] present the standard errors or even t values of sample means of the measure. Based on these values, they judge the statistical significance of the measure or the existence of herd behavior.[7]

[6] No explicit comments are made about statistical significance of the measure in Grinblatt, Titman, and Wermers[10] and Gelos and Wei[9].

[7] Another interesting attempt is Wermers[22]. He depicts in Figure 1 an actual (estimated) distribution of the LSV measure and compares it with a simulated one obtained from sufficiently large number of samples under the null hypothesis of no herding. Wermers[22] find the difference in shape between these two distributions and concluded in favor of the existence of herding. Borensztein and Gelos[4] also takes the same approach. Although this is indeed an interesting approach, it depends upon visual perception and is not an objective test.

It is highly probable, however, that the conventional test has a considerable small sample bias in the present paper. We can confirm this simply by investigating the probability distribution of the LSV measure. Suppose that there is no herding for an industry-year i. Then, P_i follows a binominal distribution with mean P_t and variance $P_t(1-P_t)/N_i$. If N_i, the number of banks, is sufficiently large, we can approximate this binominal distribution to the normal distribution with the same mean and variance, which is conventionally allowed if $N_iP_t > 5$ and $N_i(1-P_t) > 5$.[8] This approximation implies that the first term of the LSV measure, $|P_i - P_t|$, follows a half-normal distribution, and thus the distribution of the measure (1) considerably skews leftward. Therefore, when we test a sample mean of the LSV measure using the conventional test, reliable results cannot be obtained without the help of the central limit theorem. That is, only when there are a large number of industry-years (or stock-quarters in mutual fund studies) as well as a large number of banks (or fund managers), the sample mean approximately follows a normal distribution and the conventional test is reliable.

As long as the existing studies on fund managers are concerned, this condition seems to be satisfied, since they have a large enough number of stock-quarters and fund managers. As for small samples like ours, however, we cannot be sure if the testing results obtained from the conventional test are reliable. In the following, therefore, we devise a test procedure that does not suffer from the small sample bias, which could enhance the test reliability over the conventional test.

3.3.2 Chi-squared test for LSV measure

Now define a variable Z_i as,

$$Z_i \equiv \frac{P_i - P_t}{\sqrt{P_t(1-P_t)/N_i}}.$$

From (1), this equals (the non-absolute value of) the first term of the LSV measure which is normalized for its variance to take the value of 1 under the null hypothesis of no herding. From the discussion above, we know that the approximation of $Z_i \sim N(0,1)$ is allowed when $N_iP_t > 5$ and $N_i(1-P_t) > 5$. This leads to the result that

$$Z_i^2 \sim \chi(1). \tag{2}$$

This is the statistic we propose to test the significance of the herding detected by the LSV measure. When we test the statistical significance of herding

[8] See Rice[19, p.172].

for a group of industry-years Φ (or a sample mean of the LSV measure over Φ), we can use the relationship that

$$Z_\Phi^2 \equiv \sum_{i \in \Phi} Z_i^2 \sim \chi(I),$$

where I is the number of industry-years included in Φ. Note that as absolute values and squared values correspond each other, we have a close correspondence between Z_i^2 and the LSV measure, and between Z_Φ^2 and a sample mean of the LSV measure.

It should be stressed here that in order to derive the probability distribution of the Chi-squared statistic Z_i^2 (or the sum Z_Φ^2), we do not rely on the normal approximation of a sample mean of the LSV measure which is only justified with a large number of samples. Even if we are interested in herding among a small number of industry-years (i.e. small I), as long as the normal approximation of a binominal distribution of P_i is allowed, Z_i^2 statistic would be more reliable than the conventional t statistic.[9] The use of the former together with the latter would improve the reliability of the test.

3.3.3 Results for statistical significance

The test results with the t and the Chi-squared statistics are presented in Table 3. For both tests, results of the statistical significance represented by the P values parallels those of economic significance represented by the sample means of the LSV measure. For regional banks, we can reject the null hypothesis of no herding for the entire sample period, while a cyclical herding pattern is observed for city banks. We can therefore confirm the conclusion in section 3.2 from a statistical point of view.

Note that the two tests reveal some difference. P values from the t test are larger in general than those from the Chi-squared test. The conventional test has a bias toward accepting the null hypothesis of no herding. As was expected above, this implies that the Chi-squared test could avoid the small sample bias of the t test.[10]

We can thus conclude that the conventional t test is unreliable for small sample analysis, and that the Chi-squared test could make an improvement over the conventional one. Although the conventional testing is indeed easy

[9] For the case in which even the normal approximation of a binominal distribution is not allowed, see section 3.3.4.

[10] In section 4.2, we will confirm this point in a clearer way.

and convenient, and appeals to our intuition, it may accompany a loss of test efficiency and may bias the result for a small sample.

3.3.4 Test for further small sample

If we have very small N_i, which is indeed the case for city banks, the conventional criteria $N_i P_t > 5$ and $N_i(1 - P_t) > 5$ do not hold and the normal approximation of the binominal distribution may not be accepted. In this case, even the Chi-squared test might not be appropriate. Without relying upon this normal approximation, however, it is too difficult to derive the probability distribution of a sample mean of the LSV measure under the null hypothesis of no herding.

As a second best test which supports the Chi-squared one, we conducted a test for each LSV_i one by one. Since we do not know the exact distribution of a sample mean of the LSV measure, it is indeed impossible to test the significance of them in this case. However, we do know the exact binominal distribution of each $P_i - P_t$ under the null hypothesis of no herding, which makes it possible to test the significance of the statistic for each industry-year. We calculated the P value of $P_i - P_t$ one by one from the binominal distribution and find out for what proportion of industry-years the null hypothesis of no herding is rejected in each year. Although it is not a perfect test, at least it helps us to evaluate the results.

The results of this test for city banks are reported in Table 4. Consistent with what we observed in Figure 1, the proportion of industry-years for which the null hypothesis is rejected fluctuates with the magnitude of the LSV measure itself. The conclusion in section 3.2 is thus supported.

4 Causes of herding

4.1 Rationality in herding and adjusted LSV measure

We are interested in whether banks are irrationally following herd behavior. Even if the LSV measure indicates the existence of herding, it does not necessary imply that the banks are irrational. What the LSV measure tries to quantify is the extent of banks' collective deviation from each year's average lending policy. Rational behavior could lead to this deviation. For example, if there are growing industries and declining industries, rational banks would collectively increase loans to the former and decrease to the latter. Growing fund-raising demand from the former industry and shrinking demand from the latter would also lead to non-irrational herding.

Institutional factors could also lead to the deviation. In Japan, for example, different financial liberalization measures had been taken in the 1980s, which enabled firms to obtain funds from the sources other than banks. If the impact of these measures had been different across industries, loans to industries which had benefited most would have decreased by a larger amount. As our interest is in the extent to which banks herd irrationally, we adjust for herding based on rational or institutional grounds.

Since P_t is already subtracted in (1), however, we do not have to adjust for macroeconomic factors that uniformly affect each bank's lending policy. For example, if financial liberalization had had impacts on loans to all industries, it would have been reflected in a smaller P_t and does not affect the average value of LSV_i. In this sense, P_t represents overall macroeconomic or institutional factors. Furthermore, we do not have to adjust for many specific factors as existing studies do on fund manager herding. Existing studies investigate herding at an individual stock level. Factors specific to each stock must be taken into account in their studies. In contrast, due to the semi-macro nature of the data, we do not have to adjust for those factors such as future profitability, fund-raising demand, and accounting flaws of a specific borrower. Only industry level adjustment is necessary here.

In order to eliminate rational or institutional portion of herding, we estimate the following equation by OLS.

$$P_i - P_t = aX_i + \epsilon_i, \tag{3}$$

where X_i is a vector of industry level control variables. ϵ_i represents the *after adjustment* deviation from the year average lending policy that cannot be explained by rational or institutional factors. In other words, ϵ_i captures the portion of herding which cannot be explained by non-irrational factors. We can therefore quantify the extent of herding *after adjustment* by the following measure.

$$LSV_i^A \equiv |\epsilon_i| - E|\epsilon_i|.$$

Averaging this adjusted measure over each year, we can grasp the extent of irrational herding in the year.[11]

The statistical significance of this measure can be tested in a similar manner to the test of LSV_i. Define W_i as follows.

$$W_i \equiv \frac{\epsilon_i}{\sqrt{P_t(1-P_t)/N_i}}.$$

[11] Note that as P_t is calculated as a mean of P_i in each year, we do not need a constant term in the right hand side of (3). In fact, estimation results with a constant term improve little from those without it.

As W_i follows the standard normal distribution, under the null hypothesis of no herding, we obtain the following relationship,

$$W_\Phi^2 \equiv \sum_{i \in \Phi} W_i^2 \sim \chi^2(I - K),$$

where Φ is the relevant group of industry-years, I is the number of industry-years included in Φ, and K is the number of explanatory variables of the regression (3).

As a control variable X_i, we adopt the relative magnitudes of economic activities of the eleven industries in the Japanese economy. They are proxied by the real GDP growth by industry for ten industries and the growth rate of real final consumption expenditure of households for individuals and others. The data are available from the Annual Report on National Accounts.[12]

Additionally, we take into account the impact of financial liberalization as an institutional factor. The difference in the liberalization impact can be proxied by the rate of increase in corporate bonds outstanding. As we were able to obtain the rate only for total bonds and not for individual industries, however, we constructed a variable which is a product of the rate of increase in total bonds outstanding and a dummy variable for traditional industries which takes value of 1 for manufacturing and wholesale industries. As Nakagawa and Uchida[18] demonstrate, loan shares to these two industries which had been banks' main customers decreased drastically after financial liberalization. It is therefore highly probable that firms in these two industries benefited from financial liberalization and gained independence from banks. Corporate bonds outstanding are the sum of outstanding corporate bonds, asset-backed bonds, and convertible bonds. They are available from the Financial and Economic Statistics Monthly by the Bank of Japan.

Another possible institutional factor which might have had different impacts on loans to different industries could be the bad loan problem in the 1990s. However, it turned out that most of the herding in this period is eliminated by the above two control variables. This might imply that the impacts of bad loans are uniform among industries and reflected in P_t. Thus we did not include any other explanatory variables.

[12] We also considered the use of stock price indices by industry which is available from the Tokyo Stock Exchange. Because of the mismatch of the industry classification and the limited availability (only after 1983), we decided not to use them.

4.2 Results

The sample means of herding measures adjusted for rational and institutional factors are presented in Table 5. Figure 2 depicts the measures together with those without the adjustment. The difference between the bold line and the dotted line for respective type of banks represents the portion of herding which was adjusted by rational or institutional factors.

For regional banks, we see only a small part of herding was due to rational or institutional factors. Still a big magnitude of adjusted herding measure manifests itself consistently. The P values from the Chi-squared test reveal that they are significant not only economically but also statistically. We can therefore conclude that it is highly probable that regional banks had been consistently following irrational herd behavior.

In contrast, most of the herd behavior by city banks can be explained on rational or institutional grounds. As for herding in the late 1970s and the early 1990s, Figure 2 tells us that purely irrational herding was economically insignificant and non-irrational herding was dominant, although the Chi-squared test results tell us that the former was still statistically significant. We can therefore conclude that city banks' herding were not irrational in most of the sample period.

The interesting exception is the late 1980s, however. Even after adjusting for rational and institutional factors, we still observe a large extent of herding. It is also worthwhile to note here that in this period, the extent of herding had been severer for city banks than for regional banks. Needless to say, this is nothing but the period when the bubble was formed. As Table 1 tells us, city banks has been playing bigger role in supplying funds in Japan. The result here might thus imply that irrational bank behavior could have caused or accelerated the bubble formation.

It is worth noting about the difference in the two testing results. The conventional t test produces larger P values than the Chi-squared test. This result is more apparent than that observed in Table 3. We could therefore confirm the earlier statement that the Chi-squared test reduces the small sample bias of the conventional test.[13]

Finally, we should mention about the result for city banks in 1990. The adjusted measure again drops off in this year. The reason is the same as that for before adjustment: even after the adjustment, almost all the city banks increased loans outstanding to all the industries. This phenomenon

[13]The binominal test for samples with very small N_i was also conducted in a manner similar to section 3.3.4. As was the case in Table 4, the results were in line with those by the Chi-squared test.

would again be interesting to be pursued independently.

5 Further analysis for city banks in the bubble period

Among interesting results obtained thus far, lending behaviors of city banks in the bubble period (1986-1989) draws special attention. As we see in Figure 2, the results indicate that city banks had been following irrational herd behavior in this period. Since they were dominant in the Japanese loan market, which can be confirmed from Table 1, their irrational behavior could have had a big impact on the Japanese economy. To clarify their behaviors in further details, we focus only on city banks and conduct analysis by industry in this period.

It is our common belief that there was a huge influx of loans from city banks to construction, real estate, and non-bank industries. In Figure 3, we depict city banks' average increase in outstanding loans by industry from 1986 through 1989. Different from our common belief, the top two industries which experienced the biggest increase are services and individual and others, which are followed by real estate and finance and insurance. As Nakagawa and Uchida[18] indicate, these industries are relatively new customers for banks after traditional borrowers gained independence from bank loans due to financial liberalization. Loans to these industries rose, whereas those to traditional borrowers such as manufacturing and wholesale decreased or did not increase a lot. These can be confirmed by Figure 4 which depicts city banks' average loans outstanding by industry.

We calculated a sample mean of the LSV measure by industry over the period from 1986 through 1989. The results are shown in Figure 5. As for new borrowers such as real estate, services, and individual and others, on one hand, we can see that the increase in outstanding loans represented in Figure 3 can be attributed to herd behavior. In other words, city banks had been collectively deviating from each year's average lending policy to lend to these industries. Furthermore, a large portion of this herding is not based on rational or institutional grounds. On the other hand, a decrease in loans to manufacturing industry is also identified as herding. Although most of the decrease was based on rational or institutional grounds, a great extent of irrational herding still remains.[14]

[14]Mining is exceptional in the extent of herding, and so are agriculture, forest and fisheries in the sign of the measure. Although it is difficult to interpret these results, judging from the amount of total loans outstanding (Figure 4), these industries could be

We should stress that we see, on average, consistent irrational herding over industries. Of particular interest is the result that in spite of the difference in the direction and the amount of changes in loans outstanding (Figure 3), the extent of irrational herding was not very much different over industries (right columns in Figure 5).[15] Among these comparable extents of irrationality, we can see that loans to banks' new customers after the financial liberalization (real estate, services, and individuals and others) represent a relatively greater extent of herding than traditional borrowers such as manufacturing and wholesale. This difference is consistent with the results of Nakagawa and Uchida[18], which obtained herding between different types of banks for loans to traditional industries in the 1980s.

In summary, the results in this section confirm those obtained in the last section. Even a closer look at the behavior of city banks reveals irrational herding in the late 1980s. In spite of the difference in circumstances each industry had faced which could naturally lead to different results on herding, a large and comparable extent of irrational herding were observed across industries. It is therefore highly likely that behavior of city banks in this period could have been abnormal and contributed to the formation of the bubble.

6 Conclusion

For the purpose of investigating herd behavior among Japanese banks, we calculated the herding measure invented by Lakonishok, Shleifer, and Vishny [17] (LSV). The results were contrasting for regional banks and city banks. Consistent herding was observed for regional banks during the period from 1975 to 2002, whereas city banks had followed cyclical pattern of herding. Even after adjusting for rational or institutional factors that are contained in the original measure, consistency for regional bank herding was still observed. In contrast, herd behavior by city bank was mainly due to the non-irrational factors. However, the results indicative of irrationality was still obtained for city banks in the late 1980s, which implies that their herd behavior in this period might have caused or accelerated the formation of the bubble.

A few interesting issues remains unchallenged in this paper. First of all, the study about the affect of irrationality is not dealt with in this paper.

disregarded.

[15] Again mining and agriculture, forest and fisheries are the exceptions but they could be neglected.

Although it was shown that city banks were highly likely to be irrational in the bubble period, we do not know how the irrational behavior could have contributed to the formation of the bubble. Second, we should note that there might be herd behavior that cannot be captured by the LSV measure. This point was clarified by our results for the year 1990. In this year, almost all the city banks increased their loans to all the industries. Whether these unanimous increases are based on rational grounds or not is an interesting issue to be clarified.

The financial system in Japan had long been bank-oriented and banks had been playing big roles in the economy. The existence of herding among Japanese banks obtained in this paper is thus as important as that among fund managers in the US, whose system is market-oriented. Of particular interest is the result that city banks might have followed irrational herd behavior in the late 1980s. The present paper demonstrated the possibility of applying the method of analysis for herd behavior among fund managers to that among banks. In order to obtain some lesson from the Japanese experience of the bubble, it would be interesting to apply the same analysis to other bank-oriented economies.

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Table 1 Descriptive Statistics

Year	Regional banks				City banks			
	# of banks	Loans outstanding			# of banks	Loans outstanding		
		Sum (million yen)	% of increase	Standard dev.		Sum (million yen)	% of increase	Standard dev.
1975	131	39,253,944	N/A	252,361	13	49,189,620	N/A	1,564,605
1976	131	44,219,168	11.2%	278,317	13	54,014,828	8.9%	1,710,491
1977	131	49,013,308	9.8%	306,742	13	58,637,696	7.9%	1,847,785
1978	131	54,862,620	10.7%	340,936	13	63,552,000	7.7%	1,987,202
1979	131	59,715,620	8.1%	368,647	13	67,797,904	6.3%	2,096,531
1980	131	64,526,308	7.5%	400,073	13	72,688,344	6.7%	2,254,312
1981	131	71,359,984	9.6%	449,917	13	79,662,600	8.8%	2,476,634
1982	131	77,983,912	8.5%	499,816	13	87,230,416	8.7%	2,703,866
1983	131	84,740,944	8.0%	550,787	13	96,076,776	9.2%	3,058,792
1984	131	92,493,936	8.4%	613,725	13	107,203,144	10.4%	3,524,636
1985	131	96,230,544	3.9%	642,893	13	117,996,920	9.1%	4,024,413
1986	131	101,539,608	5.2%	690,261	13	130,671,192	9.7%	4,739,763
1987	131	110,406,480	8.0%	772,800	13	143,321,168	8.8%	5,298,933
1988	131	121,559,056	9.2%	868,531	13	155,045,328	7.6%	5,858,197
1989	131	136,866,944	11.2%	982,045	13	170,581,936	9.1%	6,398,479
1990	131	164,777,504	16.9%	1,201,693	12	213,880,912	20.2%	9,460,265
1991	131	172,436,192	4.4%	1,255,549	11	219,916,704	2.7%	8,855,080
1992	130	177,709,936	3.0%	1,290,116	11	224,873,088	2.2%	8,898,931
1993	129	180,294,320	1.4%	1,299,759	11	223,369,696	-0.7%	8,765,856
1994	129	183,783,216	1.9%	1,308,175	11	219,627,360	-1.7%	8,612,132
1995	129	188,678,608	2.6%	1,318,976	11	218,059,264	-0.7%	8,442,313
1996	128	188,975,248	0.2%	1,310,307	10	216,077,312	-0.9%	8,315,518
1997	126	189,692,640	0.4%	1,310,875	9	208,668,560	-3.6%	6,693,437
1998	124	190,525,280	0.4%	1,325,869	9	211,083,056	1.1%	7,095,465
1999	122	183,478,512	-3.8%	1,290,572	8	187,518,336	-12.6%	7,174,783
2000	117	179,496,176	-2.2%	1,315,798	8	185,922,912	-0.9%	6,717,941
2001	115	176,824,848	-1.5%	1,319,023	6	149,091,520	-24.7%	9,791,975
2002	113	173,431,872	-2.0%	1,329,087	4	126,880,240	-17.5%	7,392,440

Source: The Nikkei NEEDS Company (Bank) Data File.

Table 2 Mean LSV Measure

Year	Mean LSV	
	Regional banks	City banks
1975	0.0918	0.0077
1976	0.1101	0.0323
1977	0.0697	-0.0033
1978	0.0750	0.0543
1979	0.0940	0.0942
1980	0.0741	0.0297
1981	0.0488	0.0135
1982	0.0499	0.0045
1983	0.0721	0.0365
1984	0.0705	0.0296
1985	0.1203	0.0311
1986	0.1240	0.1243
1987	0.1009	0.1429
1988	0.0684	0.1156
1989	0.1051	0.0849
1990	0.0837	-0.0069
1991	0.0975	0.1290
1992	0.0732	0.0930
1993	0.0842	0.1122
1994	0.0814	0.1084
1995	0.0974	0.1332
1996	0.1347	0.1118
1997	0.0587	0.0623
1998	0.0699	0.0397
1999	0.1207	0.0202
2000	0.0975	0.0108
2001	0.1518	-0.0087
2002	0.2177	0.0114

Note: Sample means of the LSV herding measure are shown.
Source: Authors' calculations.

Table 3 Statistical Significance of Herding

Year	Regional Banks		City Banks	
	P -value from *t* test	*P* -value from Chi^2 test	*P* -value from *t* test	*P* -value from Chi^2 test
1975	0.00	0.00	0.35	0.11
1976	0.00	0.00	0.03	0.04
1977	0.00	0.00	0.68	0.65
1978	0.00	0.00	0.11	0.00
1979	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.04	0.06
1981	0.01	0.00	0.31	0.00
1982	0.01	0.00	0.31	0.33
1983	0.01	0.00	0.02	0.03
1984	0.00	0.00	0.08	0.03
1985	0.00	0.00	0.17	0.01
1986	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.02	0.00
1988	0.01	0.00	0.02	0.00
1989	0.00	0.00	0.03	0.00
1990	0.00	0.00	0.82	0.75
1991	0.00	0.00	0.00	0.00
1992	0.00	0.00	0.02	0.00
1993	0.00	0.00	0.02	0.00
1994	0.00	0.00	0.02	0.00
1995	0.00	0.00	0.01	0.00
1996	0.00	0.00	0.01	0.00
1997	0.01	0.00	0.12	0.01
1998	0.01	0.00	0.12	0.13
1999	0.00	0.00	0.32	0.15
2000	0.00	0.00	0.39	0.31
2001	0.00	0.00	0.57	0.29
2002	0.00	0.00	0.35	0.63

Note: *P* values from the Chi-squared test are shown. Shadowed figures represent the results in which the null hypothesis of no herding is rejected at a 5% significance level.

Source: Authors' calculations.

Table 4 Significance Test based on Binominal Distribution

Year	Significance level	
	5%	10%
1975	1/11	1/11
1976	1/11	1/11
1977	0/11	0/11
1978	1/11	1/11
1979	1/11	1/11
1980	0/11	0/11
1981	1/11	1/11
1982	0/11	0/11
1983	1/11	1/11
1984	1/11	1/11
1985	1/11	1/11
1986	2/11	5/11
1987	5/11	5/11
1988	5/11	5/11
1989	4/11	4/11
1990	0/11	0/11
1991	3/11	4/11
1992	2/11	3/11
1993	4/11	5/11
1994	3/11	5/11
1995	4/11	4/11
1996	2/11	4/11
1997	1/11	3/11
1998	1/11	1/11
1999	1/11	1/11
2000	0/11	1/11
2001	1/11	1/11
2002	0/11	0/11

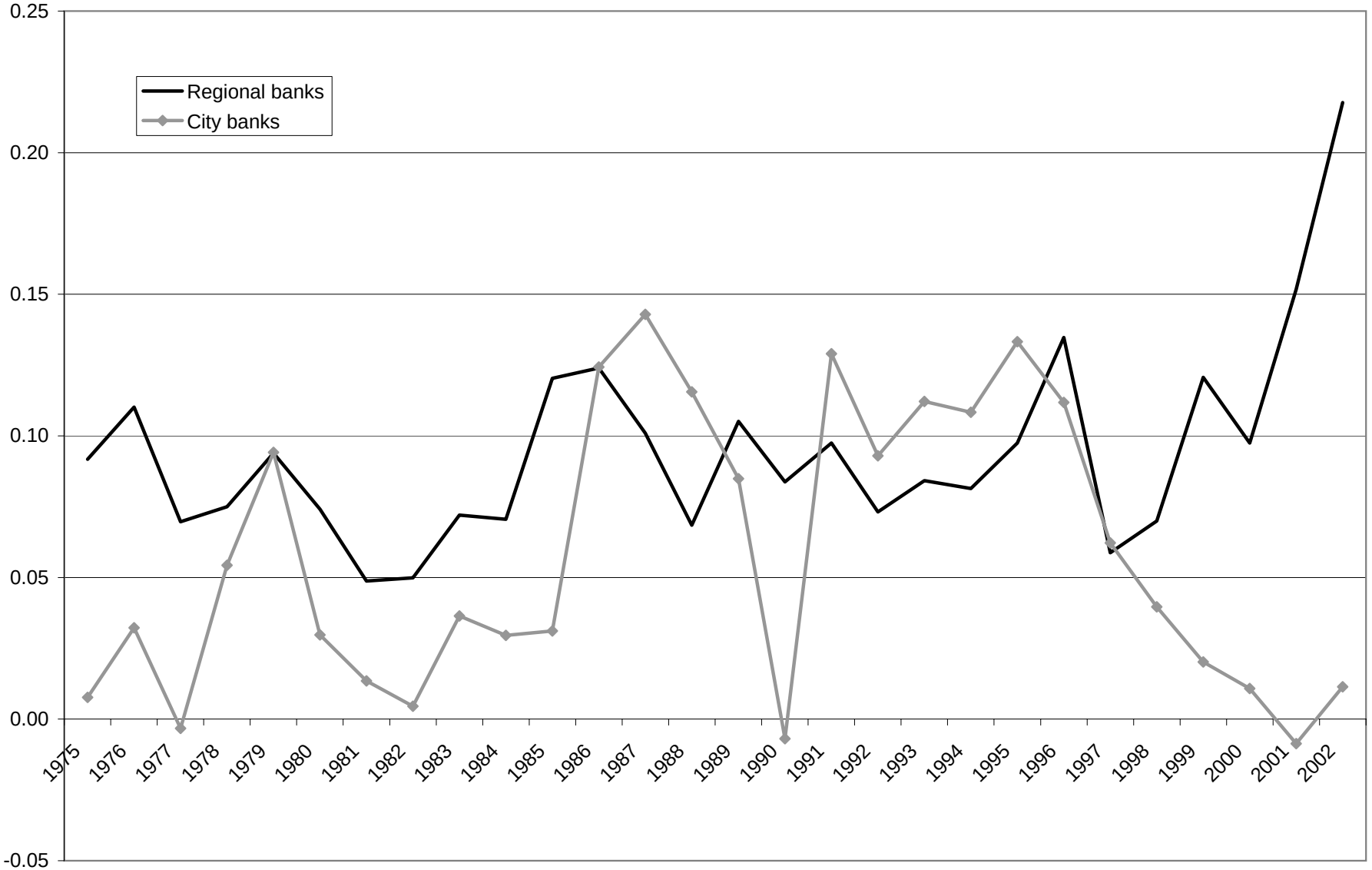
Note: The number of the industries (out of total 11) for which the null hypothesis of no herding is rejected are shown. Years with more than two rejections are highlighted.
Source: Authors' calculations.

Table 5 Mean Adjusted LSV Measure

Year	Regional banks			City banks		
	Mean LSV	*P* -value from *t* test	*P* -value from Chi^2 test	Mean LSV	*P* -value from *t* test	*P* -value from Chi^2 test
1975	0.0721	0.00	0.00	-0.0037	0.57	0.11
1976	0.0663	0.01	0.00	0.0160	0.22	0.04
1977	0.0691	0.00	0.00	-0.0107	0.88	0.58
1978	0.0623	0.00	0.00	0.0284	0.25	0.00
1979	0.0581	0.02	0.00	0.0412	0.13	0.00
1980	0.0585	0.02	0.00	0.0160	0.20	0.06
1981	0.0221	0.08	0.00	0.0060	0.42	0.00
1982	0.0437	0.02	0.00	0.0041	0.25	0.29
1983	0.0605	0.02	0.00	0.0204	0.13	0.05
1984	0.0580	0.01	0.00	0.0153	0.24	0.03
1985	0.0716	0.00	0.00	-0.0167	0.83	0.56
1986	0.0879	0.00	0.00	0.0549	0.09	0.00
1987	0.0895	0.00	0.00	0.1095	0.01	0.00
1988	0.0652	0.01	0.00	0.1107	0.00	0.00
1989	0.0927	0.00	0.00	0.0829	0.03	0.00
1990	0.0635	0.00	0.00	-0.0180	0.95	0.74
1991	0.0893	0.00	0.00	0.0294	0.20	0.04
1992	0.0746	0.00	0.00	0.0282	0.19	0.08
1993	0.0646	0.00	0.00	0.0519	0.16	0.00
1994	0.0777	0.00	0.00	0.0295	0.26	0.01
1995	0.0497	0.02	0.00	0.0324	0.24	0.01
1996	0.0923	0.00	0.00	0.0707	0.06	0.00
1997	0.0499	0.01	0.00	0.0709	0.07	0.00
1998	0.0436	0.07	0.00	0.0180	0.30	0.13
1999	0.0686	0.03	0.00	-0.0041	0.55	0.28
2000	0.0636	0.04	0.00	-0.0016	0.52	0.19
2001	0.0997	0.02	0.00	-0.0106	0.59	0.18
2002	0.1527	0.00	0.00	-0.0273	0.78	0.63

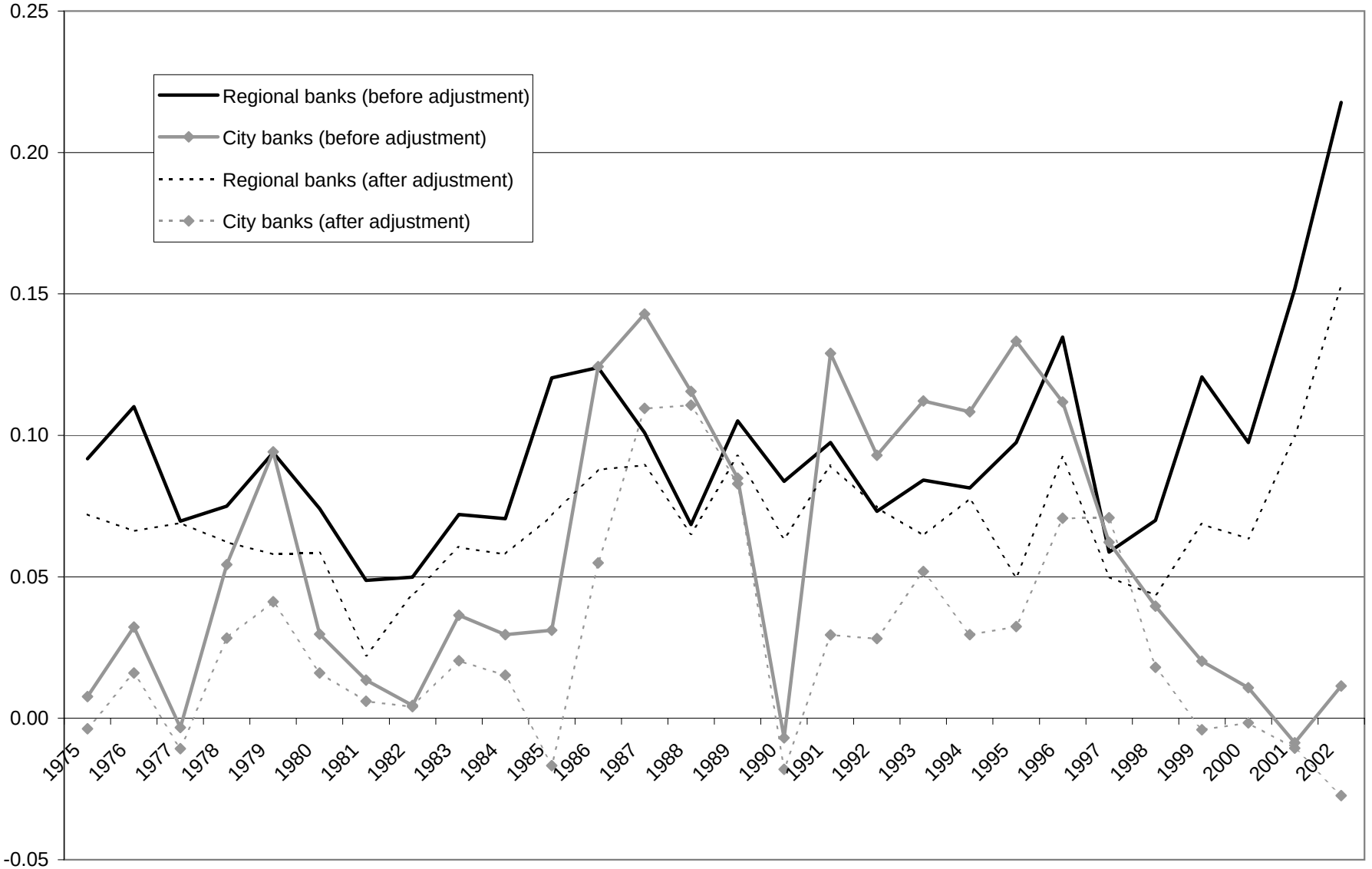
Note: Sample means of the adjusted LSV measure and respective *P* values are shown. Shadowed figures represent the results in which the null hypothesis of no herding is rejected at a 5% significance level.
Source: Authors' calculations.

Figure 1 Mean LSV Measure: Regional and City Banks



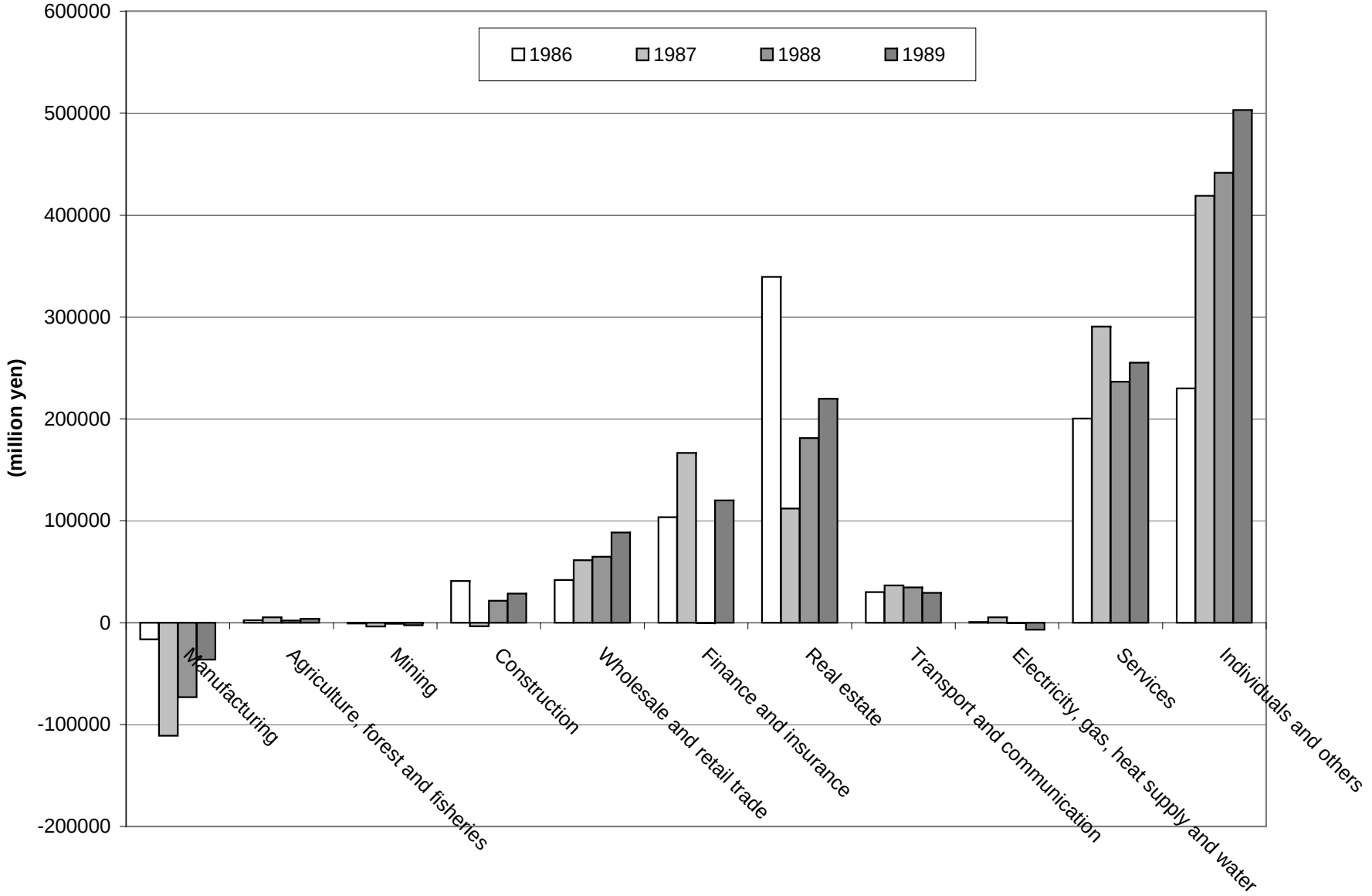
Source: Authors' calculations.

Figure 2 Mean Adjusted and Unadjusted LSV Measures: Regional and City Banks



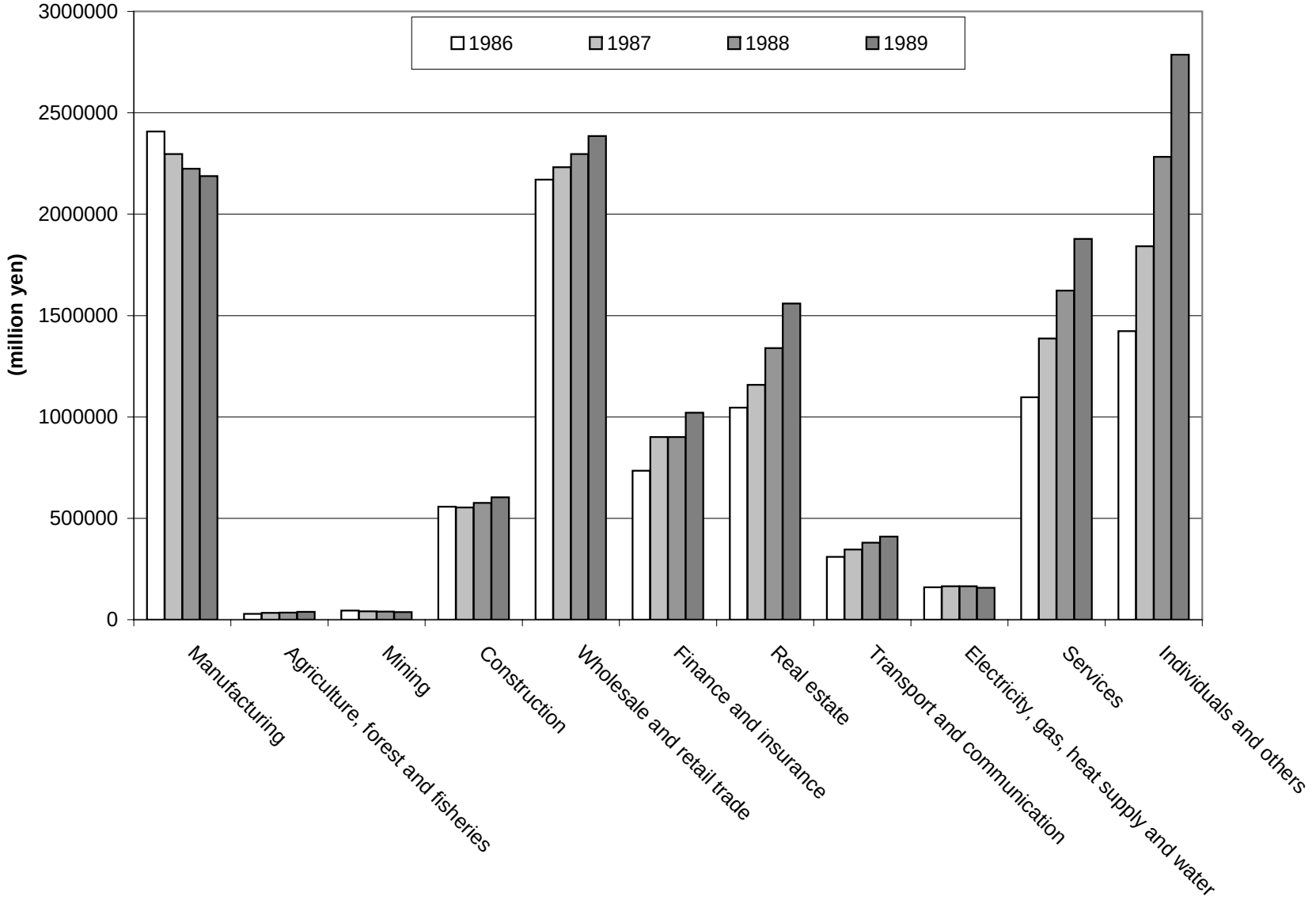
Source: Authors' calculations.

Figure 3 Average Amount of Increase in Loans Outstanding by Industry (City Banks)



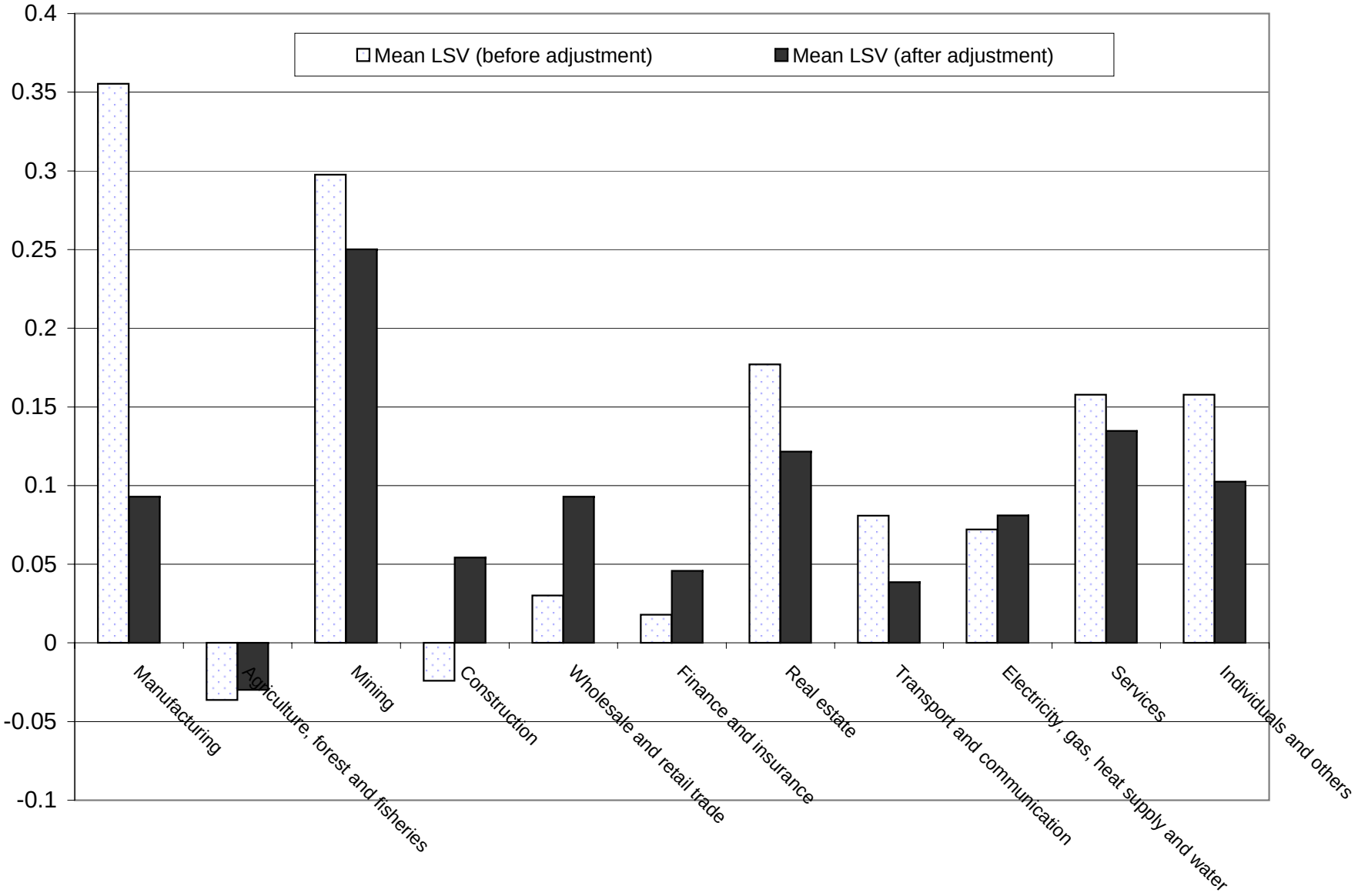
Source: Nikkei NEEDS Company (Bank) Data File.

Figure 4 Average Loans Outstanding by Induatry (City Banks)



Source: Nikkei NEEDS Company (Bank) Data File.

Figure 5 Mean LSV Herding Measure by Industry (Bubble Period (1986-1989), City Banks)



Source: Authors' calculations.