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Productivity and the Business Cycle in Japan: Evidence from Japanese Industry Data

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Productivity and the Business Cycle in Japan*

- Evidence from Japanese Industry Data -

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Abstract

Constructing thirty-seven industries database, we examines whether measured productivity in Japan is procyclical and investigates the sources of that procyclicality using the production function approach employed by Hall (1990) and Basu and Fernald (1995). At the aggregate level, the measured Solow residual shows procyclicality. Large numbers of industries show constant returns to scale. No significant evidence for the presence of thick-market externalities is found. Our results also hold when we consider labor hoarding, part-time employment, and the adjustment cost of investment. The results suggest policies to revitalize the Japanese economy should concentrate on promoting productivity growth.

JEL Classification code: E32, E47

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1 Introduction

A longstanding issue among macroeconomists is the question why measured productivity is procyclical. A representative neoclassical explanation is given by Real Business Cycle (RBC) theory, according to which economic booms are the result of productivity increases generated by technological shocks. In this case, productivity and output move in tandem and increases in total factor productivity (TFP) are attributable to technological shocks.

TFP is usually represented by the conventional Solow residual. However, Hall (1990) argued that, conceptually, increasing returns to scale, the markup ratio, labor hoarding, and demand externalities could all induce procyclicality of the Solow residual. He demonstrated that the technology factor is not the only source of the procyclicality of the Solow residual. Examining U.S. industry data, Hall (1990) as well as Caballero and Lyons (1992) found that among the different factors potentially responsible for the procyclicality of the Solow residual, increasing returns and externalities played a critical role.

Their results, however, have been questioned by Basu and Fernald (1995) and Burnside (1996), who argued that the Solow residuals calculated by Hall (1990) and Caballero and Lyons (1992) were biased because intermediate inputs were ignored and value-added was used to measure output. Basu and Fernald (1995) and Burnside (1996) showed that once intermediate inputs were incorporated into the production function, it displayed constant returns to scale, while no externalities were found. Burnside (1996) and Burnside, Eichenbaum and Rebelo (1996) attacked the studies by Hall and Caballero and Lyons from a different angle: they showed that once the operating rate of capital stock, which Hall (1990) and Caballero and Lyons (1992) did not consider, was included, increasing returns and externalities could no longer be found.

The debate regarding the cyclicality of the Solow residual and the empirical findings of these studies are also of considerable relevance to Japan, especially since economists still cannot agree on the main causes underlying the prolonged recession. Hayashi and Prescott (2002), for example, argue that the main factor has been a decline in the Solow residual which in the context of RBC theory, implies a pure technological shock. Other economists disagree with supply-side explanations such as this one and contend that it is primarily demand-factors that are to blame.[1] The diagnosis of the underlying causes of Japan's economic malaise of course has important implications for the remedies

[1] Yoshikawa (2003), for examples, proposes a growth model where the demand side plays a key role in explaining Japan's disappointing economic performance in the 1990s.

prescribed, i.e. the appropriate economic policies to aid the recovery of the Japanese economy.

In this context, a better understanding of the reasons for the decline in the Solow residual observed in Japan is essential. If technological progress is the main factor underlying the cyclicality of the Solow residual, as RBC theory suggests, economic policy making should concentrate on promoting technological progress. If, however, other factors contribute to the cyclicality of the Solow residual, then, in addition to measures to promote productivity growth, other economic policies including traditional macroeconomic measures, also have a key role to play.

Unfortunately, existing empirical studies on the procyclicality of the Solow residual have concentrated almost exclusively on the United States. Among the few studies that do look at Japan, three different approaches can be made out. The first approach is represented by Vecchi (2000), who compared the factors underlying the procyclical behavior of the Solow residual in Japan and the U.S. following Hall (1990) and others. His results suggest that an important reason for the procyclical behavior of productivity in Japan was labor hoarding. While this study on the Solow residual and the business cycle does shed light on the procyclicality of the Solow residual in Japan, we think the research approach can be improved in several respects. First, Vecchi's study relies on annual data, which makes it difficult to trace business cycles. This problem can be overcome by using quarterly or monthly data. Second, the above mentioned studies, both on Japan and the U.S., focus entirely on the manufacturing sector. However, in both countries, manufacturing industry makes up only 20% of total output. From a macroeconomic viewpoint, non-manufacturing industries should be considered. Third, Vecchi's analysis only covers the period from 1969 to the mid-1980s, but, crucially, not the 1990s. We therefore have no basis to judge whether his results also apply to the Japanese economy during the 1990s.

The second approach is that followed by Kawamoto (2004). Following Basu, Fernald and Kimball (2002), he subtracted the mark-up ratio and the utilization rate of capital and labor from the standard Solow residual and extracted the purified Solow residual at the industry level. Aggregating these purified industry-level residuals, he showed that for the economy as a whole, the purified residual did not decline in the 1990s. Instead, it is the reallocation effect, Kawamoto argues, that is the major factor underlying the lost decade.

Our approach in this paper is quite similar to Kawamoto's. However, our study differs in two regards. First, like Vecchi's, Kawamoto's study cannot trace the cyclicality of the Solow residual because he used annual data. Our study tries to capture the cyclicality using quarterly data. Second, our study considers demand externality as another demand factor which affects the movement of the Solow residual in addition to the markup ratio and the utilization rate of capital and labor which Kawamoto (2004) considered. Because aggregate demand affects the Solow residual through demand externality, the inclusion of this factor in our analysis will help us to assess the reasons underlying Japan's lost decade.

Finally, the third approach is that pursued by Yoshikawa (1992) and Abe (2004). Using production indices for the manufacturing sector, they showed that the movements in Japanese manufacturing production were affected not by macroeconomic shocks but by idiosyncratic shocks in each industry. We think that their approach could be improved in three respects. First, they focused on the movement of output instead of productivity. Thus, their approach does not really help to understand the slowdown in Japan's productivity growth during the 1990s. Second, the studies use GDP (Yoshikawa (1992)) or Stock and Watson's coincident index (Abe (2004)) to represent aggregate business cycle factors. Their studies therefore do not provide us with any understanding of what detailed factors making up the aggregate variables affect the business cycles. Third, like Vecchi, they cover only the manufacturing sector.

In order to address the various shortcomings of these preceding studies, we constructed a new database to analyze the procyclicality of productivity in Japan. Using the *Financial Statements Statistics of Corporations* (hereafter FSSC) published quarterly by the Ministry of Finance, we constructed a data set containing output, intermediate inputs, labor force, net capital stock, and factor shares, and calculated the Solow residual from 1975:4 to 2002:4. The database covers thirty-seven industries, among them nineteen from the non-manufacturing sector.[2]

The paper is organized as follows. In Section 2, we examine the cyclical features of the Solow residual in our data. We look at correlations between the growth rate of the Solow residual in each industry and business cycle indices such as the Diffusion Index (DI) and the Composite Index (CI). In Section 3, we estimate output growth functions using the formulation of Basu and Fernald (1995). In Section 4, we check the robustness of our estimates. We try estimations considering labor hoarding and the quality of capital which are possible candidates for variables affecting the procyclicality of the Solow residual. Section 5 summarizes our results and states our future research agenda.

[2] It is well known that there are discontinuities in the FSSC data between the first and the second quarter due to the replacement of sample firms. In our analysis, we adjust the FSSC data following the methodology suggested by Ogawa and Kitasaka (1998). The construction of the database from the FSSC is described in the data appendix.

2 The Solow residual and Japanese business cycles

Our first task is to check whether the Solow residual in Japan is procyclical. Economists arguing that the Solow residual is procyclical typically use aggregate national accounts data. They calculate the growth rate of the Solow residual by subtracting the growth of production factors from GDP growth.

We calculate the aggregate Solow residual from the FSSC data as follows. First, we set the aggregate production function as

(1) $$V_t = A_t F(L_t, K_t),$$

where V_t represents value-added and L_t and K_t are inputs of labor and capital. These aggregate variables are calculated by aggregating data series at the industry-level described in the appendix. A_t is the conventional measure of TFP. We convert this production function to

(2) $$\Delta a_t = \Delta v_t - \alpha_t^L \Delta l_t - (1-\alpha_t^L)\Delta k_t,$$

which represents the growth rate of the conventional aggregate Solow residual. Small letters represent the logs of their capital counterparts, so all the quantity variables in (2) are log differences, or growth rates. α_t^L is the cost-based share of labor.

We construct our industry-level quarterly data using the FSSC dataset The industry classification is provided in Table A1. The estimation period is from 1976:1 to 2002:4. In recent studies of the procyclicality of productivity, such as Burnside, Eichenbaum and Rebelo (1996), factor utilization plays a key role in the cyclicality of productivity. In our analysis, we use labor input series adjusted by hours worked in all industries and capital input series in the manufacturing sector controlled by capacity utilization. Due to data limitations, we cannot adjust capital input in the non-manufacturing data for capital utilization. A detailed description of the data is provided in the data appendix.

Table 1 presents the aggregate Solow residual as defined in equation (2) during the expansionary and recessionary phases of Japanese business cycles from 1980:1 to 2002:4. The table shows that the growth rate of the Solow residual is positive during all expansionary phases except from 1986:4 to 1991:1 and negative during all recessionary phases except from 1985:2 to 1986:4. The result also holds when we calculate the Solow residual using revenue based share. Table 1 thus confirms that the Solow residual is procyclical in Japan in the sense that it is higher during an expansion than during a recession.

(Insert Table 1)

Next, we correlate the Solow residual at the value-added base in the semi-aggregate sector (the manufacturing sector and the non-manufacturing sector) and business cycle indices such as the Diffusion Index (DI) and the difference of the Composite Index (CI) published by ESRI. The DI and the CI are summary indicators of several primary statistics reflecting the phase of the business cycle, such as the production index, sales in major stores, etc., while GDP is a secondary statistic. The reason why we select the difference of the CI instead of the CI itself is that the CI is constructed to trace the level of the real GDP series and its difference corresponds to the growth rate of the Solow residual. Table 2(a) shows the correlation between the Solow residual and business cycle indices for all industries and for the manufacturing and the non-manufacturing sector separately. The correlation is positive in all cases. Only the correlation between the Solow residual in the manufacturing sector and DI is not significant. The correlation between the Solow residual and the business cycle indices is stronger in the non-manufacturing sector than in the manufacturing sector.

(Insert Table 2(a))

Finally, given that each industry has a unique production function, we calculate the growth rate of the Solow residual at the industry-level using the FSSC data. Following Basu and Fernald (1995), we calculate the Solow residual based on gross output instead of value-added, because the Solow residual on a value-added basis yields biased estimates at the industry-level if firms enjoy monopoly power in product markets.

We set the gross output production function for industry i at period t, as follows:

(3) $$Y_{it} = A_{it} F(L_{it}, K_{it}, M_{it}),$$

where Y_{it} represents gross output, M_{it} stands for intermediate inputs of energy and materials, and A_{it} is the TFP at the industry-level. Because Y_{it} and value–added V_{it}

are made from items in the FSSC, M_{it} is constructed as $Y_{it} - V_{it}$. Therefore, we calculate the Solow residual at the industry-level in the following way:[3]

(4) $$\Delta a_{it} = \Delta y_{it} - \alpha_{it}^{L}\Delta l_{it} - \alpha_{it}^{K}\Delta k_{it} - (1 - \alpha_{it}^{L} - \alpha_{it}^{K})\Delta m_{it}$$

where α_{it}^{j} is the cost-based share of factor j(=L, K). Note that constant returns to scale are still assumed.

Calculating the correlation between the Solow residual in each industry and the two business cycle indices, our results do not allow a firm conclusion, as only six industries (nos. 4, 5, 16, 24, 27, and 36) show a positive and significant correlation.

Summarizing the results of Tables 1 and 2, the Solow residual at the aggregate level has a positive correlation with the business cycle, but no general correlation can be observed at the industry-level. This result implies that we should examine several factors influencing the Solow residual in order to understand its movements.

(Insert Table 2(b))

3 Basic estimation of productivity cycles

3.1 Production function with variable returns to scale and externalities

As Hall (1990) and Basu and Fernald (1995) argued, productivity cycles can be induced not only by technological shocks but also by several other factors such as increasing returns to scale, the markup ratio, and thick-market externalities. In order to take these factors into consideration, we rewrite equation (3) as follows:

(3)' $$Y_{it} = A'_{it_{it}} F(L_{it}, K_{it}, M_{it}; X_{it}),$$

where X_{it} stands for externalities.

Taking logs and totally differentiating (3)', we obtain

[3] The Solow residual is affected by demand externalities or production technology such as increasing returns to scale. We will examine these factors in the estimation in Sections 3 and 4.

(5) $$\Delta y_{it} = \gamma_i(\alpha_{it}^L \Delta l_{it} + \alpha_{it}^K \Delta k_{it} + \alpha_{it}^M \Delta m_{it}) + \beta_i \Delta x_{it} + \Theta_{it}$$
$$\equiv \gamma_i \Delta z_{it} + \beta_i \Delta x_{it} + \Theta_{it},$$

where γ_i is the degree of homogeneity and β_i is the degree of the externality. We obtain Θ_{it} $(\equiv \Delta a_{it}^{'})$ as a pure technological shock. $\Delta z_{it} \equiv \alpha_{it}^L \Delta l_{it} + \alpha_{it}^K \Delta k_{it} + \alpha_{it}^M \Delta m_{it}$ is the cost-weighted sum of the growth rates of the production factors.

Caballero and Lyons (1992) argued that the productivity of each industry depends on the level of aggregate activity, referring to this effect as thick-market externality. To take this issue into account, we introduce a measure of such externality calculated as $\Delta x_{it} = \sum_{j \neq i}^{N} s_{jt} \Delta y_{jt}$, where N denotes the number of industries and s_{it} is the output share.

3.2 Estimation methodology

We estimate equation (5) to examine the cyclicality of productivity, using the FSSC data. Summary statistics of the data are provided in Table A2. We estimate equation (5) simultaneously for all thirty-seven industries by three-stage least squares (3SLS). 3SLS is used to address the problem of correlation between exogenous technology shocks and the inputs used in production.[4] We use the following variables as instruments: the diffusion index of financial institutions' lending attitude, the relative price of oil, the difference between the current temperature and the average temperature, the call rate, and the nominal exchange rate.[5] The diffusion index is published in the Bank of Japan's Tankan (*Short-Term Economic Survey of All Enterprises*). While studies on U.S. productivity have used the growth rate of world oil prices, military spending, the political party of the President, and lagged dependent variables as instrumental variables, we do not think that military spending or the political party of the Prime Minister are appropriate instruments because of the 1%-of-GDP legal limit to military spending in Japan and the long-time dominance of the Liberal Democratic Party in the Japanese Diet.

[4] Estimating equation (5) by the 2SLS method in each industry, we carried out the Hausman specification test. The test showed that the 3SLS specification was valid.
[5] We do not include constant term as an instrument. So, the mean of error term is not zero as shown in the following results.

3.3 Basic results

Table 3 summarizes the regression results. Only five industries show increasing returns to scale, while twenty-nine industries show constant returns to scale. Industries with significant decreasing returns to scale are not found.[6]

(Insert Table 3)

The coefficients on the thick-market externality variable (β) are not significantly different from zero except in the electric machinery (no. 19) and the transportation equipment industry (no. 20). Thus, we find little evidence for the presence of thick-market externalities. Even if aggregate activity is high or demand from other sectors is strong, sectoral productivities do not rise. This result is at odds with Vecchi's (2000) study which found evidence for the presence of thick-market externalities in Japan.

A number of studies on U.S. industrial productivity, including Hall (1988, 1990) and Caballero and Lyons (1992), base their estimates on value-added. However, Basu and Fernald (1995) argue that in the absence of constant returns to scale and perfect competition intermediate inputs directly affect value-added; they suggest that estimates of γ are thus likely to be biased downward, while estimates of β are likely to be biased upward in a value-added specification. In order to examine whether such biases can be found in our data for Japan, we conduct an estimation using the growth rate of value-added (Δv_{it}) instead of gross output as our dependent variable. We estimate the following equation:

$$(6) \quad \Delta v_{it} = \hat{\gamma}_i \Delta z_{it}^{v} + \hat{\beta}_i \Delta x_{it} + \tilde{\Theta}_{it},$$

where $\Delta z_{it}^{v} = \alpha_{it}^{(v)L} \Delta l_{it} + \alpha_{it}^{(v)K} \Delta k_{it}$ and $\alpha_{it}^{(v)}$ is the factor cost share based on value-added.

Table 4 shows the regression results for the value-added specification. The values of

[6] Basu and Fernald (1997) showed that the link between the degree of homogeneity γ, the mark-up ratio μ and the profit rate π is $\gamma = (1-\pi)\mu$. This relation implies that if the profit rate is low, the degree of homogeneity is roughly equal to the markup ratio. Using the results in Table 3 and profit rates, we can calculate the mark-up ratio μ. The average value of μ for all industries is 1.09. This figure is consistent with the mark-up ratio (1.13) calculated by Nishimura, Ohkusa and Ariga (1999).

the coefficients on $\hat{\gamma}$ are lower than those in Table 3, in line with Basu and Fernald's (1995) prediction. In addition, in many industries, these coefficients are either not significantly positive or even negative.

(Insert Table 4)

On the other hand, the positive and significant coefficients on $\hat{\beta}$ appears in only two industries. The result is similar to Table 3.[7] Overall, the results in Table 4 point to the same conclusion as the one presented by Basu and Fernald (1995).

3.4 Estimation results for subperiods

Given that the Japanese economy has stagnated since the beginning of the 1990s, it is important to understand whether fluctuations in productivity before and after 1990 are due to different factors. We therefore split our sample into two periods: the period from 1976:1 to 1990:4 and the period from 1991:I to 2002:4. As shown in Table 1, the Japanese economy entered a period of long stagnation after 1991:1. The dependent variable is the growth rate of gross output in each industry.

Table 5(a) shows the estimation results for the earlier period, while Table 5(b) shows the results for the more recent period. For the earlier period, we find increasing returns to scale in nine industries. The coefficients on thick-market externality are not significantly different from zero except in transportation equipment, i.e. we could not find evidence suggesting the presence of thick-market externalities.

(Insert Table 5(a) and 5(b))

We next examine the results for the more recent period. The number of industries with increasing returns to scale increases from the estimation for the first subperiod, and the average estimate of γ is greater for the 1990s. As above, the coefficients on thick-market externality are not significant in many industries, i.e. there is little evidence suggesting the presence of thick-market externalities.

The overall results suggest that during the period under investigation (i.e. 1976–2002), the dominant factor underlying the procyclical behavior of productivity in Japan is pure technological shocks. In specific industries, increasing returns to scale

[7] In the SUR estimation, the estimates of coefficients on β are positive and significant in twenty-two industries. The result supports the argument by Basu and Fernald(1995).

also affect the movement of the Solow residual in the 1990s. However, no industry shows increasing returns to scale in all estimations shown in Table 3 and Table 5(a), (b), and we conclude that the effect of increasing returns to scale on the movement of the Solow residual is small. Finally, we do not find thick-market externalities.

4. Alternative estimations

4.1 Labor hoarding

A number of studies, including Burnside, Eichenbaum and Rebelo (1993), Burnside and Eichenbaum (1996), Basu (1996), and Vecchi (2000), have emphasized the role of labor hoarding as a factor responsible for the cyclicality of the Solow residual. Firms engage in labor hoarding in recessionary periods because adjusting employment is costly. Thus, during a recovery the measured labor input (i.e. hours worked) may well remain unchanged, while output increases as the unmeasured intensity with which that labor input is used (i.e. the work effort) increases. This means that the larger Solow residuals during the recovery period reflect greater labor effort rather than any changes in technology.

Following Wakita (1997), we construct a labor hoarding index using the diffusion index for employment conditions published in the Bank of Japan's Tankan (*Short-Term Economic Survey of All Enterprises*). The diffusion index is based on firms' answer regarding whether their employment was "excessive," "insufficient," or neither, i.e. just right.

Assuming a uniform distribution with regard to the answers, we can construct the following labor hoarding index (H_{it}).

$$(7) \quad H_{it} = \frac{EX - SH}{OR},$$

where EX is the percentage of firms replying that employment was excessive, SH is the percentage of firms answering that there was a shortage of labor, and OR is the percentage of firms indicating that employment was optimal.

Taking equation (7) into account, we rewrite equation (5) as follows;

$$(5)' \quad \Delta y_{it} = \gamma_i \Delta z_{it} + \beta_i \Delta x_{it} + \phi_i \Delta H_{it} + \Theta'_{it},$$

where the coefficient ϕ_i is expected to be negative.[8]

The estimation results for equation (5)' are shown in the upper half of Table 6. The labor hoarding index has a negative sign in twenty industries.[9] The negative effect is significant in the non-ferrous metals and the gas and water utility industries (nos. 16 and 31). In this specification with the labor hoarding index, only three industries display increasing return to scale, while constant returns to scale hold in most industries.

(Insert Table 6)

According to Basu and Fernald (1997) and Kawamoto (2004), labor hours can be used as a proxy for the amount of labor effort when an cost function which depends on labor effort and labor hours is added to the conventional cost function. Therefore, we estimate the following equation including the log-difference of labor hours (Δh_{it}) instead of the labor hoarding index.

(5)" $\Delta y_{it} = \gamma_i \Delta z_{it} + \beta_i \Delta x_{it} + \phi_i ' \Delta h_{it} + \Theta'_{it}$

The coefficient on ϕ_i is expected to be positive. The result of the estimation, shown in the lower half of Table 6, is similar to the one using the labor hoarding index. Though eighteen industries have positive coefficients on labor hours, they are significant in only four industries.[10] We conclude that the effect of labor hoarding is small. This result is the opposite of Kawamoto's (2004) finding. The conflicting results for labor hoarding may spring from methodological differences. His analysis is based on annual data and he assumes that the cost-weighted sum of the growth rate of the production factor Δz is constant. In addition, in his analysis, changes in labor hours include not only labor effort but also the rate of capital utilization, because his model assumes that labor

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[8] ΔH_{it} represents the difference of the labor hoarding index. We cannot calculate the growth rate of the index, because the index can take negative values.

[9] The Tankan provides no diffusion index for agriculture, fishery, forestry, and mining. We therefore omit these industries in our estimation.

[10] Comparing the estimations by industry using labor hours and using the labor hoarding index, the results are not perfectly consistent. The inconsistency reflects differences in the coverage of the two variables: the labor hoarding index covers firms that are bigger than those covered in the data on labor hours. In addition, the coefficient on labor hours captures not only labor effort but also the capital utilization rate in the non-manufacturing sector. We also carry out the two types of estimation for the 1990s. These results are similar to the results in Table 6.

hours become a proxy of the capital utilization rate.

4.2 Part-time employment

Furthermore, we consider the possibility that the results estimated so far may have been distorted by an underestimation of the labor input as a result of the increase in part-time employment. This increase can be seen in the gradual rise in the ratio of part-time employees to total employees since the second half of the 1980s.

Unfortunately, the data on the number of workers reported in the FSSC do not include part-time workers, meaning that the labor input data based on these figures and used above probably understate the true value of labor input. We therefore revised our labor input data to take into account the rise in part-time employment, using the *Report on the Monthly Labor Survey* (Ministry of Health, Labour and Welfare) which reports the proportion of part-time employees by industry from 1990 onward. Using the revised data, we re-estimated equation (5)' for the subperiod from 1990:2 to 2002:4.

(Insert Table 7)

The results are displayed in Table 7 and are similar to those presented in Table 6. Even when controlling for part-time employment, twenty-four industries have constant returns to scale and thick-market externalities do not have cyclical effects. Though the coefficient on the labor hoarding index is negative for many industries, it is significant only in the case of five industries.

4.3 Adjustment cost of investment

Another factor potentially affecting measurements of the Solow residual is the adjustment cost of investment. Basu, Fernald and Shapiro (2001), for example, argue that during a period of rapid economic expansion, observable TFP growth as conventionally measured may understate true TFP growth because of the adjustment costs that firms incur during an investment boom. In order to take this possibility into account, we revise equation (3)' as follows:

$$(3)'' \qquad Y_{it} = A'_{it_{it}} F(L_{it}, K_{it}, M_{it}; X_{it})(1-\Gamma_i(J_{it}))$$

where J_{it} represents the ratio of gross investment to capital stock in industry i and Γ_i is the internal adjustment cost of investment/capital stock ratio in industry i.

Following Basu, Fernald and Shapiro (2001), we obtain

$$(5)''' \quad \Delta y_{it} = \gamma_i \Delta z^c{}_{it} + \beta_i \Delta x_{it} + \phi_i \Delta H_{it} + \eta_i (\Delta j_{it})^2 + \Theta''_{it},$$

Considering adjustment cost of investment, we measure the gap between marginal productivity of capital and price of capital service by using Tobin's q. Tobin's q at the industry level (Q_{it}) is constructed as the ratio of the operating profit rate to cost of capital. Then, we revise a cost-weighted sum of the growth rates of the production factors as $\Delta z^c{}_{it} \equiv \alpha_{it}^{(c)L} \Delta l_{it} + \alpha_{it}^{(c)K} (\Delta q_{it} + \Delta k_{it}) + \alpha_{it}^{(c)M} \Delta m_{it}$. $\alpha_{it}^{(c)}$ is a modified cost share including adjustment cost of investment. In equation (5)''', the coefficient η_i is expected to be negative. To estimate equation (5)''', we use the square value of Δj_{it}, assuming symmetric internal adjustment costs.

Our estimation is for the period from 1976:1 to 2002:4. Labor input data are unadjusted for part-time employment for which data are available only from 1990 onward. The estimation results are presented in Table 8 and show that η is negative in nine industries in the 3SLS estimations. However, in no industry is the cost of investment significant. At the same time, there is no industry with increasing return to scale and the coefficients on thick-market externality and labor hoarding are also insignificant in all industries.

(Insert Table 8)

5 Conclusion

Since the publication of Hayashi and Prescott's (2002) controversial paper, RBC theory has received considerable attention in the debate on the causes of the long-term stagnation of the Japanese economy. However, few studies have actually examined Japan's business cycles to check the validity of the theory. Following studies on the U.S. such as Hall (1990) and Basu and Fernald (1995), if an estimated production function displays constant returns to scale and thick-market externality and labor hoarding behavior are not found, then we know that the main source of procyclical productivity movements is pure technological shocks as suggested by RBC theory. In this case, policies to revive the Japanese economy should focus on promoting productivity growth.

On the other hand, if increasing returns to scale, thick-market externality, and labor hoarding affect movements in the Solow residual, other policy tools, including conventional Keynesian economic policies, would be called for.

Against this background, the main results of our examination of the procyclicality of the conventional Solow residual in Japan can be summarized as follows:

(1) At the aggregate level, conventional measures of the Solow residual based on the assumption of constant returns to scale show a positive correlation with real GDP and business cycle indicators.

(2) Even if the assumption of constant returns to scale is dropped and variable returns and externalities are allowed for, constant returns to scale are observed in most of the thirty-seven industries. This result implies pure technological shocks are the main factor underlying the cyclicality of the Solow residual in the industries with constant return to scale.

(3) In the 1990s, increasing returns to scale were also an important factor underlying the cyclicality of productivity in some industries.

(4) The previous results also hold when taking labor hoarding, part-time employment, or the adjustment cost of capital into account.

Taken together, the above results support the hypothesis that technological shocks are the crucial factor underlying the cyclicality of the Solow residual even when other cyclical factors such as labor hoarding, part-time employment, and the adjustment cost of investment are taken into account. Viewed in the context of the long-term stagnation of the Japanese economy in the 1990s, our results imply that in order to restore growth, policies to promote productivity growth should take center place. A number of recent studies, including Fukao and Kwon (2004), Caballero, Hoshi and Kashyap (2004), and Nishimura, Nakajima and Kiyota (2005), have pointed out major causes for the slowdown in productivity growth, such as misallocations in factor markets and malfunctioning in the financial intermediation system. These findings suggest that what is needed to revitalize the Japanese economy is not only to promote R&D but also to implement policies that facilitate the reallocation of labor, capital, and loans.

Finally, we would like to point out two areas in which our research could be improved. First, while our analysis examined the effects of technological shocks on output and productivity, we did not examine how these technological shocks affect other aggregate variables such as labor hours, prices, and investment in a frame work of a general equilibrium. Recently, Lijungqvist and Uhlig (2000), and Krebs (2003) proposed general equilibrium models which made the government's interventions effective by modifying RBC theory. Nakajima (2005) constructed a dynamic general equilibrium model which explained the U.S. economy better than RBC model. In a empirical study on the U.S. economy, Basu, Fernald and Kimball (2004) investigated how a pure aggregate technological shock measured by the estimation of industry-based production function like equation (5)" affects labor hours, prices, employment, investment, and various aggregate variables by using the VAR method. As an alternative verification that the validity of RBC theory is applicable to the Japanese economy, we would like to investigate the relationship between pure technological shocks and several macroeconomic variables using the methodology employed by Basu, Fernald and Kimball (2004).

The second way in which our research could be improved is to divide the FSSC data into large, medium, and small firms and to examine differences in productivity movements for firms of different size. Before the 1990s, the conventional wisdom was that changes in production by small and medium firms were more sensitive to business cycles than those by large firms. However, in the 1990s, production by small and medium firms seems to have been less sensitive to business cycles than that by large firms. Thus, using our dataset and dividing firms by size would allow us to examine not only such structural changes but also the effectiveness of aggregate economic policies on different types of firms.

Data appendix

This appendix explains how we constructed the dataset used in this study. For our analysis, we need industry-level quarterly data. While the *Japan Industry Productivity Database* (JIP Database) (Fukao et al. 2003) and the *Japan Center for Economic Research Database* (JCER Database) (Miyagawa et al. 2004) provide industry-level statistics, these are on an annual basis and therefore make it difficult to examine business cycles. We therefore construct a new industry-level quarterly dataset, relying primarily on the *Financial Statements Statistics of Corporations* (FSSC) by the Ministry of Finance.

All variables described in the following sections are those at industry base. Table A-1 shows our industry classification and Table A-2 shows the basic statistics of our data.

A1. Output and value-added series

The nominal output series in industry i (Y_{it}) is calculated as follows:

$$Y_{it} = (Sales)_{it} + [(Inventory\ stock)_{it} - (Inventory\ stock)_{i,t-1}]$$

We convert this series from nominal to real terms based on 1990 prices by using the Consumer Price Index (CPI) and the Corporate Goods Price Index (CGPI).

The value-added series in industry i (V_{it}) in real term is calculated as follows:

$$V_{it} = (Labor\ \cos t)_{it} + (Depreciation)_{it} + (Operating\ income)_{it}$$

Labor costs are deflated using wage indices from the *Report on the Monthly Labor Survey* compiled by the Ministry of Health, Labour and Welfare. Investment goods deflators are used to deflate capital depreciation and operating income. We convert the annual investment goods deflators by industry in the JIP database to quarterly series by using Goldstein and Khan's (1976) method.

A2. Construction of capital stock series

For our nominal investment data, we use the increase in tangible fixed assets excluding land and construction in progress from the detailed descriptions of the transactions in tangible fixed assets in the FSSC. The investment series for all sectors, for the manufacturing sector total, and for industries no. 4, 5, 6, 7, 10, 12, 15, 16, 17, 18, 19, 24, 25, 26, 30, and 31, are available from 1960 onward. The investment series for the remaining industries (i.e., nos. 1, 2, 3, 8, 9, 11, 13, 14, 20, 21, 22, 23, 27, 28, 29, 32, 33, 34, 35, 36, and 37) are available only from 1975 onward. We divide the industries into two groups and label the former Group 1 and the latter Group 2. We construct the capital stock series for each group as follows:

Group 1 (data available from 1960)

We first deflate the nominal investment series by industry using investment goods deflators. The capital stock series are constructed by the perpetual inventory method. The quarterly depreciation rates which we use in the perpetual inventory method are estimated by using the average depreciation rate by industry in the JIP Database.

Group 2: (data available from 1975)

Using the real capital stock series constructed for Group 1, we can calculate the ratio of market-value to book-value of capital stock in the Group 1 industries. To calculate the real capital stock for the first quarter of 1975 by industry, we multiply the nominal capital stock by the market-value to book-value ratio of the first quarter of 1975: i.e.

$$(\textit{Real value of capital stock})_{i,\,1975} = (\textit{Book value of capital stock})_{i,\,1975}$$
$$\times \quad (\textit{Market value to book value ratio})_{i,\,1975}$$

Setting the real value of capital stock in 1975 as the benchmark stock, we then construct the capital stock series for the Group 2 industries using the perpetual inventory method.

As for the capacity utilization rate, we use the "Indices of Operating Ratio" published by the Ministry of Economy, Trade and Industry (METI) for manufacturing industries. For other industries, we assume that the capacity utilization rate is one.

A3. Intermediate input and labor force series

Real intermediate input series in industry i (M_{it}) are calculated by subtracting real value-added from real output.

For the labor force series we use the number of employees provided in the FSSC. To construct the labor input series on a man-hour basis we adjust the number of employees by hours worked provided in the *Report on the Monthly Labor Survey*.

A4. Factor cost share series

In order to compute factor cost shares, we first need to take into account capital payments. Capital payments are defined as[11]:

$$(\textit{Capital payments})_{it} = (\textit{Capital cost})_{it} \times (\textit{Real capital stock } (K_{it}))_{it}$$

To calculate capital costs, we convert the industry classifications for capital services given in the JIP database into the industry classifications of the FSSC, construct the quarterly series for capital services and divide these capital services by real capital stock. This method is applied to the data from 1975 to 1998, because JIP database series covers years from 1970 to 1998. From the first quarter of 1998 to the fourth quarter of 2002, capital cost from 1998:1 to 2002:4 is computed according to the following formula:

$$(\textit{Capital cost})_{it} = P_{I\,it} \times \left(i_{it} - \frac{\Delta P_{I\,it}}{P_{I\,it}} + \delta \right)$$

where

P_{Iit} : price of investment goods;

i : the yield of newly issued government bonds;

δ : depreciation rate (This value is 0.072 according to Ogawa and Kitasaka, (1998).)

Next, we calculate the growth rate of real capital costs from 1998 to 1999. Using this rate, we can construct the real capital cost series for the period after the first quarter of 1999.

Total costs are defined as:

$$(\textit{Total cost } (TC_{it}))_{it} = (\textit{Capital payments})_{it} + (\textit{Nominal labor cost } (w_{it}L_{it}))_{it}$$
$$+ (\textit{Nominal cost of intermediate input}(P_{Mit}M_{it}))_{it}$$

,

[11] In the following equation, we use real capital stock which is unadjusted by capital utilization rate, because capital cost is adjusted by capital utilization rate. We thank Professor Nakajima for pointing it out.

where w_{it} is nominal wage rate and P_{Mit} is a price of intermediate input respectively. The cost share of each factor can be obtained by dividing the cost of each factor of production by total costs. That is:

Cost based share of labor: $\alpha_{it}^{L} = \dfrac{w_{it}L_{it}}{TC_{it}}$

Cost based share of capital: $\alpha_{it}^{K} = \dfrac{CC_{it}K_{it}}{TC_{it}}$

Cost based share of intermediate input: $\alpha_{it}^{M} = \dfrac{P_{Mit}M_{it}}{TC_{it}}, = 1-\alpha_{it}^{L}-\alpha_{it}^{K}$

Cost based share of labor based on value-added: $\alpha_{it}^{(v)L} = \dfrac{w_{it}L_{it}}{TC_{it}-P_{Mit}M_{it}}$

Cost based share of capital based on value-added: $\alpha_{it}^{(v)K} = 1-\alpha_{it}^{(v)L}$

A5. Adjusting for discontinuities in the FSSC data

It has been pointed out that there are discontinuities in the FSSC data between the first and the second quarter because sample firms are replaced in the second quarter each year. We should therefore make adjustments to construct consistent time series and we do so by following Ogawa and Kitasaka's (1998) method. Because the second quarter survey in the FSSC has information on the balance sheet at the beginning and at the end of the quarter, we can calculate the ratio (g_t) of ex-post tangible assets in the first quarter to ex-ante tangible assets in the second quarter as follows:[12]

$$g_{it} = \frac{K_{2it}}{K_{1i,t-1}}$$

where

K_{1t-1}: the book value of tangible fixed assets at the end of the first quarter (before the replacement of sample firms);

[12] In this study, we exclude land and construction in progress from tangible fixed assets.

K_{2t} : the book value of tangible fixed assets at the beginning of the second quarter (after the replacement of sample firms).

Using the ratio we can estimate several items in the FSSC which are consistent with the samples of the second quarter. In the case of sales, assuming the ratio of sales to the book value of tangible fixed assets is constant, we can obtain the series of variables adjusted for the ratio (g) from the following formula:

$$(Sales)_{1it} = (Sales)_{1i,t-1} \times g_{it}$$

where

$(Sales)_{1t-1}$: the first quarter sales of firms surveyed in year t-1;

$(Sales)_{1t}$: the estimated first quarter sales of firms after adjusting for the gap caused by the replacement of sample firms.

We apply this procedure to all variables in the FSSC retroactively.

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Table 1 The Solow residual and the Japanese business cycles

	Expansion		Recession	
	GDP growth	Growth of Solow residual	GDP growth	Growth of Solow residual
1980:1-1983:1			2.83	-1.10
1983:1-1985:2	3.77	0.12		
1985:2-1986:4			3.19	0.53
1986:4-1991:1	5.42	-0.19		
1991:1-1993:4			0.73	-4.05
1993:4-1997:2	1.72	0.18		
1997:2-1999:1			0.45	-1.04
1999:1-2000:4	2.46	3.93		
2000:4-2002:1			-1.79	-5.12
2002:1-2002:4	3.18	1.69		

Table 2(a) Correlation between the growth of the Solow residual and business cycle indices

	All industries	Manufacturing	Non-manufacturing
TFP growth & DI	0.256	0.124	0.240
	(2.735)	(1.297)	(2.556)
TFP growth & Difference of CI	0.397	0.252	0.347
	(4.471)	(2.692)	(3.833)

Note: The figures in parentheses are t-ratios.
Source: Authors' calculations.

Table 2(b) Correlations between the growth of the Solow residual by industry and business cycle indices

	1	2	3	4	5	6	7	8	9	10
TFP growth & DI	0.030	0.040	0.063	0.196	0.184	-0.198	0.065	-0.045	0.137	0.071
	(0.309)	(0.418)	(0.652)	(2.069)	(1.941)	(-2.089)	(0.669)	(-0.469)	(1.428)	(0.740)
TFP growth & Difference of CI	0.002	0.040	0.133	0.184	0.183	-0.217	0.078	-0.043	0.062	0.093
	(0.022)	(0.417)	(1.384)	(1.932)	(1.925)	(-2.303)	(0.812)	(-0.443)	(0.647)	(0.967)

	11	12	13	14	15	16	17	18	19	20
TFP growth & DI	-0.109	0.043	0.151	-0.104	0.111	0.274	0.102	-0.030	0.027	0.088
	(-1.130)	(0.450)	(1.577)	(-1.079)	(1.151)	(2.950)	(1.061)	(-0.314)	(0.283)	(0.911)
TFP growth & Difference of CI	-0.118	0.117	0.083	-0.065	0.105	0.238	0.113	0.053	0.048	0.058
	(-1.230)	(1.223)	(0.862)	(-0.679)	(1.097)	(2.534)	(1.173)	(0.546)	(0.501)	(0.599)

	21	22	23	24	25	26	27	28	29	30
TFP growth & DI	0.110	-0.050	-0.037	0.338	-0.002	0.095	0.169	0.159	-0.011	-0.107
	(1.143)	(-0.515)	(-0.385)	(3.718)	(-0.025)	(0.988)	(1.779)	(1.661)	(-0.109)	(-1.114)
TFP growth & Difference of CI	0.125	-0.110	0.021	0.453	-0.004	0.151	0.215	0.110	0.056	-0.170
	(1.308)	(-1.140)	(0.219)	(5.254)	(-0.044)	(1.583)	(2.280)	(1.149)	(0.583)	(-1.785)

	31	32	33	34	35	36	37
TFP growth & DI	-0.079	-0.060	0.080	0.008	0.040	0.249	0.093
	(-0.825)	(-0.626)	(0.834)	(0.087)	(0.415)	(2.663)	(0.971)
TFP growth & Difference of CI	-0.127	0.028	0.111	-0.006	-0.031	0.244	0.069
	(-1.322)	(0.291)	(1.155)	(-0.059)	(-0.321)	(2.599)	(0.716)

Note: The figures in parentheses are t-ratios.
Source: Authors' calculations.

Table 3 Basic results

Dependent variable = gross output
Sample period = 1976:I - 2002:IV
Estimation method = 3SLS

Industry number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Degree of homogeneity (γ)	1.138 ***	1.064 ***	1.831 ***	**2.015** ***	0.586	1.171 ***	**1.445** ***	0.988 ***	1.082 ***	0.983 ***	1.313 ***	0.897 ***	1.073 ***	1.022 ***	0.795 ***	0.974 ***	1.010 ***	0.685 ***	0.852 ***
	(0.116)	(0.199)	(0.747)	(0.270)	(0.467)	(0.179)	(0.205)	(0.234)	(0.172)	(0.132)	(0.382)	(0.141)	(0.235)	(0.341)	(0.245)	(0.100)	(0.097)	(0.286)	(0.056)
Thick-market externality (β)	-0.134	-0.094	0.123	-0.050	0.244	-0.129	0.242	0.131	-0.001	-0.038	-0.286	0.041	0.019	-0.177	0.288	0.044	0.111	0.356	0.409 **
	(0.593)	(0.820)	(1.208)	(0.658)	(0.299)	(0.188)	(0.289)	(0.374)	(0.233)	(0.272)	(0.613)	(0.219)	(0.315)	(0.309)	(0.278)	(0.145)	(0.216)	(0.311)	(0.236)
Mean of the estimated error term	0.001	-0.004	0.003	-0.002	0.000	0.000	0.000	-0.001	0.000	-0.001	-0.002	-0.001	0.000	0.001	-0.001	-0.001	0.000	0.001	0.001
	(0.053)	(0.075)	(0.121)	(0.077)	(0.024)	(0.018)	(0.030)	(0.034)	(0.021)	(0.023)	(0.031)	(0.016)	(0.022)	(0.020)	(0.020)	(0.012)	(0.020)	(0.027)	(0.020)

Industry number	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Degree of homogeneity (γ)	0.896 ***	0.842 ***	0.048	1.160 ***	1.015 ***	1.056 ***	0.722 ***	0.848	1.432 ***	**1.276** ***	0.623 **	1.252 ***	0.725 *	**1.411** ***	1.250 ***	1.164 ***	1.208 ***	**1.168** ***
	(0.060)	(0.093)	(0.089)	(0.106)	(0.028)	(0.055)	(0.256)	(0.859)	(0.263)	(0.116)	(0.271)	(0.314)	(0.437)	(0.190)	(0.217)	(0.115)	(0.235)	(0.092)
Thick-market externality (β)	0.170 *	0.197	0.132	-0.131	0.052	0.009	0.563	0.076	0.237	-0.291	-0.113	-0.603	0.593	0.053	-0.199	0.217	-0.045	0.066
	(0.130)	(0.284)	(0.770)	(0.193)	(0.080)	(0.093)	(0.500)	(0.394)	(0.460)	(0.349)	(0.302)	(0.390)	(0.952)	(0.376)	(0.832)	(0.403)	(0.300)	(0.343)
Mean of the estimated error term	0.000	-0.001	0.008	0.000	0.000	0.000	-0.004	-0.002	0.003	-0.004	-0.001	-0.001	-0.002	0.001	-0.004	-0.002	-0.003	-0.002
	(0.011)	(0.024)	(0.066)	(0.015)	(0.003)	(0.008)	(0.061)	(0.023)	(0.044)	(0.031)	(0.018)	(0.025)	(0.051)	(0.034)	(0.059)	(0.029)	(0.022)	(0.028)

Note 1) ***, **, * indicate that the estimate is statistically significant at the 1%, 5%, and 10% level, respectively.
Note 2) Boldface indicates that the estimate of γ is significant larger than unity at 5% significance level.

Table 4 Estimation results for the value-added specification

Dependent variable = value-added
Sample period = 1976:I - 2002:IV
Estimation method = 3SLS

Industry number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Degree of homogeneity (γ)	-0.236	0.008	1.029	**3.897** ***	0.863 **	0.732	0.254	0.848	0.902	0.996	-0.030	2.490	0.875	0.294	1.505 *	0.194	-0.706	-0.359	0.767
	(2.070)	(0.453)	(2.774)	(1.240)	(0.445)	(0.751)	(1.039)	(0.678)	(1.658)	(1.545)	(1.830)	(2.352)	(1.847)	(0.939)	(0.923)	(1.413)	(0.882)	(1.077)	(0.604)
Thick-market externality (β)	-1.855	-3.451	-1.360	-0.135	0.245	-0.225	-0.265	0.271	0.363	-0.539	2.475	-3.027	0.116	0.138	-0.106	1.398	0.720	1.115	0.135
	(5.605)	(4.590)	(4.454)	(2.156)	(0.530)	(0.988)	(1.741)	(3.046)	(2.669)	(1.909)	(3.707)	(3.837)	(2.626)	(1.092)	(1.225)	(1.923)	(1.003)	(1.035)	(1.241)
Mean of the estimated error term	0.016	0.014	0.011	0.004	-0.001	0.001	-0.005	-0.003	-0.005	-0.001	-0.009	0.001	0.001	-0.002	-0.002	-0.005	-0.002	-0.004	0.000
	(0.271)	(0.287)	(0.207)	(0.158)	(0.032)	(0.057)	(0.093)	(0.179)	(0.137)	(0.074)	(0.120)	(0.119)	(0.170)	(0.065)	(0.066)	(0.063)	(0.060)	(0.059)	(0.055)

Industry number	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Degree of homogeneity (γ)	0.400	0.104	0.716	0.354	0.246	0.318	-2.085	-0.445	-0.459	0.140	1.441	1.830 **	0.115	-1.496 *	1.052	1.855	0.517	-0.196
	(0.318)	(0.599)	(1.376)	(1.296)	(0.361)	(0.566)	(1.782)	(0.780)	(1.245)	(0.662)	(1.205)	(0.869)	(0.865)	(1.128)	(1.220)	(1.466)	(0.547)	(0.519)
Thick-market externality (β)	0.449	0.832	-0.435	0.383	0.582	1.522 *	3.138	1.892 *	-1.489	1.590	-1.910	-3.285 **	2.368	1.361	1.961	-0.559	1.219	2.285
	(0.816)	(1.725)	(2.282)	(1.292)	(0.743)	(0.979)	(2.929)	(1.308)	(2.345)	(2.214)	(2.468)	(1.892)	(3.205)	(1.881)	(4.412)	(3.211)	(1.460)	(3.585)
Mean of the estimated error term	0.002	0.001	0.001	0.000	0.000	-0.001	0.002	0.002	-0.001	0.000	0.002	0.005	0.006	-0.004	-0.011	-0.001	-0.002	0.001
	(0.039)	(0.075)	(0.082)	(0.058)	(0.040)	(0.056)	(0.119)	(0.058)	(0.097)	(0.101)	(0.098)	(0.091)	(0.098)	(0.120)	(0.253)	(0.187)	(0.079)	(0.201)

Note 1) ***, **, * indicate that the estimate is statistically significant at the 1%, 5%, and 10% level, respectively.
Note 2) Boldface indicates that the estimate of γ is significant larger than unity at 5% significance level.

Table 5(a) Estimation results for subperiod: 1976:I - 1990:IV

Dependent variable = gross output
Sample period = 1976:I - 1990:IV
Estimation method = 3SLS

Industry number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Degree of homogeneity (γ)	0.774 ***	1.265 ***	1.057 ***	1.310 ***	1.038 ***	1.027 ***	1.100 ***	0.213	**1.216** ***	0.832 ***	1.096 ***	1.005 ***	1.243 ***	0.700	1.001 ***	**1.217** ***	**1.388** ***	0.947 ***	0.709 ***
	(0.190)	(0.217)	(0.307)	(0.193)	(0.120)	(0.120)	(0.187)	(0.431)	(0.125)	(0.116)	(0.086)	(0.092)	(0.216)	(0.310)	(0.222)	(0.083)	(0.135)	(0.121)	(0.046)
Thick-market externality (β)	0.291	0.192	-0.698	0.372	0.026	-0.144	-0.026	0.255	0.095	-0.009	-0.078	-0.138	0.247	0.243	0.136	-0.131	-0.156	0.090	0.415 *
	(0.866)	(0.931)	(1.252)	(0.617)	(0.170)	(0.129)	(0.267)	(0.449)	(0.244)	(0.341)	(0.322)	(0.199)	(0.299)	(0.383)	(0.329)	(0.144)	(0.223)	(0.212)	(0.255)
Mean of the estimated error term	-0.002	-0.003	0.004	-0.007	0.000	0.000	0.000	-0.003	-0.001	0.000	-0.004	-0.001	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	0.003
	(0.104)	(0.067)	(0.128)	(0.051)	(0.014)	(0.010)	(0.018)	(0.089)	(0.022)	(0.024)	(0.023)	(0.015)	(0.026)	(0.019)	(0.021)	(0.011)	(0.025)	(0.016)	(0.021)

Industry number	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Degree of homogeneity (γ)	0.843 ***	0.822 ***	0.061	0.986 ***	**1.073** ***	1.074 ***	**1.700** ***	1.078 ***	1.256 ***	1.065 ***	0.561 ***	0.850 ***	0.715 ***	**1.513** ***	**1.398** ***	**1.304** ***	**2.172** ***	0.949 ***
	(0.046)	(0.057)	(0.044)	(0.108)	(0.035)	(0.056)	(0.231)	(0.132)	(0.250)	(0.116)	(0.225)	(0.296)	(0.280)	(0.096)	(0.199)	(0.109)	(0.401)	(0.100)
Thick-market externality (β)	0.152	0.180	-0.074	0.051	-0.089	0.031	-0.091	-0.075	0.256	-0.689	-0.115	-0.441	0.329	-0.196	-0.257	-0.067	-1.068 **	0.116
	(0.128)	(0.227)	(0.875)	(0.223)	(0.100)	(0.102)	(0.605)	(0.273)	(0.550)	(0.542)	(0.328)	(0.518)	(0.851)	(0.251)	(0.897)	(0.347)	(0.496)	(0.363)
Mean of the estimated error term	0.000	-0.002	0.011	-0.002	0.000	0.000	0.002	-0.004	0.003	-0.005	-0.002	0.000	-0.005	0.003	-0.011	-0.001	-0.003	-0.006
	(0.010)	(0.018)	(0.072)	(0.014)	(0.004)	(0.006)	(0.059)	(0.021)	(0.045)	(0.047)	(0.019)	(0.028)	(0.057)	(0.020)	(0.049)	(0.023)	(0.041)	(0.032)

Note 1) ***, **, * indicate that the estimate is statistically significant at the 1%, 5%, and 10% level, respectively.
Note 2) Boldface indicates that the estimate of γ is significant larger than unity at 5% significance level.

Table 5(b) Estimation results for subperiod: 1991:I - 2002:IV

Dependent variable = gross output
Sample period = 1991:I - 2002:IV
Estimation method = 3SLS

Industry number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Degree of homogeneity (γ)	**1.964** ***	**1.396** ***	0.897	**1.407** ***	**1.181** ***	1.045 ***	**1.487** ***	1.112 ***	1.090 ***	1.301 ***	**1.154** ***	0.400	0.888 ***	**1.239** ***	1.326 ***	0.683 ***	1.042 ***	**1.169** ***	1.091 ***
	(0.119)	(0.095)	(0.534)	(0.154)	(0.091)	(0.165)	(0.073)	(0.080)	(0.082)	(0.296)	(0.084)	(0.330)	(0.173)	(0.102)	(0.519)	(0.128)	(0.071)	(0.097)	(0.178)
Thick-market externality (β)	-2.056 *	0.072	-0.985	-0.129	-0.115	-0.119	-0.358	0.018	0.006	-0.006	-0.115	0.432	0.051	-0.359	-0.182	0.238	0.322	-0.007	0.218
	(1.360)	(1.198)	(1.898)	(0.636)	(0.163)	(0.405)	(0.421)	(0.518)	(0.355)	(0.582)	(0.359)	(0.416)	(0.380)	(0.340)	(0.615)	(0.273)	(0.396)	(0.303)	(0.461)
Mean of the estimated error term	0.000	-0.004	0.014	0.003	0.000	0.001	0.002	0.001	-0.001	-0.002	-0.001	0.001	0.001	0.000	-0.001	-0.002	0.002	0.002	0.002
	(0.147)	(0.074)	(0.125)	(0.039)	(0.011)	(0.023)	(0.031)	(0.030)	(0.023)	(0.024)	(0.020)	(0.020)	(0.023)	(0.018)	(0.018)	(0.018)	(0.025)	(0.017)	(0.022)

Industry number	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Degree of homogeneity (γ)	1.071 ***	**2.401** ***	**1.550** ***	**1.230** ***	1.013 ***	1.054 ***	**1.145** ***	0.895 ***	**1.958** ***	1.094 ***	**1.559** ***	1.204 ***	**1.312** ***	1.090 ***	1.071 ***	0.994 ***	1.065 ***	**1.150** ***
	(0.071)	(0.334)	(0.106)	(0.135)	(0.020)	(0.045)	(0.086)	(0.295)	(0.174)	(0.103)	(0.317)	(0.170)	(0.091)	(0.184)	(0.250)	(0.146)	(0.162)	(0.059)
Thick-market externality (β)	0.108	-0.025	-0.280	-0.257	0.077	-0.140	0.278	0.313	0.480	0.163	-0.108	-0.215	0.252	-0.076	0.944	1.099	0.428	0.496
	(0.223)	(0.624)	(0.292)	(0.330)	(0.070)	(0.166)	(0.481)	(0.563)	(0.610)	(0.411)	(0.293)	(0.233)	(0.282)	(0.730)	(1.389)	(0.871)	(0.444)	(0.456)
Mean of the estimated error term	0.001	0.004	-0.002	0.000	0.000	0.000	-0.005	-0.002	-0.001	0.001	-0.004	0.000	-0.002	-0.001	-0.004	-0.003	-0.004	-0.001
	(0.014)	(0.073)	(0.025)	(0.017)	(0.004)	(0.011)	(0.030)	(0.025)	(0.048)	(0.027)	(0.020)	(0.015)	(0.017)	(0.049)	(0.078)	(0.048)	(0.025)	(0.035)

Note 1) ***, **, * indicate that the estimate is statistically significant at the 1%, 5%, and 10% level, respectively.
Note 2) Boldface indicates that the estimate of γ is significant larger than unity at 5% significance level.

Table 6 Estimation results including labor-hoarding

Dependent variable = gross output
Sample period = 1976:I - 2002:IV
Estimation method = 3SLS

Industry number	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Degree of homogeneity (γ)	0.840 **	1.204 ***	1.163 ***	1.121 ***	1.198 ***	0.934 ***	1.317 ***	0.949 ***	0.881 ***	1.030 ***	0.877 ***	0.842 ***	1.013 ***	0.692 **	0.527	0.909 ***	0.756 ***
	(0.495)	(0.186)	(0.303)	(0.305)	(0.385)	(0.159)	(0.381)	(0.171)	(0.311)	(0.356)	(0.319)	(0.155)	(0.109)	(0.340)	(0.714)	(0.065)	(0.129)
Thick-market externality (β)	0.093	-0.112	-0.099	0.137	0.127	-0.030	-0.433	0.029	-0.197	-0.186	0.155	-0.158	0.135	0.646	2.532	0.067	0.353
	(0.391)	(0.284)	(0.514)	(0.503)	(0.591)	(0.329)	(0.675)	(0.228)	(0.407)	(0.422)	(0.396)	(0.271)	(0.410)	(0.555)	(6.602)	(0.218)	(0.515)
Labor-hoarding (ϕ)	-0.003	0.025	-0.093	0.029	0.054	-0.025	-0.056	0.041	-0.341	-0.001	-0.016	-0.089 *	0.006	0.069	0.646	-0.022	0.072
	(0.067)	(0.178)	(0.151)	(0.190)	(0.216)	(0.111)	(0.119)	(0.142)	(0.370)	(0.155)	(0.083)	(0.064)	(0.114)	(0.100)	(2.184)	(0.038)	(0.173)
Mean of the estimated error term	0.000	0.000	0.001	-0.001	0.000	-0.001	-0.001	-0.001	0.001	0.001	-0.001	0.000	0.000	0.000	0.003	0.000	0.000
	(0.015)	(0.018)	(0.022)	(0.034)	(0.023)	(0.022)	(0.032)	(0.016)	(0.048)	(0.020)	(0.019)	(0.018)	(0.020)	(0.029)	(0.097)	(0.012)	(0.030)

Industry number	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Degree of homogeneity (γ)	-0.004	1.181 ***	0.989 ***	1.077 ***	0.751 ***	0.870	1.442 ***	**1.272** ***	0.558 **	1.729 ***	0.724	**1.452** ***	1.241 ***	**1.465** ***	1.163 ***	1.160 ***
	(0.125)	(0.136)	(0.041)	(0.082)	(0.278)	(3.492)	(0.282)	(0.141)	(0.283)	(0.657)	(0.566)	(0.214)	(0.243)	(0.220)	(0.303)	(0.145)
Thick-market externality (β)	1.164	-0.017	0.029	-0.079	0.397	-1.159	-0.478	-0.313	-0.060	-1.168 *	0.857	-0.471	0.183	-1.268	-0.290	0.178
	(1.552)	(0.225)	(0.106)	(0.283)	(0.658)	(1.914)	(0.849)	(0.630)	(0.314)	(0.795)	(1.624)	(0.631)	(1.180)	(1.212)	(0.482)	(0.555)
Labor-hoarding (ϕ)	0.270	0.054	-0.034	-0.031	-0.251	-0.638	-0.388	-0.010	-0.022	-1.302 **	0.101	-0.228	0.162	-0.307	-0.125	0.045
	(0.318)	(0.072)	(0.037)	(0.098)	(0.607)	(1.050)	(0.367)	(0.280)	(0.265)	(0.691)	(0.421)	(0.214)	(0.358)	(0.299)	(0.129)	(0.220)
Mean of the estimated error term	0.006	-0.001	0.000	0.000	-0.003	0.001	0.005	-0.004	-0.001	0.001	-0.003	0.002	-0.005	0.000	-0.002	-0.002
	(0.090)	(0.016)	(0.004)	(0.009)	(0.057)	(0.048)	(0.049)	(0.031)	(0.018)	(0.049)	(0.052)	(0.038)	(0.060)	(0.046)	(0.023)	(0.028)

Estimation method = 3SLS

Industry number	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Degree of homogeneity (γ)	0.868 **	1.265 ***	**1.428** ***	0.981 ***	1.111 ***	0.958 ***	1.380 ***	0.880 ***	1.074 ***	0.915 **	0.794 ***	0.937 ***	1.059 ***	0.697 **	0.839 ***	0.851 ***	0.814 ***
	(0.493)	(0.527)	(0.219)	(0.290)	(0.231)	(0.135)	(0.405)	(0.146)	(0.307)	(0.396)	(0.291)	(0.119)	(0.094)	(0.363)	(0.076)	(0.102)	(0.098)
Thick-market externality (β)	0.099	-0.107	0.219	0.132	0.000	0.009	-0.355	0.064	-0.028	-0.102	0.169	0.037	0.091	0.345	0.484	0.193	0.179
	(0.321)	(0.200)	(0.303)	(0.585)	(0.235)	(0.260)	(0.664)	(0.269)	(0.395)	(0.304)	(0.483)	(0.256)	(0.241)	(0.330)	(0.546)	(0.279)	(0.328)
Labor hours (ϕ)	-0.249	-0.463	0.068	1.592 **	-0.005	-0.089	0.357	0.531	0.118	-0.032	0.691	0.397	-0.100	0.004	-1.042	0.218	0.273
	(0.528)	(0.949)	(0.633)	(0.856)	(0.504)	(0.481)	(0.772)	(0.537)	(0.991)	(0.473)	(0.942)	(0.478)	(0.443)	(0.840)	(0.825)	(0.663)	(0.810)
Mean of the estimated error term	0.000	0.000	0.000	0.000	0.000	-0.001	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000
	(0.016)	(0.024)	(0.029)	(0.066)	(0.021)	(0.021)	(0.044)	(0.029)	(0.021)	(0.021)	(0.029)	(0.023)	(0.022)	(0.026)	(0.047)	(0.015)	(0.029)

Industry number	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Degree of homogeneity (γ)	0.145 *	1.072 ***	1.009 ***	0.975 ***	1.325 ***	1.148	1.364 ***	**1.654** ***	0.575 *	1.170 ***	0.163	**1.363** ***	1.351 ***	1.172 ***	1.178 ***	1.076 ***
	(0.109)	(0.118)	(0.041)	(0.075)	(0.397)	(1.246)	(0.320)	(0.315)	(0.373)	(0.354)	(0.877)	(0.213)	(0.250)	(0.152)	(0.354)	(0.097)
Thick-market externality (β)	0.793	-0.019	0.074	0.050	0.394	-0.066	0.530	-0.811	-0.112	-0.442	1.305	0.098	-0.209	0.127	0.112	0.150
	(1.986)	(0.208)	(0.116)	(0.150)	(0.753)	(0.547)	(0.953)	(1.212)	(0.414)	(0.489)	(1.584)	(0.400)	(1.229)	(0.561)	(0.607)	(0.354)
Labor hours (ϕ)	-5.294 *	-0.058	0.052	-0.438 *	2.668 *	0.684	-2.888 *	4.959 *	-0.590	1.041	-1.859	0.525	2.250	-0.808	1.561 *	-0.262
	(3.247)	(0.386)	(0.110)	(0.288)	(1.752)	(1.528)	(2.137)	(3.308)	(0.887)	(0.961)	(2.983)	(1.006)	(2.165)	(0.985)	(1.010)	(0.870)
Mean of the estimated error term	0.002	0.000	0.000	0.000	0.000	-0.001	0.000	-0.002	-0.001	0.000	0.000	0.001	-0.001	-0.003	-0.002	-0.003
	(0.225)	(0.013)	(0.004)	(0.017)	(0.091)	(0.029)	(0.099)	(0.154)	(0.024)	(0.039)	(0.103)	(0.039)	(0.118)	(0.046)	(0.071)	(0.033)

Note 1) ***, **, * indicate that the estimate is statistically significant at the 1%, 5%, and 10% level, respectively.

Note 2) Boldface indicates that the estimate of γ is significant larger than unity at 5% significance level.

Table 7 Estimation results taking into account part-time employment

Dependent variable = gross output
Sample period = 1990:II - 2002:IV
Estimation method = 3SLS

Industry number	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Degree of homogeneity (γ)	0.619 *	0.967 ***	**1.417** ***	0.944 ***	1.092 ***	**1.776** ***	**1.327** ***	0.474	0.892 ***	2.215	1.362 ***	0.860 ***	0.991 ***	1.192 ***	1.123 ***	1.137 ***	0.935 *
	(0.375)	(0.244)	(0.118)	(0.136)	(0.127)	(0.318)	(0.161)	(0.389)	(0.208)	(1.974)	(0.372)	(0.124)	(0.092)	(0.169)	(0.196)	(0.116)	(0.559)
Thick-market externality (β)	0.010	-0.009	0.085	0.145	-0.140	-0.133	-0.469	0.375	-0.207	-0.435	-0.268	-0.102	-0.008	-0.148	0.103	0.044	0.276
	(0.337)	(0.423)	(0.516)	(0.819)	(0.460)	(0.593)	(0.591)	(0.518)	(0.423)	(0.916)	(0.466)	(0.317)	(0.476)	(0.480)	(0.745)	(0.260)	(0.733)
Labor-hoarding (ϕ)	0.015	0.030	0.103 *	0.035	-0.030	-0.047	-0.011	0.021	-0.127	-0.208	-0.011	-0.044 *	-0.045	-0.019	-0.021	0.005	0.000
	(0.030)	(0.122)	(0.076)	(0.111)	(0.082)	(0.065)	(0.049)	(0.102)	(0.127)	(0.310)	(0.028)	(0.029)	(0.043)	(0.032)	(0.087)	(0.018)	(0.072)
Mean of the estimated error term	-0.001	0.000	-0.001	-0.002	0.000	-0.003	0.000	0.000	0.002	0.000	-0.002	-0.001	0.003	0.002	0.001	0.000	0.001
	(0.023)	(0.022)	(0.023)	(0.041)	(0.023)	(0.037)	(0.031)	(0.019)	(0.029)	(0.062)	(0.019)	(0.015)	(0.024)	(0.018)	(0.023)	(0.014)	(0.027)
Industry number	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
Degree of homogeneity (γ)	**1.538** ***	**1.352** ***	**1.041** ***	0.988 ***	0.889 ***	1.193 ***	**1.847** ***	1.183 ***	1.290 ***	0.769 **	**1.302** ***	1.329 ***	**1.474** ***	1.362 ***	0.974 ***	**1.190** ***	
	(0.131)	(0.174)	(0.024)	(0.069)	(0.127)	(0.201)	(0.253)	(0.148)	(0.406)	(0.360)	(0.080)	(0.251)	(0.254)	(0.444)	(0.190)	(0.062)	
Thick-market externality (β)	-0.525 *	-0.228	0.035	-0.002	-0.642	-0.263	0.416	-0.065	-0.107	-0.309	0.249	-0.091	0.186	-1.325	-0.240	0.701	
	(0.395)	(0.317)	(0.083)	(0.207)	(0.797)	(0.495)	(0.747)	(0.481)	(0.379)	(0.428)	(0.328)	(0.896)	(1.452)	(2.902)	(0.525)	(0.594)	
Labor-hoarding (ϕ)	-0.041 **	0.028	-0.004	0.019	-0.997 ***	-0.048	-0.014	-0.049	-0.363	0.650	-0.018	-0.044	0.049	-0.172	-0.174 ***	0.004	
	(0.023)	(0.032)	(0.015)	(0.025)	(0.308)	(0.085)	(0.113)	(0.078)	(0.343)	(0.569)	(0.041)	(0.113)	(0.181)	(0.146)	(0.065)	(0.084)	
Mean of the estimated error term	-0.001	-0.002	0.000	-0.001	-0.001	-0.002	0.000	0.000	-0.002	0.001	-0.001	0.000	-0.006	-0.001	0.001	-0.002	
	(0.027)	(0.020)	(0.003)	(0.011)	(0.050)	(0.021)	(0.040)	(0.024)	(0.020)	(0.021)	(0.017)	(0.043)	(0.078)	(0.035)	(0.028)	(0.031)	

Note 1) ***, **, * indicate that the estimate is statistically significant at the 1%, 5%, and 10% level, respectively.
Note 2) Boldface indicates that the estimate of γ is significant larger than unity at 5% significance level.
Note 3) We use $L^{*}=L/(1-(\text{part-time job ratio}))$ instead of L.

Table 8 Estimation results including labor-hoarding and the adjustment cost of investment

Dependent variable = gross output
Sample period = 1976:I - 2002:IV
Estimation method = 3SLS

Industry number	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Degree of homogeneity (γ)	0.393	0.950 ***	0.591	1.881 **	0.414	0.489 *	0.415	0.766 ***	0.983	0.734 *	-0.052	0.617 *	1.333 **	0.538	0.669	1.219 ***	0.752 *
	(0.657)	(0.271)	(2.102)	(0.813)	(0.823)	(0.305)	(0.537)	(0.280)	(1.690)	(0.490)	(0.452)	(0.451)	(0.633)	(0.543)	(1.032)	(0.268)	(0.469)
Thick-market externality (β)	0.197	-0.108	-0.520	0.230	-0.937	0.160	0.157	-0.058	-0.664	0.033	0.126	0.203	0.392	0.944	3.793	-0.713	-0.273
	(0.743)	(0.444)	(2.452)	(0.666)	(1.758)	(0.871)	(1.158)	(0.501)	(3.129)	(0.986)	(0.896)	(0.936)	(1.550)	(2.021)	(8.531)	(0.694)	(1.088)
Labor-hoarding (ϕ)	-0.003	-0.079	-0.099	0.406	-0.310	-0.224	-0.295	-0.169	0.907	0.006	-0.166	-0.005	0.196	0.111	1.239	-0.089	-0.271
	(0.183)	(0.397)	(1.039)	(0.355)	(0.545)	(0.272)	(0.312)	(0.247)	(4.011)	(0.557)	(0.327)	(0.295)	(0.455)	(0.347)	(2.770)	(0.109)	(0.441)
Adjustment costs of investment (η)	0.064	-0.053	-0.077	-0.101	0.105	-0.024	0.056	-0.019	-0.451	0.002	-0.061	-0.019	-0.200	-0.141	-0.681	0.177	-0.350
	(0.160)	(0.129)	(0.374)	(0.140)	(0.189)	(0.139)	(0.101)	(0.159)	(1.050)	(0.079)	(0.172)	(0.188)	(0.304)	(0.728)	(1.448)	(0.158)	(0.398)
Mean of the estimated error term	0.001	0.001	0.002	0.003	0.002	0.003	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.000	0.003	0.004
	(0.034)	(0.020)	(0.076)	(0.116)	(0.094)	(0.049)	(0.065)	(0.033)	(0.286)	(0.034)	(0.041)	(0.029)	(0.069)	(0.055)	(0.189)	(0.041)	(0.101)

Industry number	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Degree of homogeneity (γ)	0.060	0.974 ***	0.876 ***	0.995 ***	0.818	-0.586	1.252 ***	1.191 ***	1.062	1.010	0.699 *	1.005 **	0.994 ***	1.082 ***	0.367	0.912 ***
	(0.194)	(0.305)	(0.110)	(0.094)	(0.854)	(0.854)	(0.392)	(0.237)	(1.446)	(1.171)	(0.473)	(0.449)	(0.313)	(0.212)	(0.292)	(0.280)
Thick-market externality (β)	1.446	-0.171	0.209	0.144	-0.461	-0.736	-1.886	-0.748	-1.631	-1.496	0.852	-0.014	0.127	-0.177	0.051	0.218
	(1.519)	(0.584)	(0.290)	(0.344)	(3.031)	(1.442)	(1.675)	(1.071)	(3.466)	(3.129)	(1.408)	(1.663)	(1.515)	(1.202)	(1.914)	(1.147)
Labor-hoarding (ϕ)	0.313	-0.076	-0.072	0.054	0.028	-0.726	-0.825	-0.462	-3.429	-2.148	0.196	0.262	-0.096	-0.029	-0.141	0.193
	(0.331)	(0.136)	(0.162)	(0.107)	(4.700)	(0.740)	(0.649)	(0.474)	(6.292)	(2.983)	(0.292)	(0.627)	(0.649)	(0.313)	(0.656)	(0.435)
Adjustment costs of investment (η)	0.037	-0.002	0.005	-0.087	-0.075	0.071	0.045	-0.075	-0.992	-0.694	-0.168	0.162	0.062	0.009	-0.229	0.118
	(0.197)	(0.208)	(0.108)	(0.107)	(0.509)	(0.266)	(0.228)	(0.124)	(1.721)	(1.107)	(0.335)	(0.620)	(0.240)	(0.037)	(0.548)	(0.145)
Mean of the estimated error term	0.003	0.003	0.000	0.001	0.004	-0.001	0.002	0.003	0.006	0.006	0.001	0.004	0.002	0.002	0.003	0.002
	(0.092)	(0.023)	(0.010)	(0.020)	(0.102)	(0.108)	(0.083)	(0.054)	(0.378)	(0.255)	(0.047)	(0.112)	(0.081)	(0.034)	(0.109)	(0.068)

Note 1) ***, **, * indicate that the estimate is statistically significant at the 1%, 5%, and 10% level, respectively.
Note 2) Boldface indicates that the estimate of γ is significant larger than unity at 5% significance level.
Note 3) We use $L^*=L/(1-(\text{part-time job ratio}))$ instead of L.

Table A-1 Industry Classification Table

Classification in the Financial Statements Statistics of Corporations		Classification in Japan Standard Industrial Classification (The 10th Revised Edition)**
1	Agriculture	1
2	Forestry	2
3	Marine Products	3,4
4	Mining	5,6,7,8
5	Construction	9,10,11
6	Manufacture of Food Products	12, 13
7	Manufacture of Textiles	14
8	Manufacture of Wearing Apparel and Other Textile Products	15
9	Manufacture of Lumber and Wood Products	16
10	Manufacture of Pulp , Paper and Paper Products	18
11	Manufacture of Publishing and Printing	19
12	Manufacture of Chemicals and Chemical Products	20
13	Manufacture of Petroleum and Coal Products	21
14	Manufacture of Stone, Clay and Glass Products	25
15	Manufacture of Steel	26
16	Manufacture of Non-Ferrous Metals	27
17	Manufacture of Metal Products	28
18	Manufacture of General Machinery Equipment	29
19	Manufacture of Electrical Machinery	30
20	Manufacture of Transportation Equipment	31
21	Manufacture of Precision Machinery and Equipment	32
22	Manufacture of Ships	31
23	Other Manufacturing	17,22,23,24,33,34
24	Wholesale	48,49,50,51,52,53
25	Retail	54,55,56,57,58,59,60,61
26	Real Estate	70,71
27	Land Transportation	39,40,41
28	Water Transportation	42
29	Other Transportation and communication	43,44,45,46,47
30	Electricity	35
31	Gas, Waterworks	36,37,38
32	Services for Business	79,82,83,86
33	Inns, Other Lodging	75
34	Services for Individuals	72,73,74
35	Movies, Entertainment	76,80
36	Broadcasting	81
37	Other Services	77,78,84,87,88,89,91,92,95

Table A-2 Basic Statistics*

Sample Period = 1976: I —2002:IV

Series	dy	dz	dx	dH	dh	dj
Mean	0.00287	0.00424	0.00351	-0.00053	-0.00064	-0.00279
Median	0.00513	0.00492	0.00572	0.00000	0.00193	-0.00008
Maximum	0.90927	1.51006	0.08271	0.92622	0.08086	1.97591
Minimum	-1.29597	-1.00284	-0.06386	-0.74035	-0.09478	-2.35446
Std. Dev.	0.10935	0.09273	0.01955	0.10396	0.03808	0.39174
Observations	3996	3996	3996	3564	3564	3996

*Please contact the authors if you would like to know details on the database used in this study.