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# The Decline in Capital Formation in Japan: Empirical research on Japanese listed firms data*

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## Abstract

Physical investment in Japan has weakened since the bubble burst. The U.S. and other advanced countries have also experienced a slump in physical investment since the global financial crisis.

Following Crouzet and Everly (2018), we examine whether the slump in physical investment in Japan shifted to investment in intangible assets, as in other advanced countries. Using firm-level data, this study estimates a Tobin's Q-type investment function for tangible assets. Then, using these estimation results, we examine the extent to which the shift to investment in intangible assets has been a factor in Japan's weak investment in tangible assets.

Our estimation results confirm that Research and Development (R&D) investment significantly explains weak physical investments. However, R&D can explain only part of the slump in physical investment. The results suggest that, unlike in other countries, not only intangible investment but also aggressive physical investment is essential for productivity improvement in Japan.

Keywords: Intangible asset, Tobin's Q, Weak investment.
JEL Classification: D40, E22, O30.



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## 1. Introduction

Japan suffered from secular stagnation for many years after the collapse of the bubble economy. During the secular stagnation, Japan experienced a Global Financial Crisis. After this emergency, Prime Minister Abe launched a powerful economic policy called Abenomics in 2013, which included an unconventional monetary policy. This economic policy makes the Nikkei 225 average stock price almost triple the price average in 2012. In addition, the Japanese firms' rates of return have improved.

Generally, Following Q theory, a firm with a high rate of return on capital is expected to invest more in fixed assets. Despite the recovery of Japanese firms' stock prices, capital formation in Japan has not grown sufficiently. This phenomenon is not confined to matters of Abenomics. There was a gap between the rate of return on capital and the rate of investment before Abenomics.

Figure 1 shows the changes in the rate of return on capital and the rate of physical investment[1] in Japan.

(Insert Figure 1 here)

The rate of physical investment has declined drastically since the beginning of the 21st century. The rate of return on capital was very high before the Global Financial Crisis and after 2013. However, the physical investment was weak in these terms.

This phenomenon also occurs in the manufacturing and service sectors. Figure 2 shows the movements of the rate of return on capital and the rate of physical investment in the manufacturing sector. Figure 3 illustrates these changes in the service sector.

(Insert Figure 2 here)

(Insert Figure 3 here)

In the manufacturing sector, the rate of return on capital has increased more than the rate of physical investment after Abenomics, which is different from all industries' cases. However, in the service sector, the rate of physical investment has declined. However, it is essential to note that the rate of return does not decrease. Kim, Kwon, and Fukao (2019) indicate that Japanese secular stagnation occurred because of weak capital formation.

Japan is not the only country where physical investment has stagnated, despite persistently high rates of return. We also find similar problems in the U.S. and other advanced countries after the

[1] The rate of return on capital is defined by operating surplus and consumption of fixed capital dividing by real physical capital stock. Operating surplus and consumption of fixed capital are deflated by physical investment deflator. The rate of physical investment is defined by physical capital formation dividing by physical capital stock. The System of National Account (the Cabinet Office) supplied these data.

global financial crisis. As Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018) point out, the manufacturing sector in the U.S. has high value-added growth and lower capital formation growth. On the other hand, the U.S. service sector has weak capital formation but faster value-added growth than manufacturing.

Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018) examined Tobin's Q model with multiple capital goods to solve this puzzle. Firm-level Q is usually measured as firm value divided by the replacement value of all capital assets. However, when the replace value of capital counts only observable capital and does not evaluate the value of unmeasurable intangible assets, the movements in Tobin's Q evaluated by observable assets are different from those in Tobin's Q evaluated by all types of capital assets. Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018) show that because Tobin's Q evaluated by observable capital indicates excess physical investment opportunities, a firm's actual physical investment becomes lower than that explained by Tobin's Q. They show that this lower physical investment is affected by intangible assets held by firms in the U.S. Miyagawa and Ishikawa (2021) inspected cases in Japan and other advanced countries. They use industrial data from the Japanese SNA and EUKLEMS databases, and show that the gap between actual capital formation and capital formation expected from Tobin's Q widened after the financial crisis. These three studies show that investment in intangible assets, such as research and development (R&D) and software, covers a major part of these gaps.

However, previous studies point out intangibles, market power, and foreign direct investment (FDI) as the factors explaining the above gap. This study uses firm-level panel data in Japan and multiple Tobin's Q models to examine these investment gaps. Our analysis begins with ordinary least squares (OLS) panel estimations of physical investment with Q using firm level data from the Nikkei NEEDS Financial Quest from 1988 to 2019. We measure a firm's intangible asset as its expenditure on R&D or the sum of its R&D expenditure and organizational capital. We measure the indicator of market power using the Herfindahl-Hirschman Index (HHI). Moreover, we used FDI across industries. Here, we go through two empirical stages. The first stage estimates the investment gap over industrial classifications. This stage regresses physical investment on Q and the time dummy, which represents the gap between actual investment and the investment indicated by firm value. After the first estimation, the second stage regresses these industrial investment gaps on intangible assets, market power, and FDI related to the investment gap.

The main findings of this study are as follows. First, we confirm that an investment gap occurs in the service sector. Second, intangible assets explain some of the investment gaps in the service sector. Finally, intangible assets, market power, and globalization explain the investment gap in the service sector.

The remainder of this paper is organized as follows. The next section introduces the literature on investment theory and related studies. In the third section, we describe the data creation for our empirical study. The fourth section shows the investment gap measured by the first-step estimations. In the fifth section, we examine several factors that generate investment gaps. The sixth section presents this study's conclusion and future research directions.

## 2. Related Literature

Our study is based on the standard neoclassical investment theory and empirical studies developed by Hayashi (1982). He combined neoclassical investment theory with Tobin's Q and showed that marginal Q equals the average Q under certain conditions[2]. According to his study, the rate of the corporate market value of its replacement cost shows a firm's investment opportunities. After his study, many researchers estimated the investment function using average Q. However, in the case that a firm faces liquidity constraints, many studies include additional variables in estimating the investment function. For example, Ogawa et al. (1996) showed that Japanese firms faced land constraints, so a firm's amount of land played an essential role in its investment behavior.

Firms usually hold many types of assets such as buildings and machinery. Wildashin (1984) studied Tobin's Q theory with multiple capital goods, showing that the average Q is a weighted average of the marginal Qs for these types of assets[3]. Asako et al. (1989) examined the multiple Q theory in Japan. However, Wildasin (1984) and Asako et al. (1989) considered only fixed asset types (i.e., construction, machinery, tools, transportation equipment, land, etc.) and did not include any intangible assets. Some works have attempted to extend the multiple Q theory to intangibles. For example, Miyagawa et al. (2015) showed that Tobin's Q, measured by the sum of fixed capital and intangibles, is closer to one than classical Tobin's Q. Takizawa (2016) estimated the investment function with Q including intangibles. She concluded that her Q had sufficient statistics. Peters and Taylor (2017) showed that Q, including intangibles, is a good measure of both physical and intangible investment opportunities.

Tobin's Q's sensitivity to capital formation is not constant. Hori et al. (2006) estimated the investment function with Tobin's Q in the '90s in Japan. They showed that the coefficient of Q in the former of the 90s was larger than the latter of the 90s. Tanaka (2019) stated that a decline in Tobin's Q sensitivity is a factor in the stagnation of capital accumulation. He showed that the coefficient of Q in the investment function declined from 2009 to 2015. Other studies on the sensitivity linking Q and investment volume include Ogawa (2019) and Ishikawa (2021). Both these studies showed that the sensitivity of Q has declined in recent years.

Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018) explained that the amount of actual

[2] Hayashi showed that average Q equivalents to marginal Q if when (1) production market is under complete competitive, (2) production function and adjustment cost of investment are homogenous of degree 1, and (3) firm's discount rate is exogeneity. These conditions are too strict and, in theoretical, marginal Q is true.

[3] See Asako, Nakamura, and Tonogi (2020).

investment is lower than that explained by Tobin's Q[4]. They argued that intangible assets, regulations, market concentration, and globalization are part of underinvestment[5]. Based on their studies, Miyagawa and Ishikawa (2021) examined the existence of underinvestment and where countries' underinvestments occur using the Japanese SNA and KLEMS databases[6].

Other studies have examined the downturn in business investments. Murase and Ando (2014) argued that capital accumulation is sluggish because firms with weak corporate governance are more receptive to cash and government bonds, which are easier to recover than uncertain assets. On the other hand, Nakamura (2017, 2018) considered uncertainty more important than corporate governance issues. He argued that firms are restraining investment because they save reserves owing to the heightened uncertainty they face. Fukuda (2017) attributed an increase in cash and deposit companies to reserve motives. Simultaneously, he argued that well-performing large companies have liquid assets for future investment opportunities.

One study found a relationship between Tobin's Q and R&D, the market environment, and globalization (Nagaoka, 2006). He showed that R&D, market share, and foreign trade increased firm's market value in the Japanese manufacturing sector in the 1990s.

## 3. Data

First, we demonstrate how we measure investment, capital stock, and Tobin's Q for listed firms in Japan. The sample period is from 1987 to 2019. We obtained data on financial statements from the Nikkei NEEDS Financial Quest. Property, plants, and equipment accumulate the firm's capital stock. The nominal investment flow ($NI$) for $i$th firm follows:

$$NI_{it} = DA_{it} - DA_{it-1} + Dep_{it} \qquad (1),$$

where $DA$ is the book value of the property, plants, and equipment, and $Dep_t$ is depreciation. Real investment flow ($I$) is the nominal investment deflated by the price index of capital goods published by the Bank of Japan. The accumulation of real capital stock follows:

$$K_{it} = I_{it} + (1 - \delta_j)K_{it-1} \qquad (2),$$

where $\delta$ is the depreciation rate for $j$th industry[7] and $K$ is capital stock. We use the capital flow $K$ from 1987.

Tobin's average Q ($Q$) follows:

[4] Zhang (2020) argued a similar conclusion using data from the UK.
[5] Fukao et al. (2021) showed that firm's investment behavior has a relationship for intangible assets as computer software and M&A activity in Japan.
[6] There is a difference of estimation methodology between these papers. Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018) are using average Q, but Miyagawa and Ishikawa (2021) uses marginal Q. Because Miyagawa and Ishikawa (2021) uses industrial aggregate data, they cannot get the stock value of these industries.
[7] In appendix I, we list depreciation rate over industries. Those depreciation rates from Ogawa et al. (1996) in the manufacturing sector. In the non-manufacturing sector, depreciation rates are from the SNA (Cabinet Office).

$$Q_{it} = \frac{V_{it} + B_{it} - D_{it}}{p_j K_{t-1}} \quad (3),$$

where $V$ is the firm's value, $B$ is the total liabilities, $D$ is the total asset except tangible assets, and $p$ is the capital price.

For intangible assets, we chose R&D expenditures. The depreciation rate of R&D stock is 15.74% from the SNA, and the R&D deflator is from one. In addition, we used other intangible assets and organizational capital. Organizational capital is estimated from the financial statement by Hulten and Hao (2008). Following their methodology, Takizawa (2016) estimated the investment function using Tobin's Q. The organizational capital is defined as:

$$NO_{it} = 0.3 \times SGAE_{it} + Ope._{it} \times \frac{0.3 \times SGAE_{it}}{SC_{it} + R\&D_{it} + SGAE_{it}} \quad (4),$$

where $NO$ is the nominal organizational capital investment, $Ope.$ is the operation income; $SC$ is the sales cost; and $SGAE$ is the selling, general, and administrative expenses. $NO$ is deflated by the GDP deflator from the SNA. Following Hulten and Hao (2008), the depreciation rate of organizational capital stock is 20%. We use organizational capital data from 1987 to 2019.

Financial constraints are an essential factor in investment behavior. For example, Hosono and Watanabe (2002) and Masuda (2015) used liquid assets to total assets as an indicator of financial constraints. We use the liquid asset ratio to check the robustness of the models.

We construct the Herfindahl-Hirschman index (HHI) over industries to measure market concentration. In addition, to measure the globalization and deindustrialization of the domestic industry, we build the ratio of foreign direct investment to total investment[8].

Table 1 presents the descriptive statistics for the panel data. However, we winsorize Tobin's average Q at 5% and 95% to eliminate outliers[9].

(Insert Table 1 here)

## 4. Estimated Investment Gaps (1st Step Estimation)

Before estimating the investment gaps in the panel, we present an empirical background of the investment gap. Following Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018), a firm's value ($V$) is evaluated by tangible assets ($K^T$) and intangible assets ($K^I$):

$$V = q^T K^T + q^I K^I \quad (5),$$

where $q^T$ and $q^I$ are Tobin's marginal Q for each capital. Our observable capital is only tangible

[8] The total investment means fixed capital formation except housing from the SNA.
[9] In the 2000's, many firms decreased property, plants, and equipment. While, firm value is high relatively capital stock. Then, Q often took the high value.

assets ($K^T$), and Tobin's average Q is given by:

$$Q = \frac{V}{K^T} = q^T + q^I \frac{K^I}{K^T} \quad (6).$$

The standard investment function model based on Tobin's Q theory[10] is,

$$I/_{K^T} = Const. + \beta Q + e \quad (7).$$

However, considering the unobservable intangibles, Equation (8) is revised as follows,

$$I/_{K^T} = Const. + \beta_1 Q - \beta_2 q^I \frac{K^I}{K^T} + e \quad (8).$$

When $\gamma = \beta_2 q^I \frac{K^I}{K^T}$ is the year dummy coefficient, Equation (8) is transformed into Equation (9).

$$I_{i,t}/_{K^T_{i,t-1}} = Const. + \beta_1 Q_{i,t-1} + \sum \gamma_t T_t + \eta_i + \epsilon_{i,t} \quad (9).$$

This time dummy always takes a negative value because the marginal Q for intangible ($q^I$) and intangible-tangible ($K^I/K^T$) ratios are positive if intangibles affect corporate value. This condition remains unchanged in the production function form[11].

Table 2 shows some industries' estimated results of Model (9)[12].

(Insert Table 2 here)

In Table 2, we find that the coefficients of Tobin's Q have the expected signs and are significant[13]. We obtain the year dummies data from these estimations, which implies the investment gap in Figure 4. Figure 4 shows the 5-year moving average of the investment gaps.

(Insert Figure 4 here)

After the collapse of the bubble economy, the movements of the investment gap always take a negative value of approximately -5%. In the manufacturing sector, the gap diminished in 2000s. After the financial crisis, the gap in the manufacturing sector had a positive value. However, the service sector's gap remained negative after the financial crisis. Moreover, despite the introduction of

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10 Linear investment function is derived by firm's optimization model with quadratic adjustment cost (see Suzuki (2001)). Suzuki and Chida (2017) showed that the curve of adjustment cost is second order using empirical model.

11 We assume that production function satisfies homogeneous degree 1 on each capital and labor inputs. We do not assume tangible asset and intangible asset are substantially or complementary.

12 Manufacturing and Service Sector excludes the forestry and fisheries sector and the mining sector.

13 The coefficient of Q is nearly result of estimated marginal Q in Ishikawa (2021) in manufacturing in Japan. Ishikawa (2021) uses liquid asset ratio in the model, the value of coefficient of Q is 0.0231 in manufacturing. We check the estimation adding liquid asset ratio to model, coefficient of average Q is 0.0216 and 1% level of statistical away from zero.

Abenomics, the gap in the service sector has widened. Thus, the gap in the manufacturing sector is smaller than that in the service sector, consistent with Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018).

## 5. Searching for Factors Which Generate Investment Gaps (2nd Step Estimation)

Gutiérrez and Philippon (2017) and Crouzet and Eberly (2018) argued that the investment gap is caused by intangible assets, market concentration, regulation, and globalization. Crouzet and Eberly (2018) showed that intangibles explain approximately two-thirds of the investment gap. Miyagawa and Ishikawa (2021) showed that intangible assets ratio could explain approximately three-fourth of the Japanese aggregate investment gap. As in these previous studies, we examine whether the gap can be explained by the share of intangibles assets ratio ($Intan$), the indicator of market concentration ($HHI$), and the indicator of globalization ($FDI$)[14].

To verify this, we estimate the industry-level investment gaps from firm-level panel data by industry, which are classified by the table in the Appendix following as 1st stage estimation. We use these industry level investment gaps as independent variables.

The regression model for $j$th industry is,

$$\gamma_t^j = Const. + \beta_1\, Intan_t^j + \beta_2\, HHI_t^j + \beta_3\, FDI_t^j + \eta_j + \theta_t T_t + \varepsilon_t^j \qquad (10),$$

where $Intan$ is the rate of R&D stock on tangible assets or the rate of intangible assets (R&D stock plus organizational capital) on tangible assets. In addition, we use dummy variables for $FDI$ because there are some discontinuities in the statistics. Then, if the year is from 2005 to 2013, $D1$ is 1. And $D2$ takes 1 if the year is from 2014[15]. We insert the cross-terms of $FDI$ and $D1$ or $D2$ into Equation (10).

The sign of $\beta_1$ is expected to be negative because a company with a large share of intangibles conducts lower physical investment despite the high Tobin's Q. The sign of $\beta_2$ is expected to be negative if a firm facing market concentration is reluctant to invest aggressively. $HHI$ indicates market concentration, and we expect the sign of $\beta_3$ is negative. If a firm aggressively performs FDI and generates revenue from FDI, the firm's value becomes high. However, foreign assets are not included in domestic investment. Therefore, the greater the FDI, the larger the gap between the expected amounts of investment based on firm value and real domestic investment. $\theta_t$ is the coefficient of the year dummy $T_t$.

Tables 3 to 5 presents the estimation results. Table 3 shows the case for all industries, Table 4 shows

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[14] After the financial crisis, JPN yen / US dollar takes about 70 in foreign exchange market. It causes deindustrialization because factory relocation into China, east-south Asia, or Indo. On this situation, because the company only has headquarters, but does not have factory in Japan, our observable financial statement has small asset despite higher stock value and lots of sales.

[15] Definition of statistics of FDI is deferent on years. In Japan, statistics changes in 2005 and 2014. We use dummy variables to take care of these changes.

the case for the manufacturing sector, and Table 5 shows the case for the service sector.

(Insert Table 3 here)

(Insert Table 4 here)

(Insert Table 5 here)

Table 3 (all industries) shows that the R&D ratio coefficients are negative. These results imply that R&D investment partially explains the slump in physical investment. However, these coefficients are not always statistically significant. In addition, the coefficients on *HHI* and *FDI* are negative. This implies that a firm facing market concentration reduces its physical investments. A firm that makes FDI investments reduces its physical investment. However, these coefficients are also not significant.

Table 4 (manufacturing sector) shows that the coefficients of R&D and intangibles ratios are negative but not significant. However, the coefficients of the *HHI* and *FDI* are not negative. In the manufacturing sector, market concentration and FDI do not explain the slump in physical investments.

Table 5 (service sector) shows that the coefficients of the R&D ratio and intangibles are negative and significant. These results imply that aggressive R&D and other intangible investments cover a slump in physical investments in the service sector. In addition, the coefficients of the *HHI* are negative and significant. This means that a firm facing market concentration reduces its physical investment. The coefficient of the *FDI* is not negative. However, the sum of the coefficients of *FDI* and $FDI \times D_1$ or $FDI \times D_2$ are negative. This means that a global company reduces itsphysical investment to make more foreign investments[16].

How much can R&D explain the investment gap in the service sector? To answer this question, we compare the investment gap ($\gamma$) to the coefficients of the new year dummy ($\theta$) in equation (10).

Figure 5 shows the movements in the investment gap ($\gamma$) and revised investment gap ($\theta$) in the service sector. In Figure 5, the revised investment gap ($\theta A$) means estimation using R&D only (Table 5 [1]), and the revised investment gap ($\theta B$) means regression on R&D and other independent variables (Table 5 [3])[17]. These gaps are 5-year-moving averages.

[16] In appendix II, we show the IV estimation and the SNA-based estimation. IV method estimation has not passed the first stage F-test. The SNA-based estimation, using data on R&D and Software from the SNA, does not have significant results.

[17] Table 5 shows intangibles ratio explains the investment gap. However, the revised investment gap is lower than revised by R&D ratio only, because the coefficient of intangibles ratio is larger than the coefficient of R&D ratio, implying that it may be better for firms in the service sector to focus on R&D activity than investment in other intangibles assets.

(Insert Figure 5 here)

From the late 1990s to 2010, the investment gap ($\gamma$) was stable at around -0.06, while the revised investment gap ($\theta A$) is the upper trend and came close to the 0-level. From 2010 to 2012, the revised investment gap was the closest at 0. In this term, the revised investment gap is -0.0109, and the investment gap is -0.0409. However, the revised investment gap ($\theta B$) is always a positive value. Moreover, the revised investment gap ($\theta B$) revises three times higher than the revised investment gap ($\theta A$) after the global financial crisis. This implies that market concentration and globalization influence the investment gap.

## 6. Conclusion

Following Tobin's Q investment theory, a high rate of return on capital affords considerable physical investment. However, the amount of physical investment was weak despite the high return rate on capital after Japan's bubble economy collapsed. We show that this weak physical investment is relevant for intangible assets and other causes.

In the first step of our study, we measure investment gaps at the industry level based on Gutiérrez and Philippon (2017), Crouzet and Eberly (2018), and Miyagawa and Ishikawa (2021). The investment gap is a measurement error of Tobin's Q. Because firm value evaluates observable and unobservable capital, a firm's capital formation captures only observable capital.

In the second step of our study, we regress the investment gap using industrial aggregate panel data on whether the investment gap is based on intangibles, market power, and globalization.

We found two main findings in this study. First, there is an investment gap between the manufacturing and the service sectors. However, the investment gap in the manufacturing sector was positive after 2010. This means that the manufacturing sector aggressively invests in physical assets. By contrast, weak physical investment in the service sector continued after 2011. Additionally, the investment gap in the service sector is more severe than that in the manufacturing sector. This result is consistent with those of Crouzet and Eberly (2018). Second, intangible assets, market power, and globalization explain the investment gap in the service sector. However, the contraction of the investment gap by R&D is only partially and is considered smaller than the market concentration and globalization factors. In other words, R&D investment does not been able to offset the decline in tangible investments in Japan. This result suggests that the service sector requires innovation and competition policies. However, the amount of R&D investment in Japan has been insufficient. This R&D investment is a resource for innovation and is suitable for the government to supports a firm's R&D activity. Moreover, the current situation in Japan may differ from that in the U.S. and other advanced countries, as noted by Nakamura (2017), Tanaka (2019) and Ogawa, Sterken, and Tokutsu

(2019).

However, this study did not adequately capture intangible assets. Developing a method to capture intangible assets held by firms is necessary. In addition, the real effective exchange rate and other factors may affect firms' investments. However, there is no data on real effective exchange rates by industry, and estimation is needed, which will be undertaken in the future.

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**Appendix I: The Depreciation Rate in the Industry.**

| | depreciation rate |
|---|---|
| Forestry and fisheries | 0.0996 |
| Mining | 0.0645 |
| Manufacturing | 0.0774 |
| Food | 0.0735 |
| Paper and paper products | 0.0774 |
| Chemistry | 0.0778 |
| Fuel and oil | 0.0774 |
| Rubber products | 0.0774 |
| Ceramics | 0.0774 |
| Metal products | 0.0805 |
| Machinary | 0.0786 |
| Electrical machinery | 0.072 |
| Transport equipments | 0.0774 |
| Precision machinery | 0.0774 |
| Other manufacturing | 0.0774 |
| Service sectors | 0.1176 |
| Constructions | 0.1139 |
| Whole sales | 0.1059 |
| Land estates | 0.0913 |
| Transportation service | 0.0486 |
| Information services | 0.0781 |
| Erectric and gass | 0.0339 |
| Other services | 0.1176 |

**Appendix II: IV Method and SNA-Based Estimation.**

**<IV Method>**

| | All Terms | | | 1991-2011 | | |
|---|---|---|---|---|---|---|
| | All Industries | Manufacturing | Service | All Industries | Manufacturing | Service |
| R&D ratio | **-0.1145*** | **-0.2891** | **-0.0644***** | **-0.0458***** | **-0.0586** | **-0.0624***** |
| | (0.0621) | (0.2469) | (0.0221) | (0.0173) | (0.0902) | (0.0210) |
| HHI | **0.0773** | **-0.5690** | **-0.5154**** | **-0.0903** | **0.3686** | **-0.5421**** |
| | (0.1742) | (0.5904) | (0.2584) | (0.1664) | (0.4095) | (0.2662) |
| FDI | **0.0642** | **0.7956** | **1.1799** | **-0.0147** | **0.1649** | **1.0147** |
| | (0.0761) | (0.5907) | (0.9455) | (0.0574) | (0.2224) | (0.9035) |
| FDI*D1 | **-0.0715** | **-1.1970** | **-1.4309** | **-0.0020** | **-0.2837** | **-0.9162** |
| | (0.0745) | (0.8153) | (0.9794) | (0.0528) | (0.3379) | (0.8404) |
| FDI*D2 | **-0.0685** | **-1.2658** | **-1.2607** | | | |
| | (0.0769) | (1.0148) | (0.9629) | | | |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Centred R2 | -0.2262 | -1.2833 | 0.2588 | 0.1018 | 0.1173 | 0.2797 |
| Hansen J | 0.374 | 1.214 | 0.591 | 0.020 | 8.137 | 0.179 |
| (p-value) | 0.5408 | 0.2705 | 0.4422 | 0.8871 | 0.0171 | 0.6724 |
| Obs. | 616 | 364 | 196 | 462 | 273 | 147 |
| Group | 22 | 13 | 7 | 22 | 13 | 7 |
| First-Stage： R&D ratio | | | | | | |
| F-value | 2.570 | 1.870 | 2.260 | 3.320 | 2.780 | 2.330 |
| p-value | 0.078 | 0.155 | 0.108 | 0.037 | 0.064 | 0.102 |
| F-test | | | | | | |
| FDI+FDI*D1 | 0.63 | 1.64 | 2.35 | 2.63 | 0.51 | 0.10 |
| (p-value) | (0.4284) | (0.2009) | (0.1250) | (0.1050) | (0.4753) | (0.7474) |
| FDI+FDI*D2 | 0.02 | 1.03 | 1.40 | | | |
| (p-value) | (0.8840) | (0.3104) | (0.2373) | | | |

Note: *** means 1% level of significance, ** means 5% level of significance, * means 10% level of signficance. All regressions uses robust standard errors. Instrumental variables are lagged sale / total asset and lagged R&D / sales.

**<SNA-Based Estimation>**

| | All Industries | | Manufacturing Sector | | Service Sector | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| Intangibles | **0.1938** | **0.2107** | **0.1871** | **0.1905** | **1.9648*** ** | **2.1656*** ** |
| | (0.1369) | (0.1437) | (0.1123) | (0.1437) | (0.5132) | (0.5835) |
| HHI | | **-0.0661** | | **0.1872** | | **-0.1264** |
| | | (0.1235) | | (0.2517) | | (0.1138) |
| FDI | | **-0.0172** | | **0.0396** | | **-0.196** |
| | | (0.0260) | | (0.0684) | | (0.2348) |
| FDI*D1 | | **0.0168** | | **-0.2303** | | **-0.2497** |
| | | (0.0273) | | (0.2717) | | (0.2485) |
| FDI*D2 | | **0.0317** | | **-0.0474** | | **-0.0764** |
| | | (0.0296) | | (0.0871) | | (0.2568) |
| Const. | -0.0712* | -0.0607 | -0.0675 | -0.096 | -0.1147* | -0.1022 |
| | (0.0369) | (0.0440) | (0.0468) | (0.0722) | (0.0468) | (0.0694) |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | | | | | | |
| Within | 0.0741 | 0.075 | 0.1332 | 0.1368 | 0.1317 | 0.1376 |
| Between | 0.0041 | 0.0118 | 0.0023 | 0.0081 | 0.5256 | 0.5551 |
| Overall | 0.0195 | 0.0121 | 0.0778 | 0.0995 | 0.2278 | 0.2407 |
| Obs. | 660 | 660 | 390 | 390 | 210 | 210 |
| Group | 22 | 22 | 13 | 13 | 7 | 7 |
| F-test | | | | | | |
| FDI+FDI*D1 | | 0.01 | | 0.69 | | 2.76 |
| (p-value) | | (0.9338) | | (0.4216) | | (0.1477) |
| FDI+FDI*D2 | | 2.72 | | 0.01 | | 0.83 |
| (p-value) | | (0.1138) | | (0.9188) | | (0.3961) |

Note: *** means 1% level of significance, ** means 5% level of significance, * means 10% level of signficance. All regressions uses robust standard errors. Intangibles means R&D + Computer Software from SNA, here.

**Table 1. Descriptive Statistics.**

| | Firm-level panel | | | Industry-level panel | | | |
|---|---|---|---|---|---|---|---|
| | I/K | Q | Liq | R&D ratio | Intangibles | HHI | FDI |
| All Industries | | | | | | | |
| Mean | 0.1338 | 6.5383 | 0.5314 | 1.9042 | 1.2398 | 0.1666 | 0.2333 |
| Median | 0.0518 | 3.8814 | 0.5315 | 1.3921 | 0.5533 | 0.1047 | 0.0719 |
| S.D. | 0.8543 | 7.9822 | 0.2393 | 2.1586 | 1.8567 | 0.1663 | 0.9480 |
| Manufacturing | | | | | | | |
| Mean | 0.1261 | 6.8726 | 0.5496 | 2.6399 | 1.8270 | 0.1407 | 0.1222 |
| Median | 0.0370 | 4.4843 | 0.5401 | 1.9284 | 1.1865 | 0.1047 | 0.0794 |
| S.D. | 1.0172 | 7.8305 | 0.1680 | 2.2937 | 1.9679 | 0.1295 | 0.1326 |
| Service | | | | | | | |
| Mean | 0.1501 | 5.8671 | 0.4843 | 0.7155 | 0.3963 | 0.1211 | 0.0885 |
| Median | 0.0795 | 3.0799 | 0.4698 | 0.2171 | 0.0563 | 0.0727 | 0.0482 |
| S.D. | 0.6469 | 7.8761 | 0.3045 | 1.4604 | 1.4323 | 0.1308 | 0.1395 |

Note: Firm-level panel data are winsorized at 5% and 95%. R&D ratio means R&D stock to tangible capital stock. Intangibles means (R&D stock + organization capital)/tangible capital stock.

**Table 2. First-Step Estimation.**

| | | Manufacturing & Service Sectors | | |
|---|---|---|---|---|
| | All Industries | | Manufacturing | Service |
| Q | **0.0175***** | **0.0184***** | **0.0222***** | **0.0119***** |
| | (0.0022) | (0.0026) | (0.0040) | (0.0013) |
| Const. | 0.0462 | 0.0454 | -0.0035 | 0.1425*** |
| | (0.0299) | (0.0323) | (0.0439) | (0.0399) |
| Year Dummy | Yes | Yes | Yes | Yes |
| Industrial Fixd Effect | Yes | Yes | Yes | Yes |
| R-squared | | | | |
| Within | 0.0204 | 0.0187 | 0.0237 | 0.0144 |
| Between | 0.0009 | 0.0012 | 0.0027 | 0.0000 |
| Overall | 0.0129 | 0.0114 | 0.0155 | 0.0089 |
| Obs. | 51,491 | 46,645 | 27,042 | 19,603 |
| Group | 2,776 | 2,606 | 1,304 | 1,302 |

Note: *** means 1% level of statistical away from zero. Robust standard errors are used by these estimations.

**Table 3. Second-Stage Estimation (All Industries).**

| | | | | | 1991-2011 | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| R&D ratio | **-0.0144** | | **-0.0143** | | **-0.0310*** ** | |
| | (0.0108) | | (0.0109) | | (0.0091) | |
| Intangibles | | **-0.0100** | | **-0.0098** | | **-0.0268*** ** |
| | | (0.0078) | | (0.0078) | | (0.0089) |
| HHI | | | **-0.0323** | **-0.0269** | **-0.1178** | **-0.1082** |
| | | | (0.1141) | (0.1164) | (0.1298) | (0.1254) |
| FDI | | | **-0.0052** | **0.0121** | **-0.0189** | **-0.0211** |
| | | | (0.0323) | (0.0377) | (0.0559) | (0.0568) |
| FDI*D1 | | | **-0.0052** | **-0.0127** | **0.0033** | **0.0050** |
| | | | (0.0323) | (0.0383) | (0.0511) | (0.0520) |
| FDI*D2 | | | **0.0065** | **-0.0009** | | |
| | | | (0.0344) | (0.0411) | | |
| Const. | -0.0304 | -0.0185 | -0.0263 | -0.0167 | 0.0454 | 0.0524 |
| | (0.0329) | (0.0336) | (0.0428) | (0.0444) | (0.0452) | (0.0449) |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | | | | | | |
| Within | 0.0782 | 0.0761 | 0.0786 | 0.0764 | 0.1125 | 0.1092 |
| Between | 0.0035 | 0.0002 | 0.0006 | 0.0213 | 0.0019 | 0.0003 |
| Overall | 0.0493 | 0.0433 | 0.0432 | 0.0359 | 0.0410 | 0.0302 |
| Obs. | 660 | 658 | 660 | 658 | 462 | 462 |
| Group | 22 | 22 | 22 | 22 | 22 | 22 |
| F-test | | | | | | |
| FDI+FDI*D1 | | | 0.20 | 0.02 | 7.30** | 7.75** |
| (p-value) | | | (0.6651) | (0.8881) | (0.0133) | (0.0111) |
| FDI+FDI*D2 | | | 1.85 | 2.98* | | |
| (p-value) | | | (0.1888) | (0.0990) | | |

Note: *** means 1% level of significance, ** means 5% level of significance, * means 10% level of signficance. All regressions uses robust standard errors. Intangibles means R&D stock and organazational capital.

**Table 4. Second-Stage Estimation (Manufacturing Sector).**

| | | | | | 1991-2011 | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| R&D ratio | **-0.0044** | | **-0.0055** | | **-0.0218*** ** | |
| | (0.0083) | | (0.0089) | | (0.0062) | |
| Intangibles | | **-0.0066** | | **-0.0077** | | **-0.190*** ** |
| | | (0.0079) | | (0.0083) | | (0.0059) |
| HHI | | | **0.1046** | **0.1090** | **0.3694** | **0.3640** |
| | | | (0.2556) | (0.2616) | (0.6789) | (0.6732) |
| FDI | | | **0.0852** | **0.0922** | **0.1000** | **0.1056** |
| | | | (0.0691) | (0.0706) | (0.0617) | (0.0641) |
| FDI*D1 | | | **-0.2987** | **-0.3069** | **-0.1704** | **-0.1725** |
| | | | (0.2713) | (0.2732) | (0.1156) | (0.1178) |
| FDI*D2 | | | **-0.1161** | **-0.1325** | | |
| | | | (0.0996) | (0.0963) | | |
| Const. | -0.0199 | -0.0154 | -0.0440 | -0.0405 | -0.0421 | -0.0357 |
| | (0.0388) | (0.0373) | (0.0649) | (0.0647) | (0.0938) | (0.0931) |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | | | | | | |
| Within | 0.1314 | 0.1322 | 0.1354 | 0.1364 | 0.1734 | 0.1745 |
| Between | 0.0673 | 0.0945 | 0.2816 | 0.2836 | 0.2230 | 0.2477 |
| Overall | 0.1135 | 0.1179 | 0.1363 | 0.1416 | 0.1944 | 0.2052 |
| Obs. | 390 | 390 | 390 | 390 | 273 | 273 |
| Group | 13 | 13 | 13 | 13 | 13 | 13 |
| F-test | | | | | | |
| FDI+FDI*D1 | | | 0.91 | 0.92 | 0.45 | 0.40 |
| (p-value) | | | (0.3593) | (0.3555) | (0.5131) | (0.5400) |
| FDI+FDI*D2 | | | 0.14 | 0.28 | | |
| (p-value) | | | (0.7109) | (0.6069) | | |

Note: *** means 1% level of significance, ** means 5% level of significance, * means 10% level of signficance. All regressions uses robust standard errors. Intangibles means R&D stock and organazational capital.

**Table 5. Second-Stage Estimation (Service Sector).**

| | | | | | 1991-2011 | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| R&D ratio | **-0.0480*** ** | | **-0.0562*** ** | | **-0.0578*** ** | |
| | (0.0038) | | (0.0066) | | (0.0080) | |
| Intangibles | | **-0.0420*** ** | | **-0.0476*** ** | | **-0.0538*** ** |
| | | (0.0048) | | (0.0068) | | (0.0097) |
| HHI | | | **-0.3949** ** | **-0.4133* ** | **-0.5303** ** | **-0.5038** ** |
| | | | (0.1536) | (0.1951) | (0.2031) | (0.2063) |
| FDI | | | **0.5264** | **0.7040** | **0.9722** | **0.9912** |
| | | | (0.4626) | (0.7124) | (1.0817) | (1.0929) |
| FDI*D1 | | | **-0.7981* ** | **-0.9783** | **-0.7897** | **-0.9245** |
| | | | (0.4001) | (0.6419) | (0.9909) | (1.0047) |
| FDI*D2 | | | **-0.6084** | **-0.7801** | | |
| | | | (0.5351) | (0.7855) | | |
| Const. | 0.0209 | 0.0446 | -0.0183 | -0.0055 | 0.0198 | 0.0266 |
| | (0.0343) | (0.0346) | (0.1105) | (0.1132) | (0.0955) | (0.0997) |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | | | | | | |
| Within | 0.2389 | 0.2113 | 0.2668 | 0.2479 | 0.2805 | 0.2713 |
| Between | 0.6168 | 0.7139 | 0.4037 | 0.7063 | 0.4689 | 0.6651 |
| Overall | 0.0741 | 0.0346 | 0.0267 | 0.0066 | 0.0235 | 0.0128 |
| Obs. | 210 | 208 | 210 | 208 | 147 | 147 |
| Group | 7 | 7 | 7 | 7 | 7 | 7 |
| F-test | | | | | | |
| FDI+FDI*D1 | | | 3.41 | 3.26 | 0.19 | 0.08 |
| (p-value) | | | (0.1143) | (0.1211) | (0.6757) | (0.7827) |
| FDI+FDI*D2 | | | 0.81 | 0.78 | | |
| (p-value) | | | (0.4029) | (0.4099) | | |

Note: *** means 1% level of significance, ** means 5% level of significance, * means 10% level of signficance. All regressions uses robust standard errors. Intangibles means R&D stock and organazational capital.

**Figure 1. The Movements of Rate of Return on Capital and Rate of Physical investment (All Industries).**

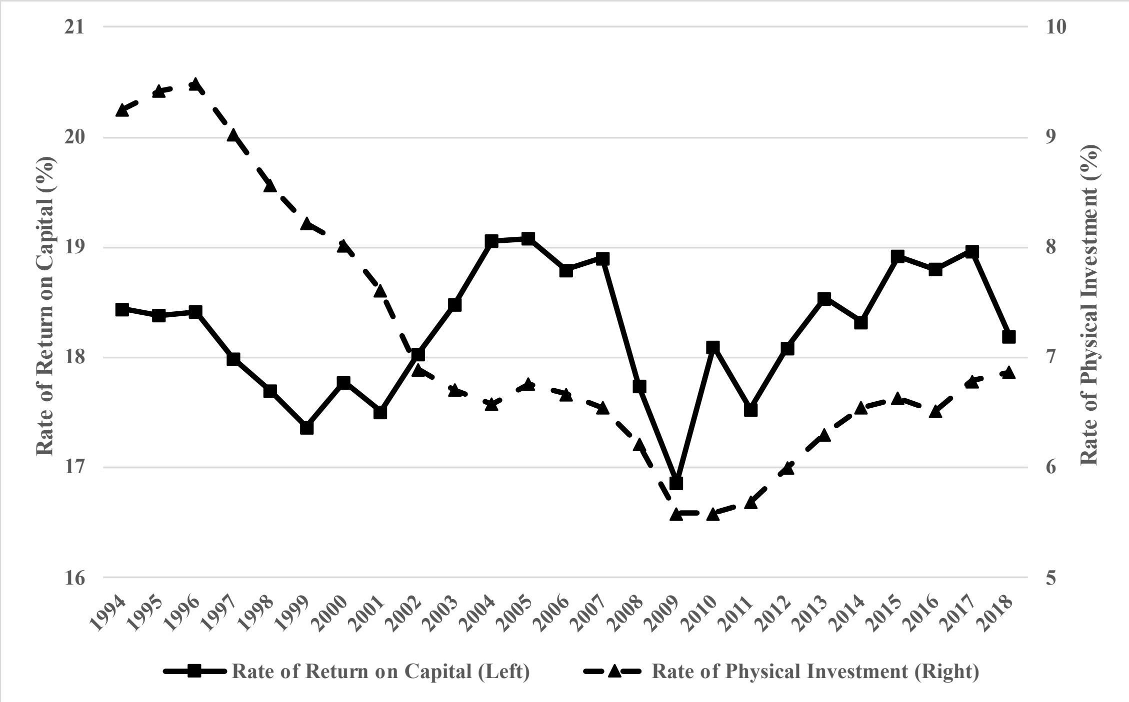


**Figure 2. The Movements of Rate of Return on Capital and Rate of Physical investment (Manufacturing Sector).**

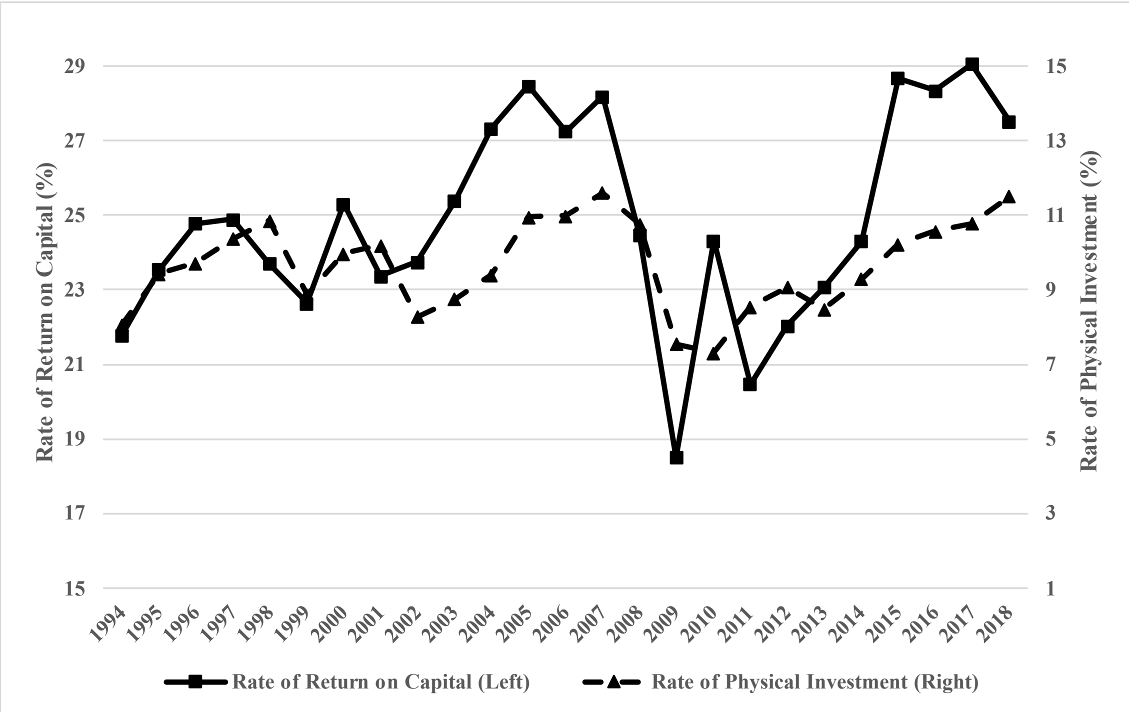

**Figure 3. The Movements of Rate of Return on Capital and Rate of Physical investment (Service Sector).**

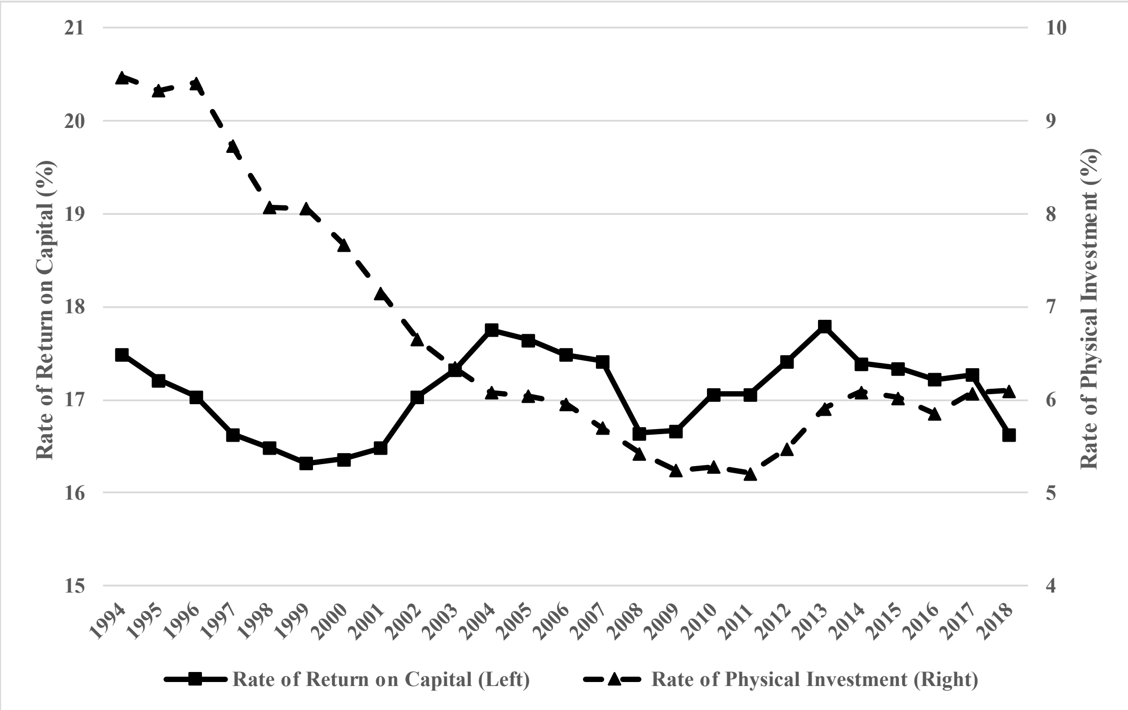


**Figure 4. The Movements of the Investment Gap.**

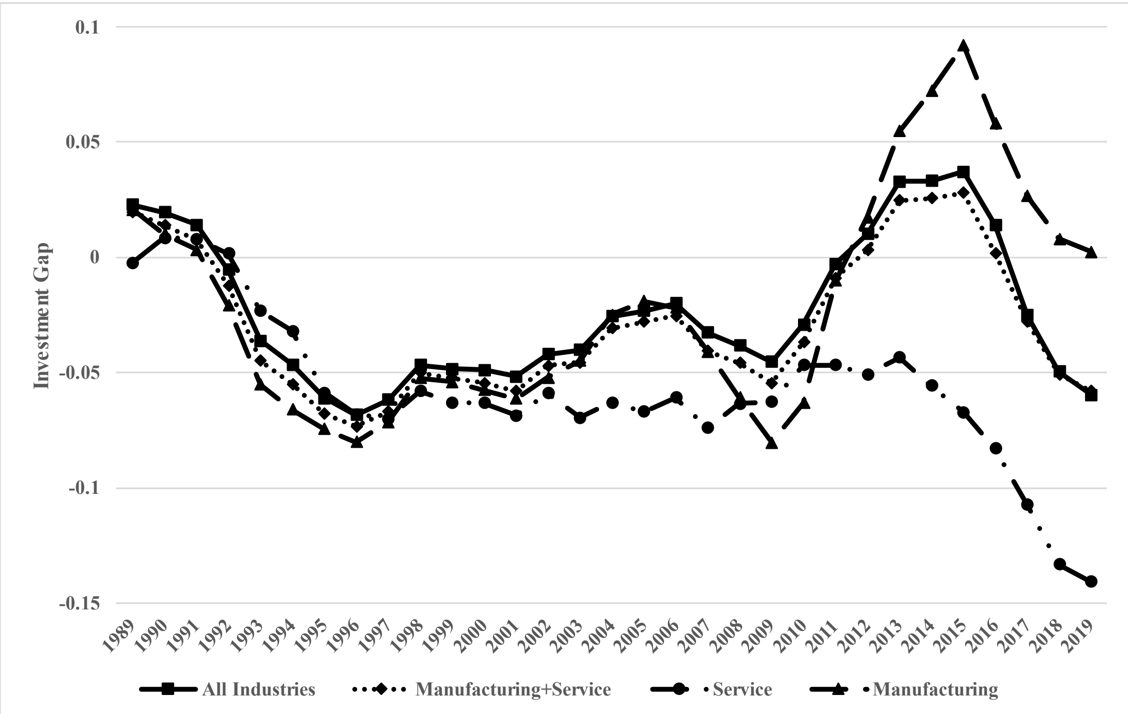

**Figure 5. The Movements of the Investment Gap and Revised Investment Gaps (Service Sector).**