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of Small and Medium-Sized Enterprises in Japan:
Time Series Evidences of Manufacturing Industries

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Exchange Rate, Marginal q and Investment Behavior of Small and Medium-Sized Enterprises in Japan: Time Series Evidences of Manufacturing Industries*

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Abstract

In this paper, we investigate Granger's causality among the exchange rate, Tobin's marginal q, and investment-capital ratio with quarterly data on firms categorized small and medium-sized enterprises (SMEs) in Japan. We utilize the data of following industries: chemical, iron and steel, production machinery, electric machinery and equipment, automobile and accessories and all manufacturing. The empirical results we obtain show that the null hypotheses of no Granger's causality from the exchange rate to other variables, investment and marginal q, are accepted in all industries. The reason is the lower percentage of export by SMEs. Thus, it is considered that the effects of Abenomics on SMEs are limited, and that other kinds of reflation measures for SMEs are needed.

Keywords: marginal q; small and medium-sized enterprises; LA-VAR model; irreversibility; exchange rate

JEL Classification Numbers: C32, F22

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1. Introduction

Small and medium-sized enterprises (SMEs) in Japan account for 99.7% of Japanese firms. The share of added value produced by SMEs is 43.1%, and number of regular employee in SMEs is 62.7% of all (Small-Medium Enterprises Agency 2014)¹. Thus, it can be supposed that SMEs in Japan play an important role in the Japanese economy, and verification of the characteristics of SMEs' investment behavior is a significant task.

In Japan, it is said that firms' business has recently recovered with depreciation of the Japanese Yen (JPY) as a result of Abenomics, the economic policies of the Abe cabinet. And, if so, it can be considered that depreciation of the Japanese currency drives firms' Tobin's q and investment in a positive direction. Here, as a factor which has certain effects on investment, we have to focus on the exchange rate. Figure 1 shows the scatter plots of real effective exchange rate and investment or Tobin's marginal q of manufacturing industry categorized SMEs. And Figure 2 shows those of non-manufacturing. The sample period is 1995:Q2 - 2010:Q1. They indicate that depreciation of JPY and growths of investment or marginal q occur simultaneously in the case of manufacturing; however, it cannot be found with the data of non-manufacturing. It seems that exchange rate has certain effects on investment and marginal q , at least, in small medium-sized manufacturing firms.

On the other hand, it is pointed out that SMEs might have not been influenced by Abenomics. In which case, is there an effect of the exchange rate on investment and Tobin's q in SMEs? And can the exchange rate forecast the trend of SMEs' investment and Tobin's q ?

In this paper, we verify Granger's causality with the lag-augmented VAR (LA-VAR) model and quarterly data on small and medium-sized manufacturing enterprises: chemical, iron and steel, production machinery, electric machinery and equipment, automobile and accessories and all manufacturing. Here, we utilize three variables: real effective exchange

¹ The English version is downloadable from following URL:
http://www.chusho.meti.go.jp/pamflet/hakusyo/H26/download/2014hakusho_eng.pdf .

rate (REER), marginal q (hereafter, Mq) and investment-capital ratio (investment over capital, I/K).

In section 2, we perform the empirical analyses and discussion. And we present the conclusion in section 3. In Appendix, we show the data description of capital stock and investment.

2. Data and Empirical Analysis

2.1 Data

In this paper, we utilize marginal q (hereafter, Mq), real effective exchange rate (REER), and investment-capital ratio (investment or I/K) to investigate Granger's causality. The period of the sample is from 1994:2Q to 2010:1Q.² The data on Mq and I/K are taken from the Company Statistics Seasonal Report by the Ministry of Finance of Japan. The data descriptions are shown in the Appendix. The Company Statistics Seasonal Report provides data by size of enterprise and by industrial classification. In this paper, we utilize the data on six industries: chemical, iron and steel, production machinery, electric machinery and equipment, automobile and accessories and all manufacturing.³ The data on REER are shown in the Monetary Statistics by the Bank of Japan.

2.2 Estimation by the LA-VAR model

In this paper, we verify Granger's causality utilizing the LA-VAR model. The LA-VAR model was developed by Toda and Yamamoto (1995). Following this procedure, we can estimate the VAR model with the level of variables without considering the degree of integration or the existence of a cointegration relationship. When the optimal lag is n and the integrated order of included variables is at most d , we set the length of lags of the VAR model

² The data on investment and marginal q are seasonal adjusted by X11.

³ According to the Small and Medium Enterprises Agency, the definition of an SME is that (1) the number of employees is not more than 300 or (2) capital is not more than three thousand million yen in the case of manufacturing. However, there is no category of "capital of not more than three thousand million yen," and we utilize the manufacturing industry's data on "capital of not more than one thousand million yen."

to $n+d$. Here, we ignore the coefficients in last d lagged vectors in the model, because these are regarded as zeros.

Then, we have to conduct the unit root test in order to check the degree of integration. Here, we employ the DF-GLS test developed by Elliot, Rotenberg, and Stock (1996). The results of this test are shown in Table 1. It is shown that REER is $I(1)$ and others are $I(0)$.

Next, we check the optimal length of lags. Following SBIC, the optimal length of lags of the three-variable VAR model is 1 for all industries. Thus, we have to use the VAR (2) model in order to investigate Granger's causality.

Table 2 shows the empirical results of Granger's causality test with the LA-VAR model. The significance level here is 5%. Following this table, we give a brief review of the empirical results. Firstly, the null hypothesis that REER does not Granger-cause Mq is accepted in all industries. And secondly, the null hypothesis that REER does not Granger-cause I/K is also accepted in all industries.

2.3 Effect of the Exchange Rate

In this subsection, we verify the relationship from the exchange rate to Tobin's marginal q and to investment-capital ratio. As we mentioned in Section 1, the exchange rate is an important factor that influences a firm's investment. Recently, it is said that corporate performance in Japan has recovered by depreciation of JPY. However, the empirical results obtained in this paper show that the exchange rate does not Granger-cause investment and marginal q in all industries we focus on. This implies that the exchange rate cannot forecast the marginal q and investment of major manufacturing industries categorized as SMEs.

The White Paper of the Small and Medium Enterprises 2008 (Small and Medium Enterprises Agency 2008) mentions that manufacturing firms, especially chemical, production machinery, and electric machinery have a high percentage of export; however, it is also shown that a large number of manufacturing firms categorized as SMEs are not

concerned with the business of export. It shows that only 29.6% of firms with 101-300 employees are concerned with the business of export.⁴ This state of affairs is the main reason for our empirical results: acceptance of the null hypothesis that the exchange rate does not Granger-cause investment and marginal q .

As an additional verification, we perform Granger's causality test with the data of non-manufacturing industry. Here, we follow the same model specification as we utilized in the previous subsection. The empirical results are shown in Table 3. It is also shown that real effective exchange rate does not Granger-cause investment and Tobin's marginal q in non-manufacturing industry categorized SMEs; they are consistent with the Figure 2.

Considering the empirical results obtained in this section, the real effective exchange rate cannot forecast the trend of SMEs' investment and Tobin's q . Then, our empirical results support the opinion that a depreciation of JPY has little effects on investment and marginal q of SMEs.

3. Conclusion

In this paper, we investigate Granger's causality among the exchange rate, Tobin's marginal q , and investment-capital ratio with data on Japanese manufacturing industries categorized as SMEs in Japan. We obtain two empirical results that the null hypothesis of no Granger's causality from the exchange rate to marginal q and investment is accepted in all manufacturing industries. The reason is that SMEs have a low percentage of export. And with the data of non-manufacturing, we obtain the same empirical results: acceptance of null. Thus, it can be considered that the effects of Abenomics on SMEs are limited, and that other kinds of reflation measures for SMEs are needed.

⁴ The English version of this the White Paper is downloadable from following URL:
http://www.chusho.meti.go.jp/pamflet/hakusyo/h20/h20/2008hakusho_eng.pdf .

Appendix: Data Descriptions of Investment, Capital Stock, and Marginal q

<Investment>

In the Company Statistics Seasonal Report, sample is revised every second quarter and its continuity is thus not maintained. Moreover, stock data is constructed by accumulating flow data. And so we have to adjust the data. Here, we utilize data on individual enterprises: variables divided by size of population. Using the data on individual enterprises, we construct flow data and capital stock following the equations below:

$$I_t = K_t^E - K_t^B + Dep_t \cdots (1).$$

K_t^E and K_t^B are tangible fixed assets at the end and beginning of period t. Land is excluded and construction-in-progress accounts are included. Dep_t is depreciation and I_t is the flow of investment in period t.

<Capital Stock>

We then calculate capital stock K_t as follows:

$$K_t = K_{t-1} - Dep_t + I_t \cdots (2).$$

Here, I_t and Dep_t are real values. We utilize the deflator of investment from 93SNA.

K_t is a real value. But in order to obtain the real value of capital stock, we have to calculate the book value in 1994:Q2, the start point of the sample, because stock data is constructed by accumulating flow data. Following the National Wealth Survey of 1970, the average duration (vintage) of manufacturing industries is seven years. An economic white paper (Cabinet Office of Japanese Government 1999) shows the way of calculating vintage in the current period with annual data. Following this, vintage is 10.405 years at the beginning of FY 1994, 1994:Q2⁵. Then, we maintain that the book value of capital stock in 1994:Q2 is the price in 1984:Q4.

⁵ By calculating with the rate of retirement of equipment printed in the Quarterly Report on National

<Tobin's Marginal q>

Next, we show the method of calculating marginal q. The model of marginal q implies a relationship between investments and their shadow price derived from firms' profit maximization problem. Following Ogawa and Kitasaka (1999) and other studies, marginal q (Mq) is written as

$$Mq_t = \frac{1}{P_t^I} E_t \left[\sum_{j=0}^{\infty} \left\{ \prod_{i=1}^j \left(\frac{1}{1+r_{t+i}} \right) \right\} (1-\delta)^j \pi_{t+j} \right] \dots (3).$$

Here, P_t^I is the price of investment goods, π_t , the profit rate, is operating profit over capital at period t, δ is the depreciation rate, and E_t is the expectation operator with the information set available at t. And r_t , the discount rate, is the interest rate for borrowing.

We assume that r_t (discount rate) and π_t (profit rate) obey the independent random walk process. And Mq can be explained as follows:

$$Mq_t = \frac{\pi_t}{P_t^I} \frac{(1+r_t)}{(r_t+\delta)} \dots (4)$$

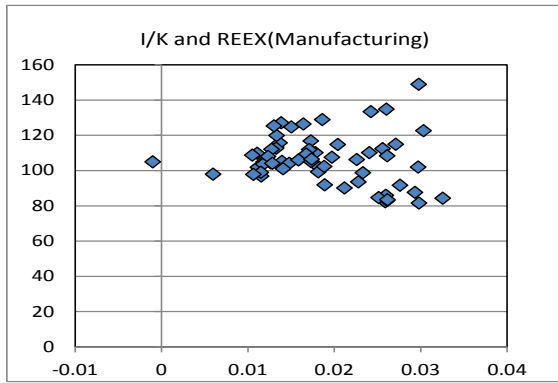
We assume δ is 0.0792, which is the value calculated for the manufacturing industry shown in Masuda (2000) referring to the methods developed by Hayashi and Inoue (1991).

Accounts of 1980 (Economic Planning Agency 1981), the vintage of manufacturing industries in 1980 is 8.3 years. Then, we calculate with the rate of retirement of equipment printed in the Quarterly Report on National Accounts of 2010.

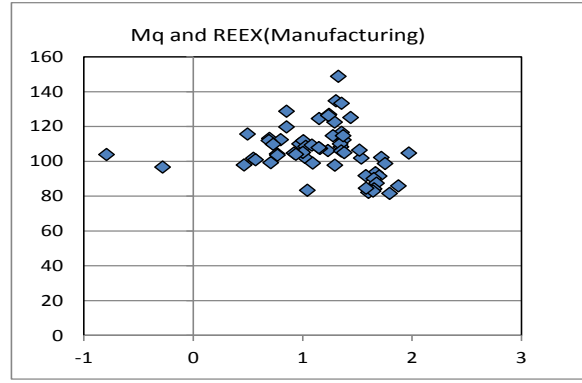
The data series of 93SNA is available only after 1980. And we thus calculate the vintage with 68SNA, which is available before 1980, and connect to 93SNA at 1980:Q1.

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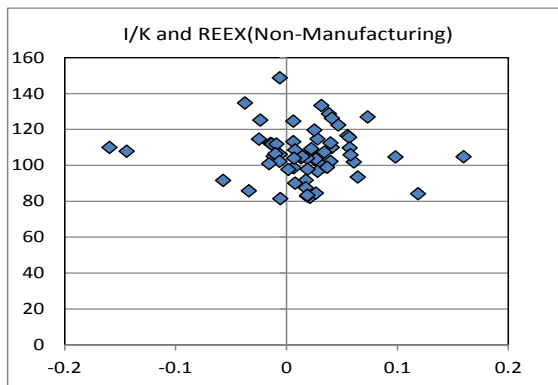
(1-A) Exchange Rate and Investment



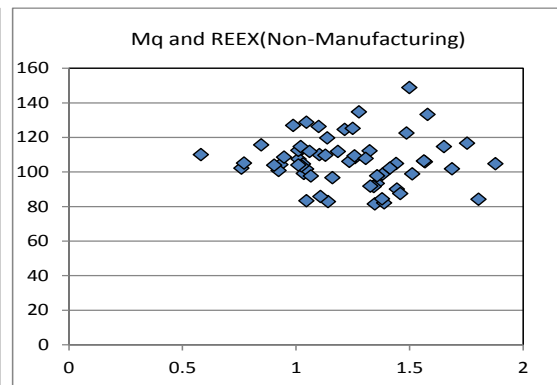
(1-B) Exchange Rate and marginal q

Figure 1 Scatter Plots (Manufacturing)

(Note) The vertical axis is real effective exchange rate (REER). The horizontal axis is investment-capital ratio (I/K) for 1-A and Tobin's marginal q (Mq) for 1-B. Correlation coefficient of REER and I/K is -0.323, and that of REER and Mq is -0.245.



(2-A) Exchange Rate and Investment



(2-B) Exchange Rate and marginal q

Figure 2 Scatter Plots (Non-manufacturing)

(Note) The vertical axis is REER. The horizontal axis is I/K for 2-A and Tobin's Mq for 2-B. Correlation coefficient of REER and I/K is -0.049, and that of REER and Mq is -0.061.

(Source of Fig.1 and 2) Mq and I/K are from the Company Statistics Seasonal Report by the Ministry of Finance. REER is from the Monetary Statistics by the Bank of Japan.

Table 1 Unit Root Test (With Constant)

Elliott-Rothenberg-Stock DF-GLS test

IK(level)			MQ(level)		
Chemical	-3.769	(1) ***	Chemical	-4.910	(0) ***
Iron and Steel	-8.386	(0) ***	Iron and Steel	-3.680	(0) ***
Production Machinery	-7.942	(0) ***	Production Machinery	-1.997	(1) **
Electric Machinery	-7.175	(0) ***	Electric Machinery	-4.834	(0) ***
Automobile/ Accessories	-7.886	(0) ***	Automobile/ Accessories	-7.049	(0) ***
Non-Manufacturing	-6.648	(0) ***	Non-Manufacturing	-3.026	(0) ***

REEX(level)			REEX(1st difference)		
REEX	-0.904	(0)	D(REEX)	-7.291	(0) ***

<Note> Critical values are -2.603 (1% level, ***) and -1.946 (5% level, **).
The critical values are shown in MacKinnon (1996).

Table 2 Granger Causality Test with the LA-VAR Model

Chemical		
Null Hypothesis:	Wald-Statistics	Prob.
REEX does not Granger-cause IK	0.133	0.715
REEX does not Granger-cause MQ	0.823	0.364
Iron and Steel		
Null Hypothesis:	Wald-Statistics	Prob.
REEX does not Granger-cause IK	0.313	0.576
REEX does not Granger-cause MQ	0.112	0.738
Production Machinery		
Null Hypothesis:	Wald-Statistics	Prob.
REEX does not Granger-cause IK	0.011	0.918
REEX does not Granger-cause MQ	0.332	0.564
Electric Machinery		
Null Hypothesis:	Wald-Statistics	Prob.
REEX does not Granger-cause IK	2.683	0.101
REEX does not Granger-cause MQ	1.137	0.286
Automobile and Accessories		
Null Hypothesis:	Wald-Statistics	Prob.
REEX does not Granger-cause IK	1.188	0.276
REEX does not Granger-cause MQ	0.657	0.418
Manufacturing (Total)		
Null Hypothesis:	Wald-Statistics	Prob.
REEX does not Granger-cause IK	0.024	0.876
REEX does not Granger-cause MQ	0.370	0.543

<Note> The Wald test statistics obey chi-square distribution with DF=1.

Table 3 Granger Causality Test (Non-Manufacturing)

Non-Manufacturing		
Null Hypothesis:	Wald-Statistics	Prob.
REEX does not Granger-cause IK	0.547	0.452
REEX does not Granger-cause MQ	1.638	0.201

<Note> The Wald test statistics obey chi-square distribution with DF=1.