Post Keynesian Review
Vol. 2, No. 1, Pages 29–38 (the 30th September, 2013)
ISSN 2187-4875

Estimation of the Kaleckian Investment Function in Japanese Manufacturing

ABE, Taro

ABSTRACT. The Kaleckian approach assumes that the sensitivity of investment to changes in utilization is relatively small, even in the long run. This approach has been controversial from both the theoretical and empirical points of view. This paper estimates,by using the error term correction model, the Kaleckian investment function in Japanese manufacturing. The result shows that the sensitivity of investment to changes in capacity utilization is quite large, thus questioning whether the investment function is applicable in the long run for the Japanese economy.

Keywords: Kaleckian investment function, Japanese manufacturing, Error term correction model

JEL Classification: E12, E32

1. Introduction

Post Keynesians regard the role of investment as very important among factors of effective demand. However, there is a disagreement in terms of the specifications. We intend to contribute to the discussion from the empirical point of view.

The Kaleckian approach, which has been influential in the Post Keynesian school, has applied the Kaleckian short-run model to the long-run, where capacity utilization freely adjusts to any disequilibrium in the product market. Some heterodox scholars have questioned this approach, because it does not account for a firm's goal-oriented behavior. They believe that the inconsistency between actual and desired utilization does not last in the long run. Some Kaleckians responded to this question in two ways, like *e.g.* Hein, et al.(2011) and Skott(2012a). One is the consistency in the long run because of the endogenous change in the desired utilization rate. Second is the discrepancy in the long run because of macroeconomic constraints and competing targets.

Skott(2008, 2012a) outlines the shortcomings of the Kaleckian investment function. He criticizes the assumption that the sensitivity of investment to changes in

The first draft received: 11th of August, 2013. The final accepted: 26th September, 2013.

utilization is relatively small, even in the long run, from both the theoretical and empirical points of view. The simple estimation using Canadian data in Skott(2008) is at odds with the Kaleckian approach. Thus, if this assumption does not hold, then we cannot regard capacity utilization as an adjustment variable in the long run.

There are few empirical studies on this issue, in contrast with those showing the significance of changes in capacity utilization in the short run, so more empirical studies are necessary to support our argument. Following Skott(2008, 2012a), we estimate the investment function in Japanese manufacturing. We choose manufacturing, because, firstly, Kaleckian models often assume that capacity utilization are adjusted in these industries, and, secondly, Skott(2008, 2012a) also uses manufacturing data in his analyses.

Recently, Post Keynesian perspectives have been applied to the Japanese economy. Azetsu, Koba, and Nakatani(2010) investigate dynamic patterns of capital accumulation and income distribution in Japan, by using a vector autoregression Kaleckian model. Nakatani and Skott(2007) discussed Japan's multi-decade recession from a Kaldorian viewpoint. This paper, which investigates the applicability of the Kaleckian investment function to the Japanese economy in the long run, is related to these heterodox economic analyses of the Japanese economy.

The plan of the paper is as follows. Section 2 derives the model of the Kaleckian investment function. Section 3 investigates data on the Japanese manufacturing industries. Section 4 estimates the investment function. Section 5 concludes.

2. Model

We show the *hysteresis Kaleckian model* following Skott(2008, 2012a). The model was proposed corresponding to the criticism that the Kaleckian model has no mechanism of consistency between actual and desired utilization rates.

The Kaleckian investment function is

$$g_t = \rho_t + \beta(u_t - u_t^d), \tag{2.1}$$

where g, ρ, β, u, and u^d stand for the investment rate, expected growth of demand, adjustment speed of capacity utilization, actual capacity utilization, and desired capacity utilization, respectively.[1] The subscript t means at time t. This is typical of a Kaleckian investment function where ρ_t and u_t^d are constant for all t.[2]

[1] 'Investment rate' means the investment to capital ratio. 'Desired' means strategic determination regarding well-defined objectives.

[2] Refer to Adachi(2000), Abe(2009), and Ikeda(2006, 2010) for the microfoundation. They derive the investment function under the assumption that the cost function is convex. Skott(1989, Ch. 6) questions this assumption and proposes another derivation.

We assume that the desired capacity utilization and expected growth rate adapt to change. It is also assumed that firms revise their targets on the basis of realized values.[3]

$$u_t^d - u_{t-1}^d = \mu(u_{t-1} - u_{t-1}^d), \tag{2.2}$$

$$\rho_t - \rho_{t-1} = v(g_{t-1} - \rho_{t-1}). \tag{2.3}$$

where μ and v denote adjustment speeds of u^d and ρ, respectively.

We transform these equations to derive an equation consisting only of observable variables. Substituting (2.1) in (2.3), we get

$$\rho_t - \rho_{t-1} = v\beta(u_{t-1} - u_{t-1}^d). \tag{2.4}$$

Using (2.2) and (2.4), we have

$$\rho_t = \frac{v\beta}{\mu}u_t^d + A, \tag{2.5}$$

where $A = \rho_{t-1} - \frac{v\beta}{\mu}u_{t-1}^d$. Following Skott(2008, 2012a), we can consider A to be an arbitrary constant.[4]

From (2.1), (2.2) and (2.5),

$$g_t = A + \beta\Big(\frac{v}{\mu} - 1\Big)[\mu u_{t-1} + (1-\mu)u_{t-1}^d] + \beta u_t. \tag{2.6}$$

Subtracting $(1-\mu)g_{t-1}$ from both sides of (2.6), we get

$$g_t - (1-\mu)g_{t-1} = \mu A + \beta(v-1)u_{t-1} + \beta u_t. \tag{2.7}$$

Thus, we derive an equation consisting only of observable variables.

In the long run, where $g_t = g_{t-1}$ and $u_t = u_{t-1}$ hold, we get

$$g = \frac{\beta v}{\mu}u + A. \tag{2.8}$$

Saving is as follows.

$$\frac{S}{K} = su\sigma, \tag{2.9}$$

[3] As for (2.2) and (2.3), refer to Lavoie(1996, 2010). Skott(2012a) questions (2.2), because we can consider that the capital accumulation adjusts the discrepancy of the utilization rate.

[4] We apply a Koyck(1954) transformation to the model. This is a common method to treat unobservable variables. Here, ρ and u^d are unobservable. However, this may not be the best way, because A is not constant when ρ and u^d change. For instance, Schoder(2012) applies an another method to the Kaleckian model. It is beyond the scope of this paper to argue it in detail.

where S, K, s, and σ denote saving, capital stock, the saving rate, and output-capital ratio in full capacity, respectively.[5]

The equilibrium in the product market is

$$g \equiv \frac{I}{K} = \frac{S}{K}. \tag{2.10}$$

From (2.8)-(2.10), the Kaleckian stability condition in the long run is

$$\frac{\partial g}{\partial u} = \frac{\beta v}{\mu} < s\sigma = \frac{\partial(\frac{S}{K})}{\partial u}. \tag{2.11}$$

We focus on the values, $\frac{\beta v}{\mu}$ and $s\sigma$.

3. Data

We translate the monthly data of the capacity utilization index for industrial production from the Japanese Ministry of Economy, Trade and Industry to quarterly data. The edited data image is shown in Figure 1.

As shown by Figure 1, changes in capacity utilization for the Japanese economy from 1980 to 2007 reveal several ups and downs. In the late 1980s, Japan experienced a 'Bubble Boom' following a recession after the 1985 Plaza agreement. The recovery era after the collapse of the 'Bubble Boom' was negatively affected by an increase in the social security premiums and consumption tax in 1997 and by the 'Asian Shock' in 1998. After the 'IT Bubble' collapsed in 2001, the recovery continued.[6]

We used quarter manufacturing data in terms of the gross capital stock of private enterprises from the Cabinet Office for constructing the private investment index. The data contains construction equipment for both completed and under-construction projects, and is based on the United Nations 1993 System of National Accounts. The data image is shown in Figure 2.

The period of study is from 1980:3 to 2007:3 based on the available data. The data are seasonally adjusted.[7]

The descriptive statistics of the data are shown in Table 1. u moves from maximum 111 to minimum 85 with the mean, 99. g moves from maximum 14 to minimum -14 with the mean, 1.

[5] It is not a saving rate in wage income like a canonical Kaleckian model, but that in national income.

[6] As for the effects of Japanese economic stagnation since the 1990s, refer to Nakatani and Skott(2007).

[7] Using the same criteria, we can get data on capacity utilization from 1978 to 2007 and on investment from 1980 to 2009.

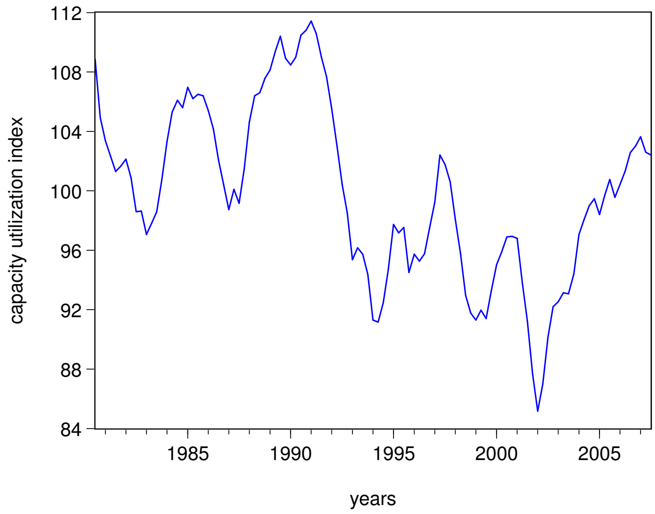

FIGURE 1. Capacity Utilization Index

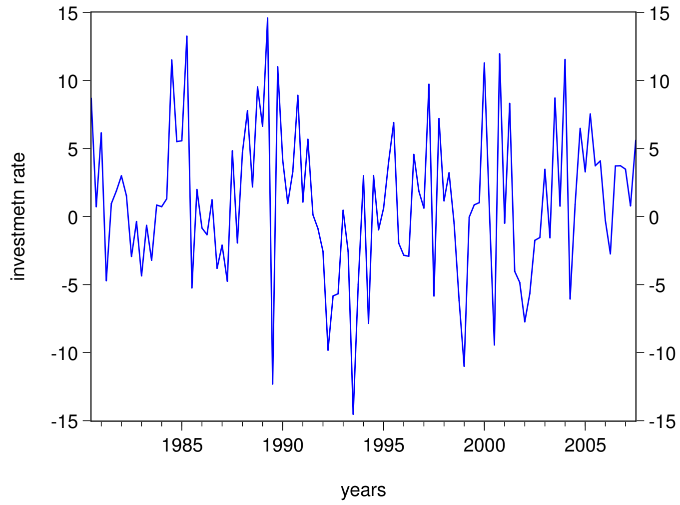

FIGURE 2. Investment Rate

3.1. Preliminary test results. First, we check for any unit root and the stationarity of variables using an augmented Dickey-Fuller test. The lag length selection is

TABLE 1. Descriptive Statistics of the Data

	u	g
Mean	99.85933	1.071439
Median	99.56667	0.857028
Maximum	111.4333	14.59363
Minimum	85.16667	−14.53784
Std. Dev.	5.902203	5.607380
Skewness	−0.026584	−0.043712
Kurtosis	2.379851	3.079955
Jarque-Bera	1.759495	0.063746
Probability	0.414888	0.968630
Sum	10884.67	116.7869
Sum Sq. Dev.	3762.287	3395.813
Observations	109	109

determined by the Schwarz Information Criterion. The result is shown in Table 2, where g follows an integrated process of order zero and u follows order one.[8]

TABLE 2. Unit Root Test

variable	trend and intercept	t-Statistic
g	none	$-5.218027^{\dagger}$
	include intercept	$-5.390649^{\dagger}$
	include trend and intercept	$-5.361523^{\dagger}$
u	none	-0.094713
	include intercept	-2.498844
	include trend and intercept	-2.776015
Δg	none	$-12.19600^{\dagger}$
	include intercept	$-12.13989^{\dagger}$
	include trend and intercept	$-12.08075^{\dagger}$
Δu	none	$-6.064114^{\dagger}$
	include intercept	$-6.026148^{\dagger}$
	include trend and intercept	$-6.012995^{\dagger}$

In Table 2 and what follows, † indicates $p < 0.01$, *i.e.* the null hypothesis is rejected at one percent level of significance.

[8] Δ in Table 2 means the difference of order one. We also take Mackinnon's (1996) one-sided p-value.

4. Estimation of the Investment Function

As the first step in estimating the investment function, we incorporate (2.7) into the error correction model.

$$\Delta g_t = g_0' + \beta \Delta u_t - \mu(g_{t-1} - \theta - \zeta u_{t-1}), \tag{4.1}$$

with $g_0' = \mu(A - \theta)$ and $\zeta = \frac{\beta v}{\mu}$, where θ is a constant term. Thus, the equations to be estimated are as follows.

$$g_t = \theta + \zeta u_t + \chi_t, \tag{4.2}$$

$$\Delta g_t = g_0' + \beta \Delta u_t - \mu \chi_{t-1} + \varepsilon_t, \tag{4.3}$$

where χ_t and ε_t are error terms. Equation (4.2) shows the relationship between investment and capacity utilization in the long run. Equation (4.3) shows that g changes in response to deviations from the long-run relation.

First, we estimate (4.2) and conduct an Engle Granger cointegration test (Engle and Granger, 1987). We then estimate (4.3).

The result of the first step is shown in Table 3.

TABLE 3. Estimations using Equation (4.2)

Dependent variable: g_{t-1}	
u_{t-1}	0.328027†
	[0.086196]
Constant	−31.68516†
	[8.622398]
Observation	109
R-squared	0.119214

Notes: Standard errors in brackets.

This can be a spurious regression, because u follows an integrated process of order one, as seen in the preceding section.

We examine the stationarity of the error term using an Augmented Dickey-Fuller test to see if there is cointegration. The lag number is determined by the Schwarz Information Criterion. The result is shown in Table 4.[9]

The null hypothesis respecting a unit root is rejected at the 1% significance level. Thus, it is possible that there is a cointegration relationship between g_{t-1} and u_{t-1}.

[9] Here, we also take Mackinnon's (1996) one-sided p-value.

TABLE 4. Cointegration Test

trend and intercept	t-Statistic
none	$-11.11443^{\dagger}$
include intercept	$-11.06314^{\dagger}$
include trend and intercept	$-11.42544^{\dagger}$

We consider how the investment function responds to capacity utilization. Equation (2.8) shows the relationship between investment and capacity utilization in the long run. We get coefficient $\zeta = \frac{v\beta}{\mu} = 0.328027$ when estimating (4.2). This result questions the Kaleckian assumption and supports the position of Skott(2008, 2012a). According to Skott(2012b), the gross saving rate in most advanced countries lies between 0.15 and 0.25, with an output-capital ratio of about 0.5.[10] Therefore, the sensitivity of the saving rate is between 0.075 and 0.125 from (2.11). Thus, the sensitivity of investment is restricted to be less than approximately 0.1.[11]

Next, we estimate (4.3) considering the estimation of (4.2) to finish our process. The result is shown in Table 5.

TABLE 5. Estimations using Equation (4.3)

Dependent variable: Δg_t	
Δu_t	$0.905612^{\dagger}$
	[0.310785]
χ_t	$-1.108607^{\dagger}$
	[0.097165]
$Constant$	-0.091145
	[0.150900]
Observation	109
Adjusted R-squared	0.502688

Notes: Standard errors in brackets.

Heteroskedasticity is rejected because p-value is 0.3708 in the light of the White test (White, 1980). We obtain good p-values and adjusted R-squareds.

Table 6 shows that the error term has no serial correction for the null hypothesis.

[10] According to Annual Report(Japanese Cabinet Office, 2012), the national saving rate in Japan had decreased from 13.6% in 1995 to 5.1% in 2008.

[11] The coefficient of investment on the utilization in the short run is β from (2.1), because ρ and u^d are constant.

TABLE 6. Correlogram of Residuals

	AC	PAC	Q-Stat	Prob
1	−0.020	−0.020	0.0440	0.834
2	0.125	0.124	1.8032	0.406
3	0.037	0.042	1.9560	0.582
4	−0.026	−0.040	2.0314	0.730
5	0.038	0.027	2.1999	0.821
6	0.103	0.114	3.4573	0.750
7	0.076	0.078	4.1494	0.762
8	−0.123	−0.157	5.9738	0.650
9	0.044	0.013	6.2109	0.719
10	−0.063	−0.022	6.7005	0.753
11	0.094	0.101	7.8019	0.731
12	−0.046	−0.069	8.0660	0.780

5. Conclusion

We investigate how investment responds to capacity utilization in Japanese manufacturing. The result questions the underlying assumption of the Kaleckian investment function and supports the argument of Skott(2008, 2012a). The responsiveness of investment to capacity utilization is greater than that assumed by the Kaleckian approach. The significance of this paper is that one must be very careful when applying the Kaleckian model to the Japanese economy in the long run. However, in this preliminary paper, we use only capacity utilization as an explanatory variable. We should include other explanatory variables in our research because R-squared in Table 3 is low and p-value of *Constant* in Table 5 is high. The task remains.

Bibliography

[1] Abe, T. (2009), "Microfoundation of Kaleckian Growth Model," *Political Economy Quarterly*, 45(4), pp. 88-96, (in Japanese).

[2] Adachi, H. (2000), "Investment decisions and the choice of technique of the firm under imperfect competition," Ch. 2 in *Imperfect Competition and Macro Dynamic Theory*, Yuhikaku, (in Japanese).

[3] Azetsu, K., Koba, T., and Nakatani, T. (2010), "Empirical Analysis of a Kaleckian-type Model of Growth and Distribution," *Political Economy Quarterly* 47(1), pp.56-65, (in Japanese).

[4] Engle R. F. and C. W. J. Granger. (1987), "Cointegration and Error Correction: Representation, Estimation, and Testing," *Econometrica* 55(2), pp. 251-76.

[5] Hein, E., Lavoie, M. and van Treeck, T. (2011), "Some Instability Puzzles in Kaleckian Models of Growth and Distribution: A Critical Survey," *Cambridge Journal of Economics* 35(3), pp. 587-612.

[6] Ikeda, T. (2010), "Reconsidering the microfoundations of Kaleckian models," *Rikkyo Economic Review*, 63(3), pp. 33-50, (in Japanese).

[7] Ikeda, T. (2006), "Kaleckian and new Keynesian," Ch. 2 in *Economic Growth and Income Distribution*, Nihon Keizai Hyouron Sha. (in Japanese).

[8] Japanese Cabinet Office (2012), *Annual Report on National Accounts.*

[9] Japanese Cabinet Office (2012), *Quarterly Estimates of Gross Capital Stock of Private Enterprises.*

[10] Japanese Ministry of Economy, Trade and Industry (2012), *Indices of Industrial Production.*

[11] Koyck, L. M. (1954), *Distributed Lags and Investment Analysis*, North-Holland, Amsterdam.

[12] Lavoie, M. (1996), "Traverse, Hysteresis, and Normal Rates of Capacity Utilization in Kaleckian Models of Growth and Distribution," *Review of Radical Political Economics* 28(4), pp. 113-47.

[13] Lavoie, M. (2010), "Surveying Short-run and Long-run Stability Issues with the Kaleckian Model of Growth," in Setterfield, M. (ed.), *Handbook of Alternative Theories of Economic Growth*, Edward Elgar, Cheltenham.

[14] MacKinnon, J. G. (1996), "Numerical Distribution Functions for Unit Root and Cointegration Tests," *Journal of Applied Econometrics* 11(6), pp. 601-18.

[15] Nakatani, T and Skott, P. (2007), "Japanese Growth and Stagnation: A Keynesian Perspective," *Structural Change and Economic Dynamics* 18(3), pp. 306-32.

[16] Schoder, C. (2012), "Hysteresis in the Kaleckian Growth Model: A Bayesian Analysis for the US Manufacturing Sector from 1984 to 2007," *Metroeconomica* 63(3), pp. 542-68.

[17] Skott, P. (1989), *Conflict and Effective Demand in Economic Growth*, Cambridge University Press.

[18] Skott, P. (2008), "Theoretical and empirical shortcomings of the Kaleckian investment function," WP 2008-11, Department of Economics, University of Massachusetts Amherst.

[19] Skott, P. (2011), "Heterodox Macro after the Crisis," *Korean Review of Social Studies* 37(2), pp. 35-63.

[20] Skott, P. (2012a) "Theoretical and Empirical Shortcomings of the Kaleckian Investment Function," *Metroeconomica* 63(1), pp. 109-138.

[21] Skott, P. (2012b), "Pluralism, the Lucas critique, and the integration of macro and micro," WP 2012-04, Department of Economics, University of Massachusetts Amherst.

[22] White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica* 48(4), pp. 817-38.

Acknowledgments: The author would like to thank Jong-seok Oh, Masao Yamaguchi, Peter Skott and three referees of this journal for their valuable comments. The usual disclaimer applies.

Correspondence: Taro ABE, Ph.D. Associate Professor, Faculty of Economics, Nagoya Gakuin University, Nagoya, Japan. (`taro-abe@ngu.ac.jp`)