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SHAPE OF AGGREGATE SUPPLY CURVE IN JAPAN

——Some Consideration of Okun's law——

By Hiroaki Fujimoto

1 Introduction

The object of this paper is to throw light on the shape of Japanese aggregate supply curve which is derived by using Okun's law, Phillips curve and mark-up principle. Okun's law expresses the relation between aggregate production and unemployment rate. Phillips curve shows the relation between unemployment rate and proportionate rate of change of wages. Mark-up principle represents the relation between proportionate rate of change of wages and proportionate rate of change of prices. We are able to get an expression between proportionate rate of change of prices and aggregate production by substituting unemployment rate and proportionate rate of change of wages. The expression is nothing but aggregate supply curve. These can be formulated as follows.

(1) Okun's law

$$Y=-a+bU \qquad ,a>0, \qquad (1)$$

where: $Y=\frac{PGNP-GNP}{PGNP}\times 100$; GNP=real gross national product; PGNP=potential GNP : U=unemployment rate (%).

(2) Phillips curve

$$W=c-dU+eP \qquad ,d>0 \ ,0<e<1, \qquad (2)$$

where: $W=\frac{w-w(-1)}{w(-1)}\times 100$;w=nominal wages; (−1) =one year lag:

P=proportionate rate of change of consumer price index, See (3).

(3) Mark-up principle

$$P=f+gP(-1)+hW-iS+jQ \ ,0<h<1 \ ,h=i, \qquad (3)$$

where: $P=\frac{p-p(-1)}{p(-1)}\times 100$;p=consumer price index:

S=proportionate rate of change of productivity (%) : Q=proportionate rate of change of WPI (wholesale price index) (%). And letters from a to j are parameters.

We can get (4) from (1), (2) and (3) by substituting U and W.

(4) Macro aggregate supply function

$$(1-eh)P=f+ch-\frac{dh}{b}(Y+a)+gP(-1)-iS+jQ. \qquad (4)$$

Therefore, the grade (in this case, the elasticity) of aggregate supply function is $\frac{dh}{1-eh}\cdot\frac{1}{b}$. $\frac{1}{b}$ is a parameter which is derived from Okun's law. The larger is b, which is called Okun coefficient, the smaller the elasticity becomes. $\frac{dh}{1-eh}$ is a parameter which derives from wages adjustment at the labor market. This depends of the grade of short-run Phillips curve (d), the mark-up ratio (h) and the expected rate of change of prices (e). Excluding the expectation (e), the larger d and h changes (as for h, if h gets near to unity), the larger the elasticity of aggregate supply function turns into.

Moreover, if we consider a shape of macro aggregate demand curve in addition to that of macro aggregate supply curve, we can appreciate a macro economic performance of the effect that a fluctuation of GNP and a fluctuation in prices will be great or not for a demand-side shift or for a shock of supply side. It is not difficult to understand such a performance if an illustration helps us. The figure 1 about a shift of demand side shows that the nearer an aggregate supply curve (AS1) gets into the horizon, the larger the fluctuation of GNP changes and the smaller that of prices does[1]. The figure 2 is about a shock of supply side. It is shown that the nearer an aggregate supply curve (AS1) comes

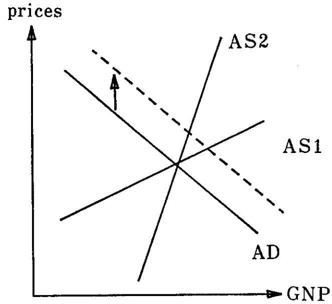

Figure. 2

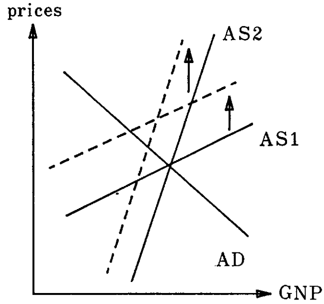

Figure. 1

to the vertical, the less the fluctuation in GNP becomes and the bigger that in prices does. It is, therefore, needlles to say that a shock of supply side like the oil crisis will affect the living of people and a demand management policy will be very effective for the living of people if the grade of aggregate supply curve is inelastic (AS1).

2 Okun's Law

First of all, we have to obtain the real gross national poduct(GNP) gaps the same way as Kurosaka and Hamada have shown us[2]. We estimate the growth rate of potential real gross national product (PGNP) by the following regression equation:

$$\log G=\alpha+\beta T, \quad (5)$$

where G is the actual value of real GNP, β is the growth rate of PGNP, T is the time trend. We devide the period into the two subperiods by reason of the structual change due to the oil shock. The following PGNP growth rates are gotton, each: 7.48% (1965-75), 4.19% (1975-85)[3]. PGNP is extrapolated with these trend values. See the fourth column of table 1.

Table 1

year	U	GNP	PGNP	Y
1965	2.08 (0.0)	92,028 (0.0)	98,916 (0.0)	6.96 (0.0)
1966	2.34 (12.5)	102,210 (11.1)	106,320 (7.5)	3.87 (−44.5)
1967	1.67 (−28.6)	113,182 (10.7)	114,278 (7.5)	0.96 (−75.2)
1968	1.49 (−10.6)	127,709 (12.8)	122,831 (7.5)	−3.97 (999.9)
1969	1.32 (−11.9)	142,994 (12.0)	132,025 (7.5)	−8.31 (109.2)
1970	1.56 (17.5)	153,915 (7.6)	141,907 (7.5)	−8.46 (1.9)
1971	1.81 (17.2)	161,688 (5.0)	152,528 (7.5)	−6.01 (−29.0)
1972	1.56 (−14.1)	176,628 (9.2)	163,945 (7.5)	−7.74 (28.8)
1973	1.72 (10.7)	184,569 (4.5)	176,216 (7.5)	−4.74 (−38.7)
1974	2.16 (25.2)	183,798 (−0.4)	189,406 (7.5)	2.96 (999.9)
1975	2.37 (9.6)	190,875 (3.9)	203,583 (7.5)	6.24 (110.8)
1976	2.37 (0.2)	199,630 (4.6)	212,126 (4.2)	5.89 (− 5.6)
1977	2.59 (9.4)	210,234 (5.3)	221,027 (4.2)	4.88 (−17.1)
1978	2.46 (− 5.1)	221,243 (5.2)	230,301 (4.2)	3.93 (−19.4)
1979	2.24 (− 9.1)	232,878 (5.3)	239,965 (4.2)	2.95 (−24.9)
1980	2.52 (12.9)	242,131 (4.0)	250,034 (4.2)	3.16 (7.0)
1981	2.58 (2.3)	250,159 (3.3)	260,525 (4.2)	3.98 (25.9)
1982	2.96 (14.8)	258,241 (3.2)	271,457 (4.2)	4.87 (22.4)
1983	3.05 (3.0)	267,782 (3.7)	282,848 (4.2)	5.33 (9.4)
1984	2.96 (− 3.1)	281,102 (5.0)	294,717 (4.2)	4.62 (−13.3)
1985	3.08 (4.3)	292,838 (4.2)	307,083 (4.2)	4.64 (0.4)
Unit	per cent %	billion yen ¥	billion yen ¥	per cent %

note: U=unemployment rate: GNP=real gross national product: PGNP=potential GNP: Y=GNP gaps, which is defined in (6): the value in parenthesis is annual growth rate. U and GNP are taken from Economate (brought out by Tohyohkeizaishinpohsha).

And then we can calculate the GNP gaps (Y) by the following formula:

$$Y=\frac{PGNP-GNP}{PGNP}\times 100. \qquad (6)$$

Y appears in the fifth column of table 1. It is shown that the Japanese economy was in operation over PGNP from 1968 to 1973.

The second, we have to estimate the Okun coefficient in the Japanese economy. There are three methods to obtain it.

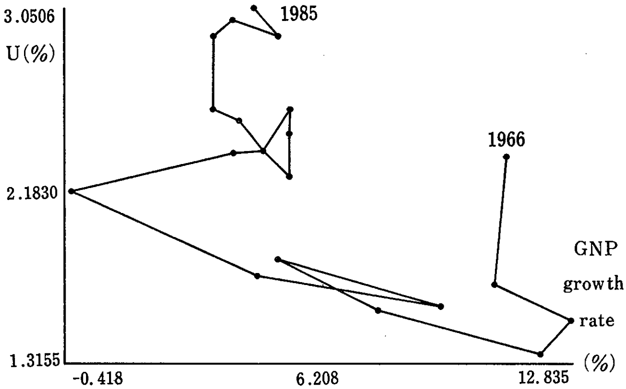

Figure. 3

(A) The easiest method is to relate the unemployment rate to the real GNP growth rate, in other words, to regress the second column (U) in table 1 on the value in parenthesis of the third column (GNP). Figure 3 illustrates the negative relation between the unemployment rate and the real GNP growth rate. Moreover, the goodness of fit of regression is not satisfactory much as follows:

$$U=2.784-0.096\ DOTG \qquad (1966\text{-}85),\ (7)$$
$$(13.75)(-3.33)$$
$$R^2=0.359, S=0.43, DW=0.454,$$

where, DOTG=the growth rate of real GNP, R^2=adjusted coefficient of determination, S=standard error, DW=Durbin-Watson statistics, t-value in parenthesis.

(B) The second method is to regress the GNP gaps (Y) on the uneployment rate (U), that is, to estimate the regression equation (1).

$$Y=-17.049+8.036U(=8.036(U-2.122)) \qquad (1966\text{-}85), (8)$$
$$(-6.49)\ (7.05)$$

$R^2=0.719, S=2.78, DW=0.525.$

The regression equation (8) shows that the Okun coefficient is 8 and a 2.12% unemployment rate corresponds to a full employment level without inflation in Japanese economy. The GNP gaps and unemployment rate gaps are illustrated in figure 4 and 5. In order to see how narrowly the gaps of unemployment rate fluctuates, figure 4 is made in terms of percent, i. e., in the same measure. Figure 5 represents the positive relationship between the gaps of GNP and that of unemplyment rate well except 1967. And we must pay attention to the difference of scale in figure 5.

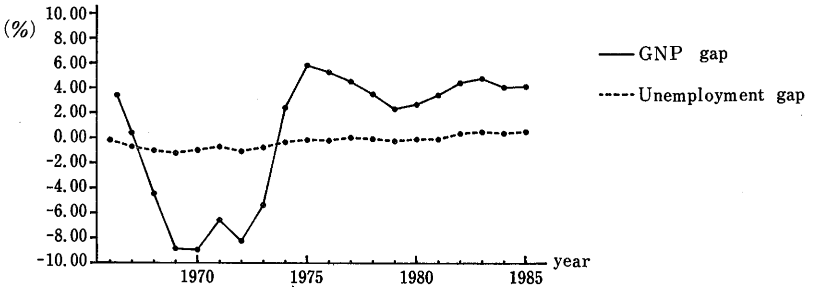

Figure. 4

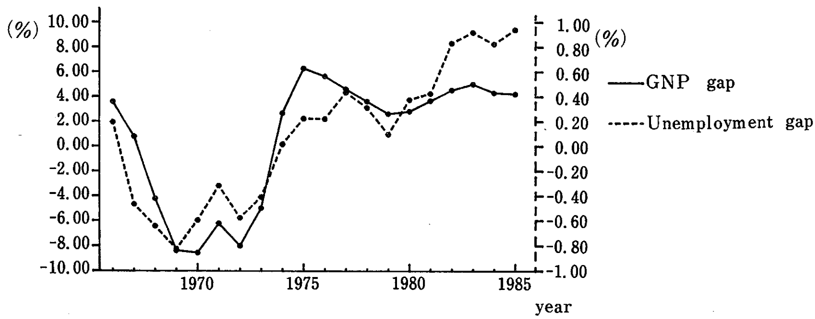

Figure. 5

(C) The last method, which is the second method taken by Kurosaka and Hamada in their thesis, is to estimate the following equation:

$$\log(100-U)=\gamma+\delta\log(GNP)+\varepsilon T, \quad (9)$$

where, $100-U=$ the rate of employment in terms of %. They approximately regard the reciprocal of elasticity of employment rate with respect to real GNP, namely, $\frac{1}{\delta}$ as the Okun coefficient, because they explain that 1% change in the unemployment rate is very nearly a relative 1% change in the employment rate. We differentiate both sides of the equation (9) in respect of GNP, and set differential coefficients in order, then gain the Okun coefficient below:

$$\frac{\partial GNP}{GNP}\Big/\frac{\partial(100-U)}{100-U}=\frac{1}{\delta}\equiv\text{the Okun coefficient.} \quad (10)$$

By the way, we indicate the result of estimating the regression (9) as follows:

$$\log(100-U)=\underset{(47.34)}{4.155}+\underset{(4.97)}{0.0375}\log(GNP)-\underset{(-7.03)}{0.0027}T \quad (1966\text{-}85), \quad (11)$$

$R^2=0.873, S=0.08, DW=1.213.$

So, we can calculate the Okun coefficient. It is $\frac{1}{0.0375}$, namely, 27.

The third, let us check how much the Okun coefficient is in Japanese economy once again. If we choose the regression (8), the Okun coefficient is 8. But, If we accept the equation (11), that is 27. It has been reported by Kurosaka and Hamada that the Okun coefficient (=28) of Japan is about nine times larger than that (=3) of U. S. They have accepted the regression equation (11). However, we should not approve how to construct the Okun coefficient with the reciprocal of parameter δ, because the regression equation has some residuals at least, and is not estimated with the minimization of the sum of squared residuals from vertical axis, but done with that from horizontal one. Consequently, when we want to obtain the value of the equation (10), we had better change log(GNP) on the right hand side in the equation (9) for the dependent variable. The above can be formulated below:

$$\log(GNP)=\zeta+\eta\log(100-U)+\theta T. \quad (12)$$

We differetiate both side of the equation (12) in respect to (100−U), then gain the equation (10). So, in this case, the Okun coefficient is the parameter η itself. Immediately, we compute the regression equation (12):

$$\log(GNP) = -60.925 + 15.805\log(100-U) + 0.0632T \quad (1966\text{-}85), \quad (13)$$
$$(-4.17) \quad (4.97) \quad (20.53)$$
$$R^2 = 0.982, S = 0.04, DW = 0.607.$$

To our surprise, the Okun coefficient is 16, which is about 41% smaller than that of the equation (11). Conversely, we calcurate the reciprocal of parameter concerning the regression equation (8). And then the Okun coefficient is 11[4]. Accordingly, the Okun coefficient in Japanese economy is from 8 to 16. Besides, if we think over Taira's report[5], the Okun coefficient will become less than half of the above, because the standard deviation of Japanese unemployment rate, which is adjusted with U. S. system, is more double than that of Japanese unemploment without such an adjustment[6]. After all, in Japanese economy the Okun coefficient may be more than 5 and less than 10.

The last, let us mention about the Frish-Waugh theorem. Haraf and Mairesse have made frank, outspoken and interesting comments on Hamada and Kurosaka's article. Mairesse has indicated a result of the Frish-Waugh theorem, after he said the fact that the 'two methods' used by Hamada and Kurosaka (in this paper, method (B) and (C)) yielded almost the same values should not come as a surprise or be considered as a sort of confirmation[7]. But, his suggestion is beside the mark. We should pay attention to the difference of explanatory variables. Particularly, we can not do logarithmic calculation of variable Y, because some values of Y are non-positive. See the fifth column in table 1.

3 Phillips Curve

To begin with, We estimate the regression equation (2) as follows:

$$W=16.782-5.423U+0.973P \quad (1967\text{-}85), \quad (14)$$
$$(6.033)(-5.131)\ (8.110)$$
$$R^2=0.879, S=2.441, DW=1.585.$$

In this paper, we assume that the relation between proportionate rate of change of nominal wages (W) and unemployment rate (U) is liner. And it is assumed an expectation to be full-prediction[8], that is to say, real proportionate rate of change of consumer price index would correspond with expected one, in other formulation, E(P)=P, where, the letter E is abbreviation of expectation.

As you know, Phillips curve is not derived from Economic theory, but from his experience. So we have to decide as to which the explanatory variable in Japanese economy is, W or U. We must determine the relation of cause and effect between W and U, i. e., W causes U or U causes W. It is said that W may cause U in Japan where the wage negotiation, which is called Shuntou, is held only a year[9]. Let us try Granger's test[10].

(α) W causes U:

The first step;

$$U=2.819+1.000U(-1)+0.0006U(-2) \quad (1967\text{-}85), \quad (15)$$
$$(0.22)\ (4.05)\ \ (0.02)$$
$$R^2=0.844, S=14.92, DW=1.411,$$

$Q_1=\Sigma\hat{u}^2=308560.6055$, $DF_1=2$, Where, DF=degree of freedom.

The second step;

$$U=-19.652+0.970U(-1)+0.158U(-2)+75.185W(-1)$$
$$(-0.70)\ (3.87)\ \ (0.50)\ \ (0.91) \quad (1967\text{-}85), \quad (16)$$

$R^2=0.842, S=15.00, DW=1.359.$

$Q_2=\sum\hat{u}^2=308745.3333$, $DF_2=3$,

$Q_3=\sum e^2=3377.0465$, $DF_3=19-1-DF_2=15$, Where, e=residuals.

The third step;

$Q_4=Q_2-Q_1=184.7278$, $DF_4=DF_2-DF_1=1$.

The last step;

H_θ: parameters of W=0, H_1: one of parameters of $W\neq0$ at least, $F_\theta=\frac{Q_4}{DF_4}\Big/\frac{Q_3}{DF_3}=0.821<4.54=F_{5\%}(1, 15)$, where, $F_{5\%}(1, 15)$=5 percent point for the distribution of F with DF (1, 15). It is shown that null hypothesis H_θ is not rejected.

(β) U causes W:

The first step;

$$W=0.031+0.700W(-1) \qquad (1967\text{-}85), (17)$$
$$(1.25)\ (3.78)$$

$R^2=0.425, S=0.05, DW=2.012,$

$Q_5=\sum\hat{w}^2=0.27624084$, $DF_5=1$.

The second step;

$$W=0.234+0.256W(-1)-0.001U(-1)-0.0001U(-2)$$
$$(2.83)\ (1.05)\qquad(-1.60)\qquad(-0.11) \qquad (1967\text{-}85), (18)$$

$R^2=0.602, S=0.04, DW=1.893,$

$Q_6=\sum\hat{w}^2=0.29502251$, $DF_6=3$,

$Q_7=\sum e^2=0.02926797$, $DF_7=19-1-DF_6=15$.

The third step;

$Q_8=Q_6-Q_5=0.01888167$, $DF_8=DF_6-DF_5=2$.

The last step;

H_θ=parameters of U=0, H_1: one of parameters of $U\neq0$ at least, $F_9=\frac{Q_8}{DF_8}\Big/\frac{Q_7}{DF_7}=4.84>3.68=F_{5\%}(2, 15)$. Owing to F_9, H_θ is rejected.

The above results deny a rumor that W may cause U[11]. Therefore, we may as well regard variable U as an explanatory variable like the equation (14)[12].

4 Mark-up Principle

There is a specification equation on price determination worked out by Lipsey and Parkin[13]. In addition to this equation, we think out a divice to solve the problem of price expectation. Then we compute the regression equation (3) as followings:

$$P=0.677+0.286P(-1)+0.339W-0.215S+0.287Q \quad (1967\text{-}85), \quad (19)$$

$$(1.06)\ (4.82)\qquad (5.84)\ (-1.92)\ (6.33)$$

$$R^2=0.967, S=0.92, DW=2.019,$$

$$R_1=\sum e^2=11.743440, DF_1=19-5=14.$$

$$P=1.444+0.255P(-1)+0.356(W-S)+0.268Q \quad (1967\text{-}85), \quad (20)$$

$$(3.79)\ (4.43)\qquad (6.06)\qquad (5.95)$$

$$R^2=0.965, S=0.95, DW=1.874,$$

$R_2=\sum e^2=13.548651$, $DF_2=1$ (the number of constraint).

We have estimated the unconstrained regression (19) and the constrained one (20). Its constraint condition, in terms of the regression equation (2), is h=i. In order to achieve mark-up principle, we have to check F -test as follows:

H_0: $f\neq0$, $g\neq0$, $h=i$, $j\neq0$, H_1: $f\neq0$, $g\neq0$, $h\neq i$, $j\neq0$.

Constraint condution: $(0\ \ 0\ \ 1\ -1\ \ 0)\ (f\ \ g\ \ h\ \ i\ \ j)^T=h-i=0$,

where mark 'T' means transposed vector.

$$F_0=\frac{DF_1}{DF_2}\left(\frac{R_2}{R_1}-1\right)=2.152<4.60=F_{5\%}(1,14).$$

Consequently, the hypothesis H_0 is accepted. We can use the regression equation (20).

By the way, we may make use of a specification equation about price determination originated by Monetarist such as the following equation:

$$P=0.867+0.410P(-1)+0.119(DOTM-DOTG)+0.470Q$$
$$(1.07)\ (4.47)\qquad (1.22)\qquad\qquad (8.99)\quad (1967\text{-}85),\ (21)$$
$$R^2=0.889, S=1.68, DW=1.512,$$

where, DOTM=the growth rate of M2CD, DOTG=that of real GNP. In this equation, F-test with constraint condition is not rejected either[14]. But, t-value of parameter with constraint condition is 1.22, then null hypothesis will be accepted. To be comprehensive with you, we had better choose the regression equation (20) based on mark-up principle.

5 Simulation

In this section, We practice the easiest simulation analysis of macro aggregate supply function by using Okun's law, Phillips curve and mark-up principle. Concerning Okun's law, we can not use the equation (8) directly, because we have to make allowance for endogenous variable in our model. We reform it as follows:

$$U=2.161+0.092Y\qquad\qquad (1967\text{-}85),\ (22)$$
$$(30.81)\ (6.93)$$
$$R^2=0.723, S=0.302, DW=0.384.$$

About Phillips curve and mark-up principle, we make use of the equation (14) and (20) respectively. Table 2 is the result of final test, where

Table 2 Measures of predicitive accuracy

equation	variable	R. M. S. E.	M.A.P.E.(%)	R.M.S.P.E.(%)
No. (22)	U	0.2859	10.6835	13.3021
No. (14)	W	4.1679	46.7089	69.6805
No. (20)	P	2.2694	40.9058	55.6434

note: Each equation is estimated with ordinary least square(OLS).(6): The term of estimation is from 1967 to 1985 at a request of time lag.

R. M. S. E. =root mean squared error, M. A. P. E. (%)=mean absolute percent error, R. M. S. P. E. (%)=root mean squared percent error[15].

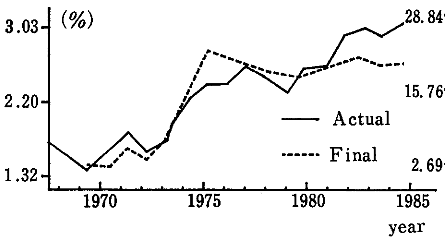

Figure. 6 (U)

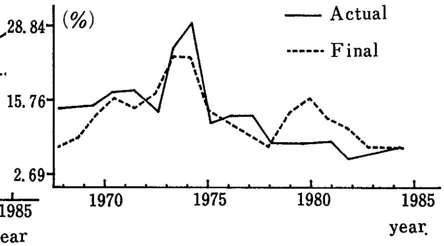

Figure. 7 (W)

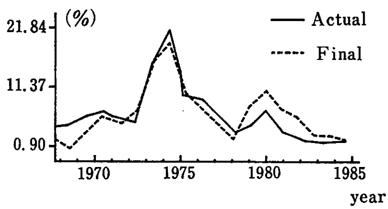

Figure. 8 (P)

In table 2, it seems not to have goodness of fit of final test. In stead of it three figures appeal to our eyesight distinctly. Each figure generally satisfies us. We should find the three endogenous variables have the same unit in terms of percent. We, therefore, may use the above R. M. S. E. in table 2 as a criterion of the performance of final test in this paper.

Besides, let us try to analyze cumulative multiplier effect. We try three cases. The first, one unit of GNP gap is decreased, namely -1%, which also means that hundred units of GNP is increased, i. e. 100 billion yen, due to the definition of equation (1) or (6). The second, in order to test a sullpy side shock, we substitute proportionate rate of change of WPI for import price such an oil price, so that one unit of Q is increased, that is, +1%. The last, we blend the first case with the second one. These three cases are respectively (a), (b) and (c) in table 3. The row of 1967 in table 3 indicates impact multiplier[17]. It is shown that the case (a) has more influence in W than in P, but the case (b) conversely has more influence in P than in W.

Table 3 Cumulative multiplier

year	(a), Y; −1 unit			(b), Q;+1 unit			(c), (a)+(b)		
	U	W	P	U	W	P	U	W	P
1967	−0.092L	0.769	0.274	0K	0.401	0.411	−0.092L	1.167	0.684
1968	−0.092	0.871	0.380	0	0.556	0.571	−0.092	1.427	0.951
1969	−0.092	0.911	0.422	0	0.615	0.633	−0.092	1.526	1.054
1970	−0.092	0.925	0.437	0	0.640	0.657	−0.092	1.563	1.094
1971	−0.092	0.923	0.441	0	0.640	0.663	−0.092	1.573	1.107
1972	−0.092	0.934	0.445	0	0.650	0.669	−0.092	1.585	1.115
1973	−0.092	0.918	0.441	0	0.639	0.666	−0.092	1.569	1.111
1974	−0.092	0.932	0.445	0	0.649	0.669	−0.092	1.583	1.115
1975	−0.092	0.936	0.447	0	0.653	0.671	−0.092	1.587	1.118
1976	−0.092	0.936	0.448	0	0.653	0.672	−0.092	1.591	1.120
1977	−0.092	0.936	0.448	0	0.653	0.672	−0.092	1.590	1.120
1978	−0.092	0.938	0.448	0	0.656	0.673	−0.092	1.587	1.119
1979	−0.092	0.941M	0.450M	0	0.658M	0.674M	−0.092	1.595M	1.121M
1980	−0.092	0.937	0.449	0	0.654	0.673	−0.092	1.590	1.121
1981	−0.092	0.937	0.448	0	0.655	0.673	−0.092	1.591	1.121
1982	−0.092	0.937	0.448	0	0.654	0.673	−0.092	1.591	1.121
1983	−0.092	0.936	0.448	0	0.654	0.672	−0.092	1.593	1.121
1984	−0.092	0.936	0.448	0	0.654	0.672	−0.092	1.590	1.120
1985	−0.092	0.934	0.447	0	0.652	0.672	−0.092	1.589	1.120

note : K ; The regression (22) only has the exogenous variable, i. e., Y, so that another exogenous variables do not influence variable U.
L ; Because of the above reason, the equation (22) has the same negative effect of its parameter, 0.092.
M ; These are maximum points of the cumulative multiplier effect.

Furthermore, we calculate the grade of aggregate supply function and the Okun coefficient in this final test model. Although we can compute the formmer by refering to the equation (4), we can easily get it from table 3. It is equivalent to the impact multiplier of P in the case (a), because the reduced form equation on P is the equation (4) itself. So, the formmer is 0.274. The latter is inverse estimate of 0.092, which is equal to the minus reciprocal of the impact multiplier of U. Then, the latter is 11.

6 Results and Problems After This

In this paper, we obtain the following main results:

A) According to the third paragraph of section 5, the Okun coefficient is 11. Moreover, consider the residuals in Econometric procedure as said in the third paragraph of section 2, and it will be 8[18]. Furthermore, if we think over Taira's article, it will become 5 or 4. Each value is less than half of what it was, and may be close to the Okun coefficient of U.S..

B) According to section 3, in Japanese economy the rate of unempolyment causes the proportionate rate of change of nominal wages by making use of Granger's test.

C) The price determination equation derived from mark-up principle has the more goodness of fit of the regression than that from formulation of Monetarism does, as mentioned in section 4.

D) According to the last paragraph of section 5, the grade of aggregate supply curve is inelastic, that is, 0.274[19]. Therefore, section 1 shows that Japanese economy is not good at a supply side shock and a demand management policy is very effective for the living of people in Japan.

By the way, we have a few problems after this as follows:

a) We should have maintenance of our simulation model in section 5, and improve it well in order to get the goodness of fit of the regression.

b) We must link a regression of wholesale price determination to our simulation model for the purpose of estimating how much a unit increse of import price affects the Japanese economy.

c) It is the most important for us to recognize how effective a demand management policy will be. Therefore, the aggregate demand curve have to be connected.

The above is going to be solve in the near future.

Footnotes

1) See reference [6], p. 12.

2) See reference [7], p. 79.

3) $\log(GNP)=11.428+0.0748T$　　(1965-75),

$(286.33)(12.72)$　$R^2=0.941, S=0.06, DW=0.426.$

$\log(GNP)=11.711+0.0419T$　　(1975-85),

$(684.46)(40.00)$　$R^2=0.994, S=0.01, DW=0.504.$

See reference [8], p. 56, footnote. We passed Chow's test of structural change of the growth rate of GNP.

4) $U=2.153+0.091Y$　　(1966-85),

$(31.92)\ (7.05)$　$R^2=0.719, S=0.30, DW=0.473.$

The Okun coefficient$=1/0.091=10.989$.

5) See reference [13], p. 9.

6) See reference [7], p. 56.

7) See reference [10], p. 99.

8) See reference [11], p. 96.

9) See reference [5], p. 103.

10) See reference [1].

11) Although we used reciprocal of U, i. e., 1/U, as a variable instead of U and tried Granger's test, we had the same conclusion that had derived from section 3 in this thesis.

12) See reference [11], p. 122.

13) See reference [9].

14) See reference [4].

15) See reference [3].

16) Insted of table 2, we compute with two step least square (TSLS).

variable	R. M. S. E.	M.A.P.E.(%)	R.M.S.P.E.(%)
U	0.2859	10.6835	13.3021
W	4.1366	44.7266	66.1646
P	2.2730	41.0905	54.1443

17) Only impact multiplier with TSLS is tabled.

year	(a), Y ; −1 unit			(b), Q ; +1 unit		
	U	W	P	U	W	P
1967	−0.092	0.827	0.318	0	0.319	0.374

18) $Y = -17.077 + 7.999U$ (1967-85),

$(-6.425)(6.933)$ $R^2 = 0.723, S = 2.81, DW = 0.499.$

The Okun coefficient=7.999.

19) According to footnote[17], the grade of aggregate supply curve with TSLS=0.318. It is still inelastic.

POSTSCRIPT

I estimated all regressions in my thesis with software of ECONOMATE brought out by Tohyohkeizaishinpohsha and that of PCEMS brought out by CBS shuppan. Please see reference [12]. And I thank Mr. Kousuke Ohya for helping the proofreading of this paper.

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