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Long-term stagnation and Japanese macro economy1

Version 1

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Long-term stagnation and Japanese macro economy[1] Version 1

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(Summary)

We study the Japanese economy since 2000 using the theory of long-term economic stagnation. We study the mechanism of falling into long-term economic stagnation, where the sudden credit crunch called Minsky Moment, or sharp decline in liquidity became a chance to begin. In our discussion, we set three households, such as young, middle and aged one. Each rational generation optimally consumes and saves. Even if "Minsky Moment" shock occurs it does not necessarily result in the long-term stagnation. We call this case as stabilization function. Moreover, it does not work under economic environments such as decline in birthrate, aging population and technology innovation with labor adjustment.

In fact, consumption of young Japanese people has gotten decreasing trend in the deterioration of the employment. Therefore, stabilization function had not fully worked. In addition, we assessed monetary policy, which is a pillar of "Abenomics" using this analysis.

Key word

Long-term stagnation, Minsky Moment, DSGE, Aging, Abenomics

1. Motivation

Study of long-term stagnation has advanced. Long-term stagnation theory, suddenly, began to take attention by Summers (2013). Whether the world faces to fall into long-term stagnation or not is theoretically approaching by Eggertsson and Krugman (2012), Eggertsson and Mehrota (2014). What is the long-term stagnation? Hansen (1939) argued that a long-term stagnation such as the Great Depression was accompanied by unemployment and serious economic depression and could not be artificially prevented. We define the long-term stagnation as follows (1) The economy fall into the economic recession, although we make every effort to avoid, (2) We cannot get out of recession for certain of the time.

Where is a cause of stagnation? Long-term stagnation theory has focused on the decline in consumer confidence of young people. While the income of young people sluggish, the income gap between each generation (young, middle-aged, old age) has been expanded. It causes a slowdown in potential economic growth power. Under the circumstances, the

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economy worsened by some shocks just as if it falls into the cliff. For example, De-leverage (decline of leverage) is referred to as a Minsky Moment [2] to bear the name of the Minsky who is a typical researcher in the field of the financial crisis. It is the first stage of long-term stagnation. The second stage proceeds in a worsening economy and lowering the interest rate, which is caused by excess supply of funds. Under the influence of the economic downturn. Lowering of interest rates has an impact on the economy through two routes, although these effects are just the opposite.

In the first route, saving incentive is discouraged by lower interest rates and expands the consumption. This has the effect pushing up interest rates again. In particular, on behalf of the young people who are forced to decrease the loan demand by de-leveraging, middle-aged people expand the consumption and reduce the savings. Therefore, eventually, the interest rate gradually starts to rise, while the supply of money is reduced. Thus, sudden shock such as Minsky Moment must be absorbed.

However, economists who advocate the stagnation theory, have questions about this story. Under recession, the funding requirements of young people will decrease. At that time, will the middle-aged and elderly households expand consumption sufficiently enough to cover an amount of consumption reduction by young ones?

Another route is the zero lower bound of interest rates. The lowest of nominal interest rates is zero (=0). Under the declining of prices, real interest rate rises. Once you have rising real interest rates under such a zero lower bound, middle-aged and elderly households will not necessarily strengthen the tendency of consumption from savings.

In fact, one of the causes of de-leverage shock lies in the heavy loan burden of the household sector（Atif Mian and Samir Sufi (2014)）In the West, the collapse of Lehman Brothers just before the 2008. The debt ratio of households has expanded. The real debt burden has increased by decreasing in prices due to the financial shock. We believe, it greatly diminished the borrowing willingness of households.

A phenomenon similar to de-leverage shock is also generated by a sharp decrease in the young population. A rapid decrease of the young population has the same effect as a decrease in the total amount of consumption of the young. In other words, just as the de-leverage shock to young people has occurred, the younger generation has a tendency to reduce consumption.

Let's consider the case of Japan. In aging, consumption level of young households (below householder 35 years) tends to decrease. Discussed later in detail, but at the same

[2] Minsky Moment is derived from the name of the United States of economist Minsky (1919-1996). This word was first used in a newspaper article of WSJ just before the collapse of Lehman Brothers. It is not fact that Minsky used this word.

time, disparities between generations are occurring. The economic environment for young people, is an important issue of this paper. We consider the effect of the reduction of young households by these declining birthrate and aging.

2．Model setting

（1）Household

The household sector shall consist of three generations of the young (YOUNG), the middle (MIDDLE) and the old generation (OLD). Here, i of below equations, defines i = {i | Young, Middle, Old}. The household is assumed utility maximization. Originally, the household sector, while it obtains a positive effect of the consumption, feels disutility by providing labor. It is assumed, as a feature of the present model, the household sector shall not decide the amount of labor supply. In particular, it is assumed that under the recession where bargaining power of workers is extremely low, the household sector will only accept employment (L) by the company. Later we assume that "real wages" are adjusted in the labor supply and demand balance.

$$\max_{C_t^i, C_{t+1}^i(i), C_{t+2}^i} E_t \left\{ \begin{array}{l} \log(C_t^i)) + \beta \log(C_{t+1}^i) + \beta^2 \log(C_{t+2}^i) \\ + \beta \log(H_{t+1}^i) + \beta^2 \log(H_{t+2}^i) \end{array} \right\}$$

s.t.

$$C_t^y = w_t L_t^y - T_t^y + B_t^y$$

$$C_{t+1}^m = w_{t+1} L_{t+1}^m - T_{t+1}^m - \frac{1+i_{t+1}^2}{\pi_{t+1}} B_{t+1}^m$$

$$C_{t+2}^o = w_{t+2} L_{t+2}^o - T_{t+2}^o - \frac{1+i_{t+1}^2}{\pi_{t+2}} B_{t+2}^o$$

$$B_t^y \le E_t (1 + r_{t+1}) D_t$$

（Epstein Zin　Version）

$$u\left(c_{i,t}, L_{i,t}\right) = \frac{c_{i,t}^{1-\gamma}}{1-\gamma} + \frac{H_{i,t}^{1-\eta}}{1-\eta} - \chi_0 \frac{L_{i,t}^{1+\chi}}{1+\chi} \quad (1)$$

$$\max_{\{C_t^i, H_t^i(i), L_t^i\}} E_t \sum_{t=0}^{\infty} \beta^t U\left(c_t^i, H_{t+1}^i, L_t^i\right) (2)$$

The maximization in equation (1) can be expressed in first order recursive forms.

Some part of young households at time t, in the next period, sift to middle-aged households. At the same time, some part of middle-aged one at time t will move to old age one. In their life stages, each household takes the economic rational behavior.

We calculate optimal consumption at each life stage and define C as consumption. For example, the lower and upper subscriptions (t, y) indicate time and a young. Each household pays taxes, while they obtain the factor income (=WL). However, income transfer to the young family in our model of DSGE is set to be zero.

When it comes to the next period, middle-aged households buy the house (H) where housing price defines as qh. It is one feature of our paper that the acquisition of housing has been added to the EM model. Middle households pay back to banks the amount of the loan when young. On the other hand, they borrow a new loan to get a new house and to consume. Therefore, a net position of the loan by the middle-aged households is the acquiring funds from the bank (= $B^m_{t+1} - \frac{1+i^1_t}{\pi_{t+1}} B^m_t$). Loan to young should be equal to the borrowing limit D. The interest rate is assumed to be i^1_t if you have borrowed a loan until the loan limit. In contrast, the normal interest rate to be raised in a financial market is equal to be interest rate (= i^2_t). In addition, old age households, no longer try to buy a house. With the exception of the payment of the tax and the repayment of the loan, the household sector is assumed to consume all of the income. The relationship between market interest rates and applicable lending limit interest rates, will be described later. We set borrowing limit (=D) as financial constraints in the young. Normally, it should be set in each generation so that it is not possible to raise funds beyond the credit limit. However, since EM is focusing on the sudden de-leverage in young household, this constraint is set to be applied only to young households. It is the reason that we want to consider how serious impact on the economy, if credit constraints on the young generation binds. We set below setting to avoid the complication of discussion. In the EM model, the amount of borrowing limit (D) is calculated based on the expected value of collateral for loans to young people.

For example, currently the period t, the expected collateral value of loan after j year must be calculated such as $E_{t+j}(1+i^1_{t+j+1})D_{t+j}$. We assume the borrowing limit is derived from the bank capital requirement. Now, we want to focus on the current time t. We can find three generations at the current time.

Under the financial constraints, we consider the optimal consumption levels of young household using the Kuhn-Tukker conditions. For example, consumption of young

households in period t is shown in the form of C_t^y . When young households face in with financial constraints, consider their optimal consumption using Kuhn-Tukker conditions.

(EQ1) Consumption of young household ;

$$\frac{1}{C_t^y} - E_t \frac{\beta(1+i_{t+1})}{\pi_{t+1}} \frac{1}{C_{t+1}^m} = \phi_{2,t}$$

In addition, we calculate the consumption of young household under financial constraints.

(EQ2) Young consumption;

$$C_t^y = E_t \pi_t \frac{D_t}{(1+i_t^1)}$$

Subsequently, a middle-aged households decide the consumption level based on the expected consumption (=C^o) when they become old age. In that case, we find the following relationship between middle aged consumption and old aged one.

(EQ3) (Euler equation of optimal consumption);

$$\frac{1}{C_t^m} = \beta E_t \frac{(1+i_{t+1}^2)}{\pi_{t+1} C_{t+1}^o}$$

The sum of each number of each generation (L^y, L^m, L^o) is equal to the total number of generations.

(EQ4) Definition of generations;

$$L_t^{\,y} + L_t^m + L_t^o = L_t$$

Furthermore, it is assumed that the number of each generation has the following relationship.

$$L_t^{\,y} = (1 - \frac{1}{T_{y\sim m}}) L_{t-1}^{\,y} + N_t - N_{t-1}$$

(EQ 5) $$L_t^m = (1 - \frac{1}{T_{m\sim o}}) L_{t-1}^m + \frac{1}{T_{y\sim m}} L_{t-1}^{\,y}$$

$$L_t^o = (1 - \mathrm{R}_{exit}) L_{t-1}^o + \frac{1}{T_{m\sim o}} L_{t-1}^m$$

N is the total population. The difference of the population (N_t-N_{t-1}) is the number to enter the labor market. We assume workers follow a process; the young ⇒ the middle aged ⇒ the old-aged⇒retiring from the labor market (the exit rate (=Rexit)). In each period, some percent of young workers (= 1-1 / Ty ~ 1/Tm), move to the middle aged workers from young. Replacement of the same kind of generation occurs from middle-aged workers to old ones.

g is the growth rate of the population (N) (annual rate). Total consumption (C) is the sum of the consumption of each generation.

(EQ 6) Definition of total consumption; $C_t = C_t^y + C_t^m + C_t^0$

We derive demand of housing (H) /

(EQ7) Housing demand ; $\frac{1}{H_{t+1}} = \beta E_t \frac{(1+i_{t+1}^2)}{2C_{t+1}^o \pi_{t+1}} qh_{t+1}$

Using these equations, we derive consumption of the middle aged and old aged households, respectively. Tax is introduced to take into account for the government sector. Tm and To indicate the income transfer to middle aged household and old aged household from government.

(EQ8) Middle aged household's consumption;

$$C_t^m = Y_t^m - q_t H_t - D_{t-1} + B_t^m - T_t^m$$

(EQ9) Old aged household's consumption ;

$$C_t^O = Y_t^O + \frac{(1+i_{t-1}^2)}{\pi_t} B_{t-1}^m - T_t^O$$

2.1 Firms

Let's start to set the production fiction such as EQ 10. We define Capital as K and labor as L. A indicates the level of technology.

(EQ10) Production function ; $Y_t = A_t K_t^{1-\alpha} L_t^{\alpha}$

Differentiating with L, real wage (W / P) is set to be equal to the productivity of labor.

(EQ 11) Wage and labor productivity ; $\frac{W_t^{flex}}{P_t} = \alpha \frac{Y_t}{L_t}$

Since wages are rigid in practice, current wage is affected by the past wages. Considering the wage stickiness, it is set in Equation 12 where it is 0 <γ <1.

(EQ12) Rigidity of wages;

$$W_t = \gamma W_{t-1} + (1-\gamma) P_t w_t^{flex}$$

(EQ 13) Marginal productivity of capital and real interest rate;

$$r_t^K = (1-\alpha) \frac{Y_t}{K_t}$$

Equation 13 describes the marginal return of capital (=$(1-\alpha)\frac{Y_t}{K_t}$) is equal to be the real interest rate (=r^k). Equation (14) means the financing cost from banks is equal to the marginal return of capital adjusted by the inflation.

(EQ 14) Nominal interest rate and productivity of companies;

$$1+i_t^f=\left(1+r_t^K\right)\frac{P_{t+1}}{P_t}$$

Furthermore, in the paper, when the benefit (Prf) generated by business activities is above the level of investment, it is assumed to be stored as internal reserves in the enterprise. On the other hand, for large-scale investment in excess of the profit of a single year, it is assumed that firms borrow from private banks because it is not possible to cover the self-funded.

$$\Pr f_t - I_t = P_t Y_t - W_t L_t - r_t^K K_t$$

We set the accumulation of capital (K) as usual,

(EQ 15) Investment (I) and capital accumulation (K);

$$K_{t+1}=I_t+(1-\delta)K_t$$

Investment (I) is determined based on the degree of easiness of loan acquisition from the bank (=Lf) and investment in previous time (= I_{t-1}). In addition, investment is also affected by the expected future investment premium (=r^k-r). The greater, the difference between the expected return (r_t^k) and the expected real interest cost from financial markets (= r_t), the more, investment was stimulated. In addition, the greater the funds (Lf) that firms can procure from financial institutions, investment will be further intensified.

(EQ 16) Investment;

$$I_t=\mu_1 Lf_t+\mu_2 I_{t-1}+\mu_3 E_t\left(r_{t+1}^k-r_{t+1}\right)$$

$\mu_1>0$, $\mu_2>0$, $\mu_3>0$

2.3 Banking

Supposed de-leverage has suddenly occurred. How will spread to each generation or

each household through the banking sector? It is desired to observe the transmission mechanism by incorporating the banking model.

We will introduce a simple banking sector. The asset side of banking sector consists of loans to the households (D + B), and loan to enterprises (Lf), the government bonds (TB) while the liability side is constructed from deposit (DP) and paid in the capital (E).

Fugue1

Bank Balance sheet

Loan	B＋ D+LF	Deposit	DP
Bond	TB		
Reserve	zero	Capital	E

(Simplified bank balance sheet)

Bank profit (Profit bank) was set as follows. The interest rate in the case of young household is indicated such as i_t^1 where an amount of borrowing is limited to the borrowing limit (D). The middle-aged households get loan (B) and pay the interest rate (i_t^2). We introduce the lending rate to the company (i_t^f) and the government bond price (q_b). Banking sector paid the deposit interest rate (id) for the deposit (DP). In addition, Banks need to pay the administrative cost to manage the banking business (at cost), which was assumed to be quadratic function of D, B and Lf.

$$\Pr ofitbank_t = i_t^1 D_t + i_t^2 B_t + i_t^f Lf_t + q_{bt} TB_t - i_{dt} DP_t - ad\cos t_t$$

We introduce a capital adequacy ratio (R_b), which bank sectors are assumed to be obliged to hold a certain percentage of loan or more.

(EQ 17) Capital adequacy requirements;

$$R_{bt} \le \frac{E_{bt}}{D_t + B_t + Lf_t}$$

We calculate the Kuhn-Tukker conditions in the case of capital controls to constrain the

bank behavior. We derive optimal conditions in the case of capital constraint (17)). It should be noticed that in this paper, we have modeled the case of regulatory capital.
Bank Balance sheet;

$$D_t + B_t + Lf_t + q_{b,t}TB_t = DP_t + E_t$$

Using the balance sheet, we differentiate the profit function with bank lending company (Lf) and own funds (E) and lending upper limit to the young (D).

$$i_t^1 - i_t^2 - \eta_t R_B - \frac{\partial ad\cos t_t}{D_t} = 0$$

$$-i_t^2 + i_t^f - \frac{\partial ad\cos t_t}{Lf_t} - \eta_t R_B = 0$$

$$i_t^2 + \eta_t = 0$$

For the sake of simplicity, we will ignore the correlations among each loan [3]. We only focus on the case that capital regulation has been a constraint. Capital adequacy requirement of bank sector EQ 17 is redefined such as EQ 17'.
(EQ17) 'Capital adequacy ratio;

$$R_B\left(D_t + Lf + B_t\right) = E_{bt}$$

Using this, loan interest rates for young household and companies, is the market interest rates (i_t^2) plus an adjustment cost worth.

(EQ 18) Loan interest rates for young household;

$$i_t^1 = i_t^2 + a_2 D_t$$

(EQ19) Loan interest rates for companies;

$$i_t^f = i_t^2 + a_2 Lf_t$$

2.4 Clearing Conditions

We consider the Clearing Conditions. First, bank deposits are constituted of savings by the household sector (DPh) and retained earnings by companies (DPf).

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[3] $\frac{\partial ad\cos t_t}{D_t} = a_1 D_t \quad \frac{\partial a\,dc\,o\,s_t t}{Lf_t} = a_2\, L\, f$

(EQ 20) Definition equation Deposits;

$$DP_t = DPf_t + DPh_t$$

Retained earnings of the private firms (DPf) are obtained by subtracting wage and interest payment from the output (=sale), where these earnings will be deposited to their banking account.

(EQ 21) Corporate sector deposits;

$$DPf_t = P_t Y_t - W_t L_t - i_t^f K_t$$

In the same way, the bank deposits of the household sector (DPh) should be the amount by subtracting consumption, housing purchase, the net payment of loans and tax of factor income (WL). In addition, Bank of balance sheet (EQ 23), supply of production and demand of production (EQ 24), is respectively introduced as follows.

(EQ22) Household and deposit;

$$DPh_t = W_t L_t - P_t C_t - qh_t H_t + D_t - (1+i_t)D_{t-1} + B_t^m - L_{mt-1}(1+i_t)B_{t-1}^m - T_t^m - T_t^0$$

(EQ23) Bank of balance sheet;

$$D_t + B_t + Lf_t + q_{b,t}TB_t = DP_t + E_t$$

(EQ 24) GDP;

$$Y_t = P_t C_t + I_t + G_t + qh_t H_t$$

2.5 Monetary policy

For monetary policy, this will introduce a case that “zero interest rates” becomes a constraint on the model. It is not possible to lower the nominal interest rate zero. It is referred to “zero constraints”. We will analyze what effect the economy under this constraint. It will be analyzed using the tool kit developed by Lecovielo (2014) et al. In addition, we introduce the interest target (i *) controlled by the central bank and the inflation target (π *) as exogenous variables. We analyze two calibrations respectively (“zero constraints” and “no- constraints”), where “zero constrains” is prevented from lowering interest by central banks. In the usual economy, it is possible for a central bank to adjust market interest (i_t^2) by controlling policy target interest (i*) to some extent.

Zero constraints;

$$i_t^2 = 0$$

No-zero constraints;

(EQ 25) Monetary policy;

$$i_t^2 = i^* + \varphi\left(\pi_t - \pi^*\right)$$

Central bank sets the inflation target π *. In the case of which Actual inflation is lower than the target interest rate, the central bank tries to lower interest rates. Furthermore, central bank tries to change market interest rate by adjusting rate i*. Each policy target has autoregressive process of order 1 in order to reflect the history of these financial policies, given policy innovation (σ_i, σ_π). For example, deviations of the interest (inflation) target are triggered by innovations of σ_i, (σ_π) [4]

(EQ 26) Interest rate target;

$$i_t^* = \beta_{i^*} i_{t-1}^* + \sigma_{i^*,t}$$

(EQ 27) Inflation target;

$$\pi_t^* = \beta_{\pi^*} \pi_{t-1}^* + \sigma_{\pi^*,t}$$

What will changing target interest rate affect the financing of firms and households? In case of investment, the difference between the procurement interest rate and real return rate of investment should be equal to the investment premium. Firms decide investment in order to acquire the investment premium. If premium attrition was reduced by some shocks, investment willingness would be diminished. We assume market interest rate, which is equal to procure cost can be controlled, to some extent, by a central bank. It is, however, difficult to adjust the real return of investment by financial tools. In our thesis, central bank sets manipulating short-term interest rate target to restore the original level of investment premium again. On the other hand, household sectors are assumed that changes in market interest rate affect the payment cost of interest. For example, if a central bank increases the interest rate, the market interest rate will rise and the demand of loan will decrease.

[4] We estimate β_{i^*} and β_{π^*} using Bayes estimation. In the table 4, these parameters are β ῖcb and β icb.

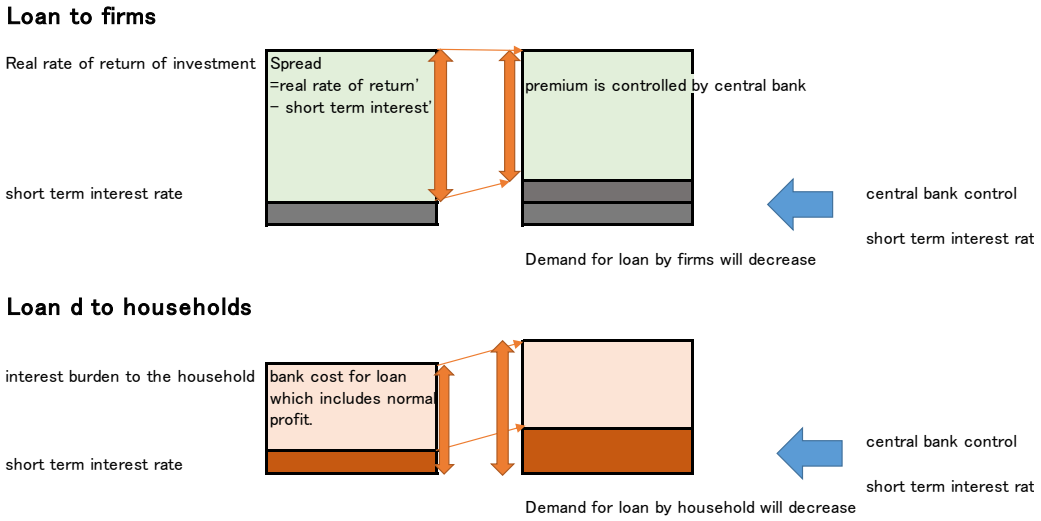


Figure 2

2.6 Government

We introduce government sector. The government uses money, such as government expenditure (G) and tax for middle aged and old generation households. Young household taxation is assumed to be zero (Ty=0), because net income deducting the amount of borrowing is negative. Model sets that the difference between government spending and revenue is issued as government bonds. Here, the bond issuing (TB_t - TB_{t-1}) at this period is the difference between the previous fiscal year balances and the current balance. In addition, for the outstanding of the previous fiscal year, it is assumed to pay the interest payments (i^2× TB) where TB interest rate should be equal to be the market rate(i^2) . Taxation is set as a progressive tax system and its tax rates are fixed respectively (0 <βm, βo <1).

(EQ 28) Government Bond;

$$q_t TB_t - \frac{(1+i)}{\pi_t} TB_{t-1} = G_t - \left(T_t^m + T_t^O\right)$$

(EQ 29) Tax;

$$T_t^m = \beta_m W_t L_t^m$$

$$T_t^O = \beta_O W_t L_t^o$$

2.7 Other autonomous mechanisms

The above description is a summary of the model to estimate DSGE (Dynamic General Equilibrium Model). We introduce some other exogenous variables. Among main variables, population growth rate and technology progress are assumed in accordance with AR (1) process.

(EQ 30) Technology;

$$L n(A_t) = \beta_A \, L n(A_{t-1}) + \varepsilon_{At}$$

We define the population of labor force (N_t) at time t and its growth rate (g). In addition, government expenditure obeys AR process.

(EQ 31) Population growth and labor force;

$$1 + g_t = \frac{N_t}{N_{t-1}}$$

(EQ 32) Government expenditure;

$$Ln(G_t) = \beta_G Ln(G_{t-1}) + \sigma_G$$

2.8 Handling money in our model

Intuitively, the current long-term stagnation models have not been incorporated into money. A typical way to handle money in DSGE is to incorporate money in the utility function. We have been going with the aim of analyzing the effect of the large supply of base money by the Bank of Japan. We set the balance sheets of the central bank and private banks. Then, we assume base money was supplied by a central bank to buy government bonds from private banks. The government will issue new bonds（TB） to fill the shortage of revenue, if government spending exceeds tax revenue. Eventually, the amount of additional underwriting by the central bank （△TB) is equal to the amount of additional new money (△BaseM)[5].

$$\Delta \Delta BaseM_t = \Delta TB_t$$

$$Ln(BaseM_t) = \beta base \bullet Ln(BaseM_{t-1}) + \varepsilon_{baset}$$

3. Estimation Model and Implication

3.1 Result of Estimation

Upon analysis using dynamic general equilibrium model, these equations in the previous section are linearized. We use 51 quarterly data (2002-2014) which is transformed into logarithmic form and deviated from the average except interest rate. Actual parameter estimates are estimated using Bayesian statistics. See Estimation results (Table 2).

Let's compare the actual data with the estimated one. Figure3 shows GDP, young household consumption, new housing, prices, new house construction, and real estate prices. The upper data (GDP, consumption of young, new housing construction) can be seen that

[5] Base money consists of reserve account and banknote. However, for the sake of simplicity in this paper, we ignore the reserve account.

（**Data**）

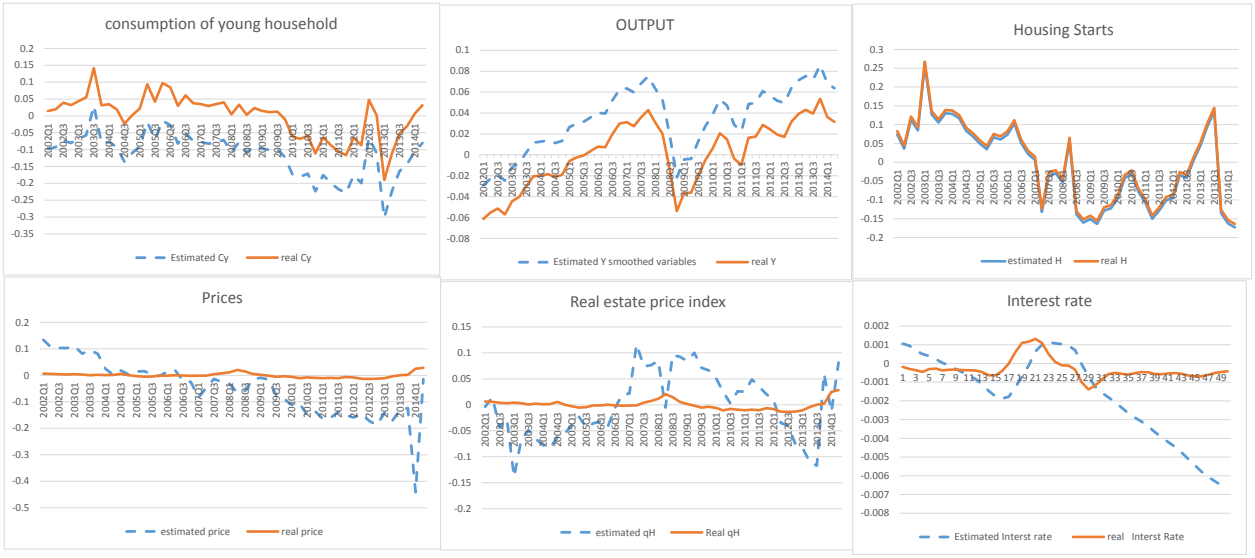
Table 1　Data for using estimation

Data	Source
Real Estate Index(TSE)	Tokyo Stock Exchage
Household Consumption	Household Means Test and Author Estimated
New housing	Ministry of land ,Infrastructure, Transport and Tourism
Real GDP	Bank of Japan
Call Rate	Bank of Japan
Labor	Outline of the labour force Survey
Base Money	Bank of Japan
Wage	Statistics Bureau, ministry of Internal Affairs and Communications
Vital Statistics	Ministry of Health, Labour and Wealth
Bank Capital	Bank of Japan

Table 2 Estimated Parameters

Figure３ Result of Estimation

	Prior Mean	Post Mean	90% HPD	Interval	Prior	pstdev
μ 1	1	0.9828	0.831	1.1412	gamma	0.1
μ 2	0.8	0.8115	0.6429	0.9942	gamma	0.1
μ 3	0.8	0.7673	0.6285	0.9291	gamma	0.1
a1	2	2.5035	2.1858	2.841	gamma	0.2
a2	1	1.0377	0.6845	1.3812	gamma	0.2
γ	0.8	0.4154	0.3842	0.446	gamma	0.1
α	0.6	0.6055	0.5276	0.6847	gamma	0.05
β A(parameter technology innovation AR	0.5	0.9609	0.9297	0.9938	gamma	0.5
β qH(Real estate index AR(1) Parameters	0.9	0.7979	0.6709	0.9128	gamma	0.1
β W(Wage AR(1) Parameters)	0.8	0.9979	0.9952	1	gamma	0.1
β M(Base money AR(1) Parameter)	0.9	0.8538	0.7485	0.9999	gamma	0.1
β iicb(Policy Interest AR(1) parameter)	0.9	0.871	0.7633	0.9936	gamma	0.1
β icb(Prices target AR(1) Parameter)	0.9	0.8619	0.7531	0.9934	gamma	0.1
e_W(Wage shock)	0	0.0368	0.0306	0.0431	invg	Inf
e_q(bond price shock)	0.014	0.0262	0.0217	0.0309	invg	Inf
e_g(Population shock)	0.1	0.0157	0.0134	0.0182	invg	Inf
e_A(Technology shock)	0.032	0.0122	0.0102	0.0144	invg	Inf
e_pai(Prices shock)	0.065	0.0111	0.009	0.0129	invg	Inf
e_M(Base money shock)	0.1	0.0139	0.0118	0.0159	invg	Inf
e_pai2(Prices Target changing shocks)	0.1	0.0153	0.0125	0.018	invg	Inf
e_ii2(Policy interest rate changing shock)	0.1	0.0237	0.0181	0.0294	invg	Inf
e_qh(Real Estate price Index shock)	0.1	0.0761	0.0624	0.0892	invg	Inf



They capture the reality data. On the other hand, prices, real estate prices, interest rates are not adequate to explain the movement of the actual data. In our estimation, while indicating that there is room for improvement, we indicate a model that can explain to some extent the actual situation of the Japanese economy.

3.2 Demographic Impact

We consider the results of the estimated model. We observe the impulse for each shock. In particular, we are interested in how the population increasing-shock has the influence of the Japanese economy. **Figure4-1-2** shows the impulses by population-shock (=e-g). In our model, middle and old household have an effect of expanding consumption (Cm and, Co). In addition, middle and aged households actively borrow funds from financial institutions (rise of H). Middle and old are trying to hold a new housing. On the other hand, young households will be forced to suppress consumption because they cannot borrow enough from the banks (decreasing of D). Under these circumstances, consumption by the middle-aged and elderly household stimulate production. We find that the impact of population on the economy is reversed for the young households and for the middle and elderly ones. In other words, population shock has the inverse effects of the savings and consumption to the young and to the others. The economy has features such that population impact on the overall economy is offset and absorbed.

Figure5 shows the historical decomposition of the Japanese real GDP. Since the collapse of Lehman Brothers, demographic change shock has been a negative impact on the economy. However, it shows that technology shock has a greater effect on the real GDP. In the same way, Observing historical decomposition of the new construction housing (**Figure6**), wage has a negative impact consistently to new housing supply. In other words, supply and demand balance of the housing market, is dependent on the labor market such as wage. In addition, we find Abenomics has some contributed to the recovery of housing

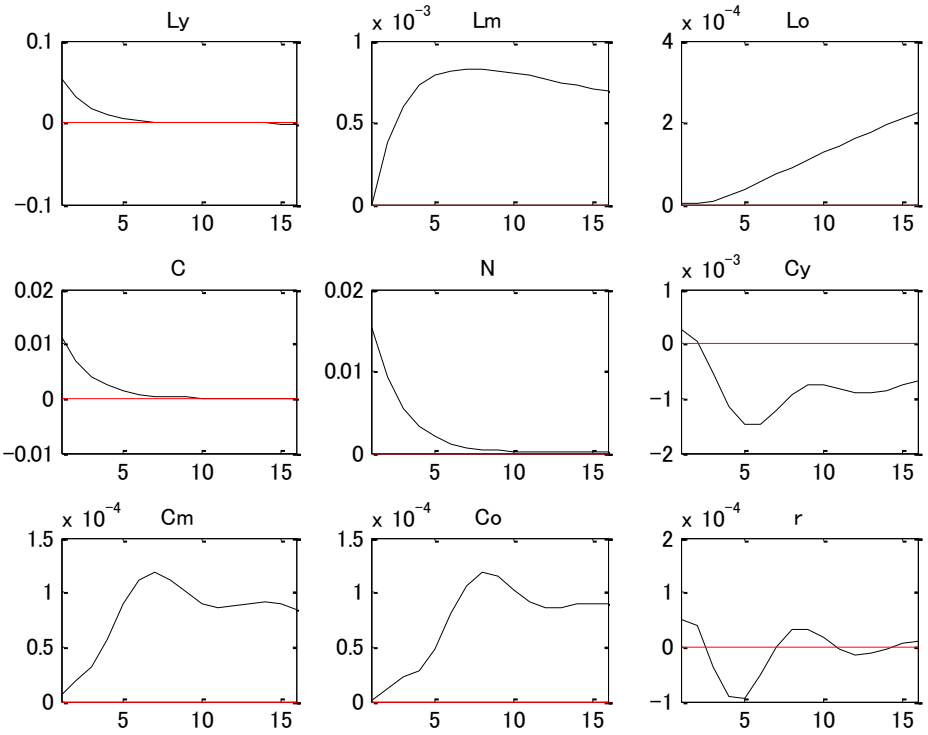
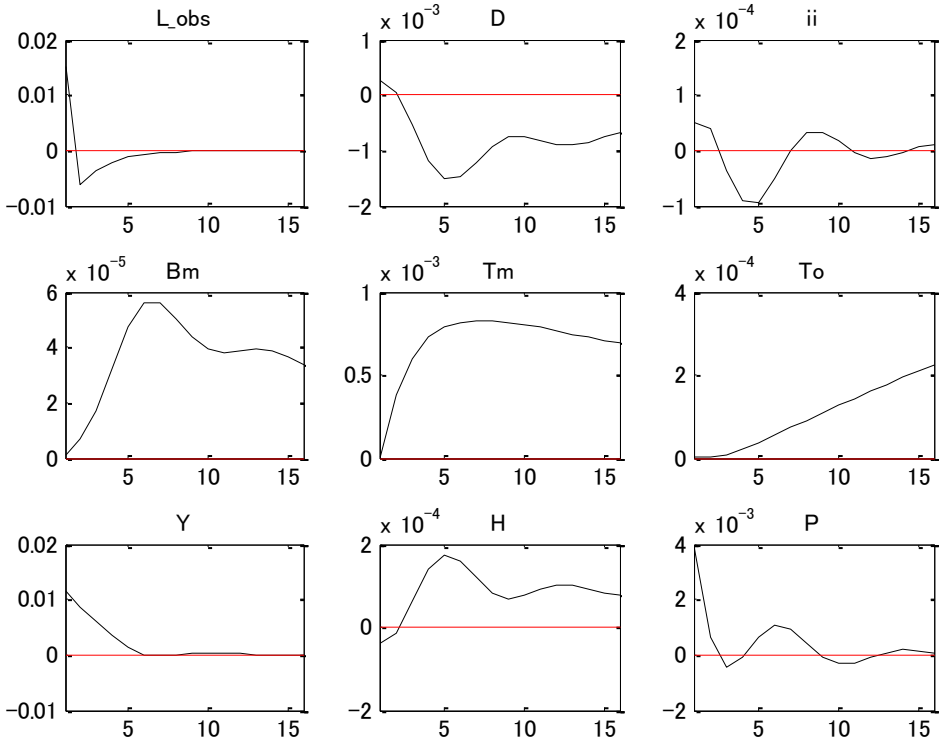


Figure 4－１～２　Impact by population



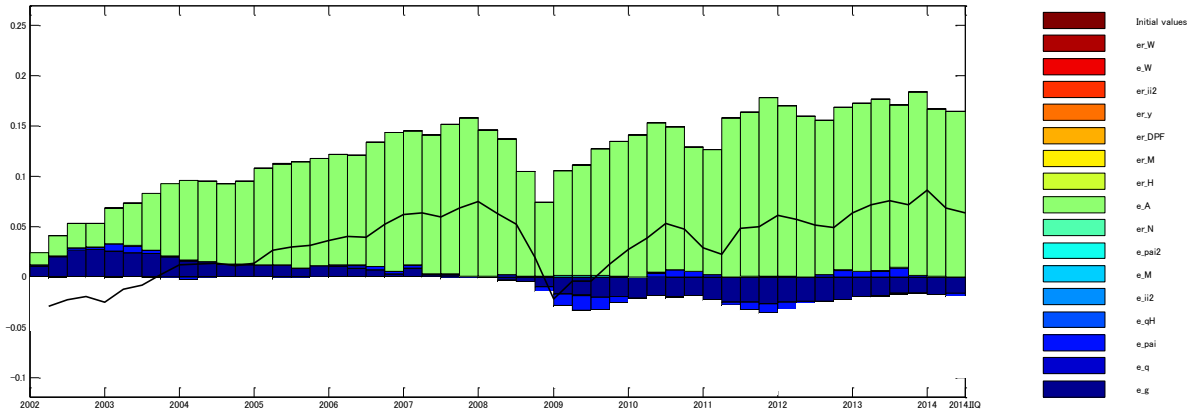


Figure 5　Historical decomposition（GDP）

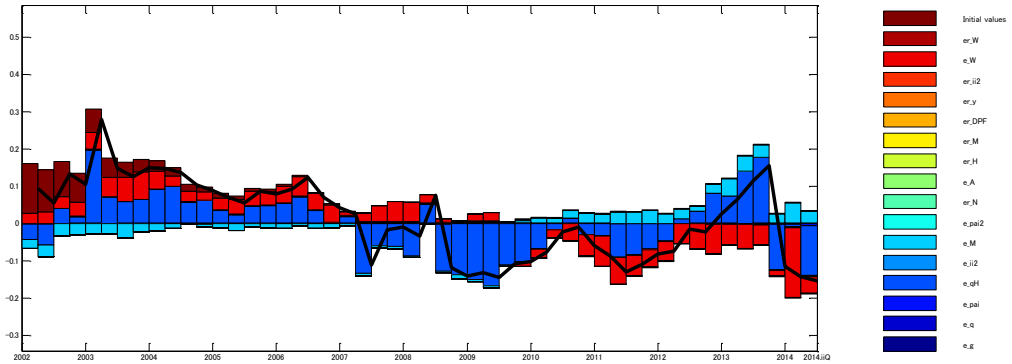


Figure 6 Historical decomposition (New housing)

3.3 Deleveraging effects and Minsky Moment

The Long-term stagnation theory is focusing on the sudden de-leveraging called “Minsky Moment “. In particular, young people in the United States has faced under recession to a substantial increase in the burden of debt.

We wonder such a sudden de-leveraging can explain Japanese economy? Our model challenges to reproduce the economic mechanism how to fall into the stagnation. Specifically, Guerieri and Lacoviello (2014) developed a toolkit to examine the effect of phenomenon under some constraints. Using this toolkit, we reproduce the artificial phenomenon such as Minsky moment. Specifically, we try to calibrate and compare the following two cases. One is the case of zero constraint which the central bank cannot be

lowered below zero. Another is a case that it can be freely determined. Our aim is to compare the two cases and to find how “zero constraints” affects to Japanese economy using Figure7 [6] . Basic Japanese model is revised such that the productivity of the firms (=lowering of rK) is rapidly worsening at time 10th.We confirm that the sudden reduction of credit to the firms is serious whether the economy faces to the zero bound or not. Under the non-constraint, household consumption isn’t affected because the impact of productivity shocks will be absorbed by the monetary policy.

How does the productivity shock translate into the households under the “zero constraint”? We find that young and middle age households take asymmetrical consumption behavior, where the nominal interest rate is fixed at zero. The middle age households have a trend to decrease the consumption partly because wages are reduced with the productivity worse. The new housing demand will also decrease because middle age households are concerned with their future income in old age. In other words, our model implies that the demand of new housing at middle age, to some extent, depends on the labor income in old age. If middle age households expect that economy is weak not enough to recover the factor income, housing demand will be reduced. As a result, borrowing demand is gradually reduced. Furthermore, real interest rate remains relatively high because prices decrease under the zero nominal interest. They will increase the savings and decline the consumption.

On the other hand, young household has a chance to increases the new loans so as to compensate the decline of borrowing by middle-aged households. In our model, the amount of young household borrowing (D) is limited by banks, where banks make some effort to expand loan to young as an alternative loan to offset the loan reduction of middle aged. As a result, the financial constraints to the young people will be relaxed and young household consumption will be activated. Increased consumption of young household will be offset the recession impact caused by the consumption decline of middle-aged. Model simulation predicted that de-leverage shock is immunized by these asymmetric effects. Our paper call this influence as “economic stabilization” which means the economy can be stabilized so as to avoid falling into serious crisis. We find that degree of impact to output by the sudden de-leverage caused by productivity shock are no difference, whether the economy faces to the zero constraint or not. We further discuss how this result can be applied to the Japanese economy.

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[6] In this numerical calculation, we slightly modify the model. The government adjusts the amount of bond issuing (ΔTB)

$$\Delta BaseM_t + \Delta D - \Delta Bm = \Delta TB_t$$

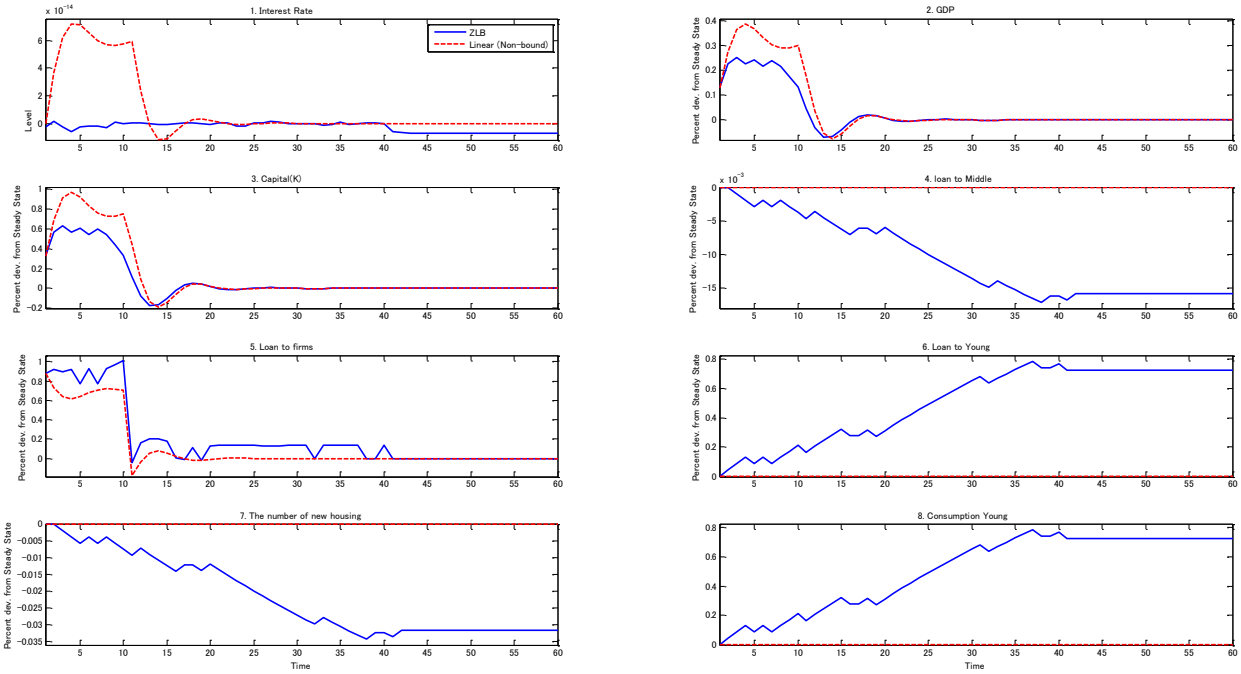


Figure 7　Impact of Credit under zero constraints

4　Implications

4.1 Apply to the Japanese economy

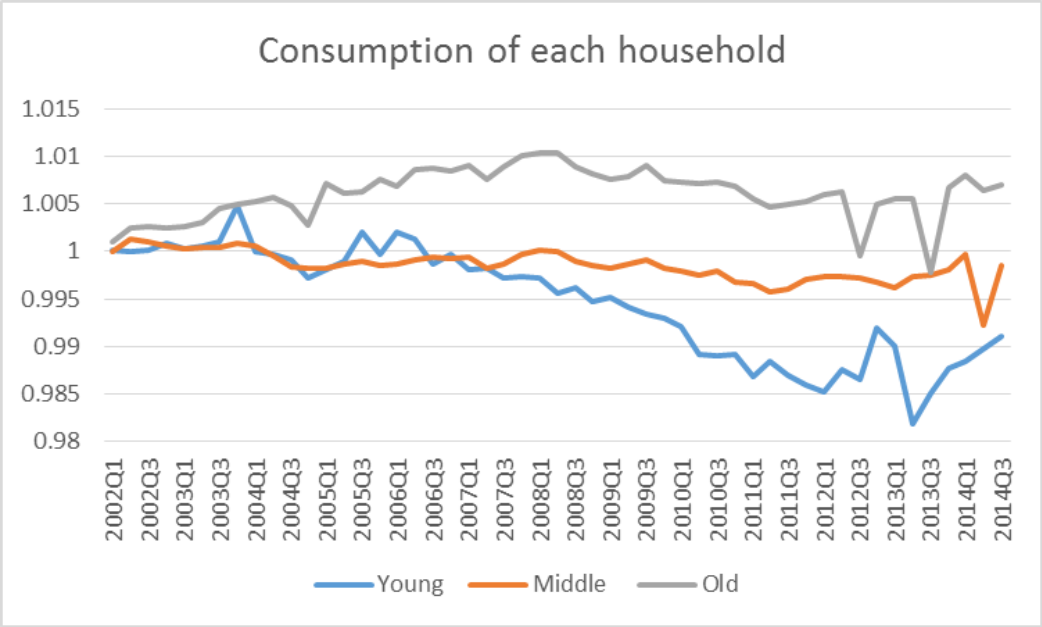
（economic stabilization）

First, we should consider whether the stabilization function described above worked or not. The Japanese economy since 1990 has been suffering from the long-term deterioration of the economy called 'last two decades'. It is hard to say that stabilizing function has been sufficiently demonstrated. As described above, the Japanese consumption has been on a downward trend over the whole households (**Figure 8**)[7]. In particular, consumption decline in young household is remarkable.

In the model analysis described above, although the consumption of middle aged will be reduced due to the sudden de-leverage, consumption of young household will be supposed to expand so as to offset it. But, it is actually different. The young household reduced consumption more rapidly than any other households. Stabilization function to absorb shocks don't work.

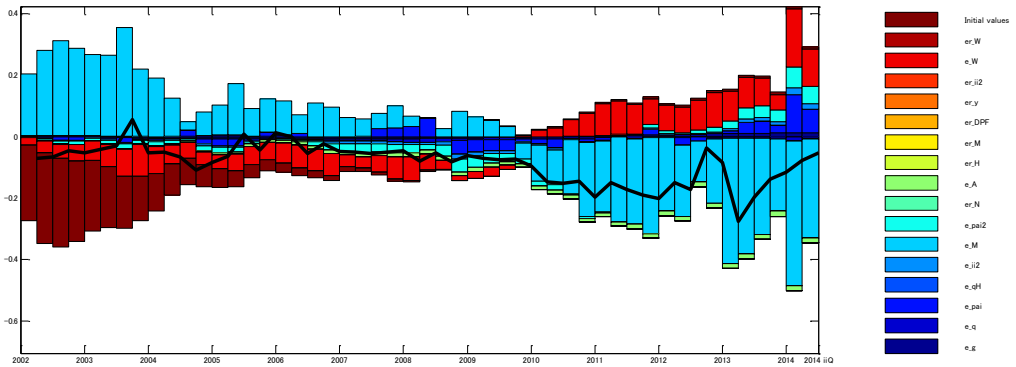
[7] Each consumption of 2001 1Q is calculated as 1.

Figure 8



（Source）Author estimation using household means test published by Japan Statistical Bureau.

Figure 9 Consumption of Young household (C^y)



For consumption behavior of young household, discuss a little more. Looking at the estimated historical decomposition of young household consumption (**Figure 9**), base money shock (e_M) and wage shock (e_wage) seriously affect young consumption among macro shocks. Liquidity factor such as base money shocks has been a positive effect on the young consumption from 2000 to 2007. It became the largest factor of sluggishness of young consumption since 2008. On the other hand, wage shocks have been a positive factor to prop up consumption during the past few years. Under the present situation,

stabilization function doesn't work because young households lose the incentive to recover consumption in the face of liquidity constraints. The Japanese economy cannot easily escape from long-term stagnation. We contend that liquidity constraints are main factor of stagnation in the period after the collapse of Leman Brothers. In this regard, elimination of liquidity constraints by a large supply of base money based on "Abenomics", may contribute in terms of breakthrough present economy.

On the other hand, our arguments also include an inconsistent content. We were not able to break away from 2000-2007 economic downward in spite of the relatively abundant provided liquidity. Speaking our conclusion, the stabilization function didn't work well from 2000 to 2007. Again, observing the historical decomposition of young household consumption, sluggishness of young consumption is due to the severity of the employment situation and wage cut before 2008. Our DSGE model indicates that technology innovation had consistently a positive effect trend in the Japanese economy. In other words, if the positive technology innovation occurred in those days, wages should be rising. It should have had the positive effect of the consumption. However, the actual consumption of young household, in the deterioration of the employment situation, has declined.

Our model is supposed to have a positive effect on wages with rising productivity of technology innovation (EQ11). The young workers tend to decrease by aging. Given these labor markets, wages of young people should be increased. However, in practice, young households have long-term decreased consumption under low factor income. In short, both the reduction in wage income that reflects the severity of the employment situation and the productivity improvement by technical innovation are difficult to explain consistently. Our model analysis leads to lack of rationality. We wonder why we obtain such a contradiction.

The first reason is to miss specify the model because some actual and estimated data don't match. Our paper implies another reason because technology innovation has been charged with some new characteristics.

4.2 Influence of technology innovation

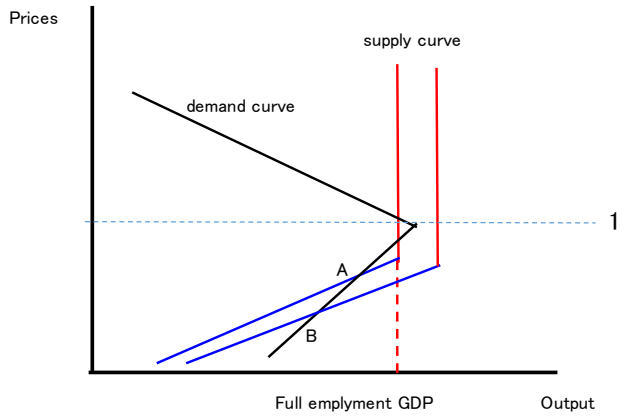
In recent years we find the signs such that technology innovation has progressed in the developed countries. What is the change of technology innovation in progress? Eric Brynjolfsson and Andrew McAfee (2013) claim that the progress of IT technologies such as artificial intelligence has impact of changing our lifestyle and being deprived our jobs. They also point out the possibility of coexistence of the new technology. However, 200,000 graduated students in Japan are no job every year. In the USA, job market for university students is further severe. Young people, in particular, people with higher education level have been deprived of their job opportunity by the computer machine.

According to the EM paper, under the background of such a phenomenon, technology

innovation has been affected. Figure 12 shows price-output supply and demand curves. The supply curve is upward sloping until corresponding to full employment. It becomes the vertical in output volume corresponding full employment. This figure is normal in the textbook. Inflation demand curve is normal of downward slopping as long as the prices rate exceeds 1. However, we curiously find upward sloping demand curve if price level reached below 1. Consumers who had a debt, discouraged demand because the burden of real debt is increased with prices declining. These demand and supply curves show in **figure 10.**

Under such deflation, consider the case that technological progress has occurred. In this case, both production volume and employment will decrease (point A ⇒point B). The basics of economics tell us the technology innovation should activate the economy. However, in figure 10, technology innovation in an environment under severe depression would cause serious stagnation of the economy. If we apply this story to our arguments, the Japanese economy has been forced to the technological innovation with output reduction and employment adjustment.

Figure 10 Technology innovation with adjustment of employment



（Source）Eggertsson and Mehrotra (2014)

5. Future tasks

By using long-term stagnation theory, we analyzed the Japanese economy since 2001. We study the mechanisms to fall into long-term economic stagnation, where the sudden credit crunch called Minsky Moment, or sharp decline phenomenon of liquidity became a trigger

We introduce households are divided into three households (Young, Middle and Old), where each household rationally performs different consumption and savings. In this case, we can avoid falling into the stagnation, even if a shock such as Minsky Moment occurs. It's called economic stabilization feature in this paper. However, this stabilization function does not work in the economy changes such as the technological innovation with employment adjustment. This can be the origin where we would have fallen to the long-term economic

stagnation. We try to make clear how the economic shocks can be offset by each household behavior using the DSGE model. Given the actual situation of the Japanese economy, consumption of young household, in the deterioration of the employment environment, has gotten a decreasing trend. The stabilizing economy doesn't come fully functional.

In this study, we find several problems. For example, it is simply setting about entry and exit to the labor market, where young workers reaching in the working age can only enter into the labor market. Furthermore, to analyze the differences in behavior between households, it is insufficient to assume representative agents in DSGE. However, the development of calibration models that incorporate the differences between individuals in heterogeneous does not progress as much as the representative models. We want to evaluate these implications of this model, while we also incorporated these advanced research.

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