Monetary Policy and the Liquidity Trap
Simulations using a Short-Run Macro Econometric Model of the Japanese Economy

By

Masahiro Hori, Toshiyuki Tanabe, Makoto Yamane and Daiju Aoki

December 2002

Economic and Social Research Institute
Cabinet Office
Tokyo, Japan
Monetary Policy and the Liquidity Trap
Simulations using a Short-Run Macro Econometric Model of the Japanese Economy

by

Masahiro Hori, Toshiyuki Tanabe, Makoto Yamane and Daiju Aoki

December 2002

Please address correspondence to:
Masahiro Hori, ESRI-CAO, Japanese Government

* We would like to thank Takashi Omori for helpful discussions. We also would like to thank all the participants of the 5th Workshop on Forward-Looking Type Model Building held at NIESR, London, especially, Pete Richardson for his generous comments. The views expressed in this paper do not necessarily reflect those of the Economic and Social Research Institute or of the Cabinet Office, and needless to say, author’s are responsible for the remaining errors.
Abstract:

In this paper, we tried to examine empirically the constraints to monetary policy posed by the zero-lower bound on nominal interest rates. To evaluate numerically the views expressed on policy effectiveness, we run several policy simulations, making full use of the two different versions of the ESRI Short-Run Macroeconometric Model, i.e. the backward-looking version and the forward-looking version. Though the monetary transmission mechanisms in the real world may be far more complicated than those depicted in the compact model, the authors believe that we could learn (or obtain a new understanding of) the following lessons from our model simulations.

1) The effectiveness of monetary policy in Japan seems to have declined through the 1990s in its backward-looking settings, as suggested by the theory of the liquidity trap.
2) However, with forward-looking agents, monetary policy still may be effective in fighting deflation. There are (at least) two distinct possible forward-looking responses to the permanent monetary expansions under zero interest rates, i.e. bull and bear equilibrium, depending on the people’s knowledge or their belief in long-run monetary neutrality.
I. Introduction

Following the collapse of the asset price bubble in early 1990, Japan’s growth steadily deteriorated through the first half of the 1990s, and has been generally weak since then. Price inflation followed the economy downward, falling below zero in the mid-1990s. In response, money market rates in Japan have been consistently below 0.5 percent; the Bank of Japan claims that it can do no more, yet the economy is sliding deeper into recession.

The continued stagnation of the Japanese economy, despite very low interest rates, is surely one of the major dilemmas of macroeconomic policy around the world today. Studying Japan’s experience in the first half of the 1990s, Ahearne et al (2002) draw some lessons for situations in which inflation and interest rates have fallen close to zero, and the risk of deflation is high. Krugman (1998) argues that Japan was stuck in a “liquidity trap” in late 1990s. It is time to reexamine the theory of the liquidity trap, which has turned out to be relevant.

The objective of this paper is to examine the constraints to monetary policy posed by the zero-lower bound on nominal interest rates. Though several leading economists including Krugman advocate the use of non-conventional means of monetary stimulus, almost all analysts would agree that once the zero bound is reached, re-activating the economy becomes more difficult and more uncertain. Considering the necessity of policy evaluation even under those difficult and uncertain circumstances, this paper presents some simulation results of Japanese monetary expansion using the ESRI Short-Run Macroeconometric Model of the Japanese Economy, developed by the Economic and Social Research Institute (ESRI), Cabinet Office of the Japanese government. In each simulation, growth rate of monetary aggregates (M2+CD) are exogenously raised/lowered for several quarters to reach a certain level of monetary expansion/contraction. Given the exogenous path of money supply, short-term interest rates are derived from a reversed money demand function, respecting zero bound on interest rates by specifying that the rate is the maximum of zero and the rate implied by the reversed function.

We use two versions of the ESRI model—the traditional backward-looking version and the forward-looking version at its testing stage—in our monetary expansion experiments. Simulation results using the traditional version indicate that the effectiveness of monetary policy in Japan declined through the 1990s in its backward-looking setting, as suggested by the zero bound and the liquidity trap theory. However, with forward-looking agents, monetary policy may be effective to fight deflation, even with extraordinarily interest-elastic money demand, provided that agents believe monetary neutrality will hold in the long run.

---

1 For detailed specifications of the current ESRI model, see Hori et al (2001).
2 In its standard setting of the ESRI model, short-term rates follow a policy reaction function; however, we exclude the reaction function from our model to change the level of money supply exogenously.
This paper is organized as follows. Section II describes the schematic structure of the ESRI Short-Run Macroeconometric Model of the Japanese Economy. The model is a classic data-mining style econometric model. Though its use of recent econometric techniques such as co-integration and error-correction guarantees long-run stability, it basically utilizes the traditional Keynesian framework with gradual price adjustments. The traditional version adopts backward-looking settings with adaptive expectations; recently, we also tentatively developed a forward-looking version. Section III briefly reviews recent discussions over Japanese monetary policy, and presents simulation results using the backward-looking version. The backward model confirms the general observation that the effectiveness of Japanese monetary expansion in boosting the economy might have diminished in the periods of low interest rates. Section IV outlines alterations in our tentative forward-looking model, and presents results from forward-looking simulations. Unlike backward results, some forward-looking results suggest that changes in money supply may be effective in stopping deflation even under a liquidity trap. Section V sums up the findings in this paper.

II. Basic Structure of the Model

1. Background

The Economic and Social Research Institute (ESRI), Cabinet Office, Japanese government has a long history of economic model building. It developed the EPA world econometric model in the 1980s and entered it for leading projects among model builders around the world (see Bryant et al [1988] for example). However, facing the change of the tide of economic modeling, ESRI decided to not continue to maintain the large-scale world model in late 1990s, and released a demand-oriented compact econometric model of the Japanese economy in 1998 for policy analyses and short-run forecasting (Hori et al [1998]). The ESRI Short-Run Macroeconometric Model, on which we are working in this paper, is a revised version of the compact Japanese model, and is developed under key concepts of theoretical transparency and practical maneuverability.

By regularly releasing the revision of this compact ESRI model, which incorporates newly released data on and current developments in the Japanese economy, we have kept the model’s transparency and maneuverability, and would like to offer materials for constructive policy discussions.

2. Basic Structure

The ESRI Short-Run Macroeconometric Model is a quarterly macro econometric model of the Japanese economy designed for policy analysis and short-run forecasting. To keep the model transparent to the general public, we have avoided unnecessary complications and developed a
maneuverable compact model with 145 equations (including 98 identities) relying on the simple textbook-style framework. Coefficients are econometrically estimated using time-series data from 1985 to the present.

Theoretically, the model is composed of four markets: goods, labor, money, and foreign exchange. As the labor market is roughly described through a two-sided coin relation with the goods market (i.e. Okun’s law), the model basically utilizes the traditional small open economy IS-LM framework. Since price is endogenized by the expectations-augmented Phillips curve, the model can be understood as an “open Keynesian model with gradual price adjustments.” Sketchy structures by market are as follows:

2.1 Goods Market

In the goods market, private domestic demand is derived through the behavior of private agents. Households and firms choose levels of consumption and investment respectively. Net exports (export-import) are determined by income and real exchange rate—the price of foreign goods in units of domestic goods. Effective demand is defined as the sum of those private demands plus exogenously given government expenditures. In the short-run, during which the price adjustments are incomplete, the level of GDP is determined by the defined effective demand, and the downward sloping relation between income and interest rate constitutes the so-called IS-curve relation. On the other (i.e. supply) side, amounts of capital and labor are combined to produce output. Since the availability of the inputs to production is almost fixed for some time, we can derive the level of potential (or full-employment) GDP through the estimated production function. Capacity utilization, or the gap between the potential and effective GDP, affects price level through the expectations-augmented Phillips curve, and the GDP gap is dissolved over time through the price adjusting mechanisms.

\[
\begin{align*}
C &= C(HK, Y, r) \\
I &= I(\Delta Y, r, K_{-1}) \\
NX &= NX(Y, Y', EP' / P) \\
G &= G \\
Y &= C + I + G + X - M \\
K &= K_{-1} + I
\end{align*}
\]

Notes: The model in this paper is set out in terms of schematic structure, ignoring details and dynamics.
Supply
\[ Y^p = Y^p (K, L_s) \]
\[ \dot{P} = P(\dot{P}^e, Y / Y^p) \]
\[ \dot{P}^e = B(L)P \]

Potential GDP (Production Function)
GDP Deflator Expectation (Augmented Phillips Curve)
Inflation Expectation (Backward-Looking)

Note: See Table 1 (Glossary) for the notations.

2.2 Labor Market

In the labor market, given the level of goods production, labor demand is derived through a sort of Okun's law, and through the level of nominal wage determined through labor share negotiations that reflect economic conditions. Traditionally, we used real wage adjustments on the axioms of the classical school. However, that strategy was renounced since the working of wage mechanisms through which the labor market equilibrates is quite weak in Japan. It is more realistic to assume that the labor share is adjusted, reflecting labor market conditions.

\[ L_s = L_s (W / P, POP) \]
\[ L_D = L_D (Y / Y^p, K) \]
\[ W = W (PY / L, Y / Y^p) \]

Labor Supply
Labor Demand (Unemployment Rate)
Wage (determined through labor share negotiations)

Note: See Table 1 (Glossary) for the notations.

2.3 Money (Financial) Market

In our standard setting, monetary policy (short-term interest rates) follows a policy reaction function that reflects past policy rules. Given any interest rate, level of money supply is derived through money demand function for monetary aggregates (M2+CD). When we need to treat money supply exogenously, we exclude the reaction function and derive short-term rates from the reversed money function. The level of long-term interest rates is determined by the term structure theory of interest rates. Real rates, defined as long-term interest rates minus inflation expectations, enter into the user cost of capital and affect the level of the effective demand.

\[ i_s = i_s (\dot{P}, Y / Y^p) \]
\[ M_s = M_s (Y, P, i_s) \]
\[ i_l = C(L) i_s \]
\[ r = i_l - \dot{P} \]

Short-term Interest Rate (Policy Reaction Function)
Money Outstanding (Money Demand (LM Curve))
Long-term Interest Rates (Term Structure of Interests)
Real Long-term Interest Rates (Fisher Equation)

(Notes: See Table 1 (Glossary) for the notations.)

2.4 Foreign Exchange Market

The foreign exchange market determines the level of nominal exchange rates. We use the so-called assets approach to foreign exchange determination, in which equilibrium rates, interest rate
differentials, and risk premiums work through an arbitrage. The nominal exchange rates affect the current accounts (net exports) through real rates - the price of foreign goods in units of domestic goods. Given the condition of current account, capital account is defined on a foreign exchange market equilibrium (the BP curve).

\[
\dot{E} = E(E_{-1}\{P_{-1}/P^*_t\}, i_t^* - i_t, \sum BC_{-1}) \quad \text{Exchange Rate (Arbitrage)}
\]

\[
BC = P \times X - EP^* \times M
\]

\[
BC + BK = 0
\]

Current Accounts
Balance of Payments (BP Curve)

<table>
<thead>
<tr>
<th>Table 1  Glossary</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC : Current Account</td>
</tr>
<tr>
<td>BK : Capital Account</td>
</tr>
<tr>
<td>C : Consumption (Real)</td>
</tr>
<tr>
<td>E : Exchange Rate</td>
</tr>
<tr>
<td>G : Government Exp.(Real)</td>
</tr>
<tr>
<td>I : Investment (Real)</td>
</tr>
<tr>
<td>P : GDP Deflator</td>
</tr>
<tr>
<td>W : Wage</td>
</tr>
</tbody>
</table>

Note: \( X \) denotes the growth rate of X, \( \Delta \) denotes first difference, * denotes foreign variables, B(L) etc. denote Lag-Operators.

3. Estimation Strategy

3.1 Data and Estimation Method

To estimate coefficients for behavioral equations, we used quarterly time-series data, mainly from Japanese SNA and financial data found in the BOJ Financial and Economic Statistics Monthly. Since almost all data used are publicly available and easily accessible, any outsider with the minimum knowledge of macroeconomics can reproduce the model. Data period for the coefficient estimation is from 1985 to 2001 in principle. Unfortunately, the Japanese 1993 SNA dates back only to 1990; we thus used statistical bridge equations between the 68 SNA and the 93 SNA to constitute substitutes for the unavailable data for the 1980s.

To produce consistent estimates under obvious simultaneity, we took a single-equation instrumental variable approach, using predetermined endogenous and exogenous variables as instruments.

3.2 Use of Stationary Data and Error Correction Specifications

To avoid spurious regressions, we frequently applied the recent techniques of time series econometrics, i.e. a unit-root, co-integration, and error-correction regressions. As examined in earlier studies (see Soejima [1994] for example), we cannot nullify the possible existence of unit roots in most Japanese aggregate variables, i.e. they are integrated of order (at least) one. For most major behavioral equations, we took first difference forms as their dependent variables, and used the following error-correction specifications to guarantee long-run equilibrium in the model.
\[ DEL(\log_e (X),I) = \beta \times \log_e (X_{-1}/\phi(Y_{-1})) + \gamma \times DEL(\log_e (Z),I) + \ldots + \epsilon \quad (1) \]

(\log_e (\cdot) denotes natural logarithm, \( DEL(\cdot,I) \) denotes a first difference, and \( \phi(\cdot) \) denotes an arbitrary function.

\( X, Y, \) and \( Z \) are arbitrary variables in the model. The coefficient \( \beta \) satisfies inequality \( \beta < 0 \).)

Relying on a certain theory or a co-integration \( X = \phi(Y) + \mu \) (here \( \mu \) is a stationary innovation), we assume there is a long-run equilibrium relation \( X^* = \phi(Y) \). If a behavioral function takes the form (1), the endogenous variable \( X \) gradually approaches equilibrium level \( X^* \) and satisfies \( X = \phi(Y) \) in its steady state.

III. The Liquidity Trap and Effectiveness of Monetary Policy in the Backward-Looking Settings

1. Some Background

Given the rough description of the ESRI model above, we now turn to the main issue of this paper: whether the effectiveness of Japanese monetary policy in influencing the economy has diminished in the 1990s.

In the late 1990s especially, the growth of the monetary base rose above that of broader aggregates. This is about the time when an indication that a “liquidity trap” may have emerged. The view that Japan is stuck in a liquidity trap is most closely associated with Krugman (1998). He argues that a liquidity trap happened to Japan, and over the past several years money-market rates in Japan have been consistently below one percent, and yet the economy is sliding deeper into recession.

A polemic argument by the world-famous figure gave rise to public debate, dragging in leading economists at home and abroad (see Mikitani and Pozen eds. [2000], Komiya and JCER eds. [2002] as examples). Though most analysts may agree that the conventional policy is constrained and that re-activating the economy becomes more difficult and more uncertain when stuck in the “trap,” daring use of non-conventional means of monetary stimulus, including inflation targeting, is still keenly debated. Roughly generalizing, foreign economists are generally positive toward further monetary expansion (see Krugman [1998], Bernanke [2000], and Svensson [2001], among others), while Japanese economists, especially those related to the Bank of Japan or Japanese short-term money markets (Okina [1999], Oda and Okina [2001] and Kato [2001]), are negative and reluctant.3 For example, Nakashima and Saito (2002) typically argue that money nominal prices do not respond to changes in money supply under the low-interest-rate policy.

3 Of course, there are notable exceptions. These include Ito (2002), Fukao (2002), Iwata (2002), and Hamada (2000).
2. Backward-Looking Simulations

Although the view that the zero rate policy may weaken the relationship between monetary aggregates and nominal prices is not universally accepted, it is widespread in Japan today.\(^4\) Considering its strong implications for Japanese policy choices, it is worth examining the view through econometric model simulations. As the first step in our quantitative analyses, we present a few simulations of monetary expansion/contraction using the backward-looking ESRI model, which was outlined in the previous section.

Table 2 reports that the impact of monetary expansion (increases in monetary aggregates by one percent), evaluated by the previous and current versions of the ESRI model, declined over time, keeping pace with the fall of interest rates. Figure 1-1 reports the response of GDP and private consumption deflator to monetary expansion or contraction in our latest model (the backward-looking version). In both cases, i.e. expansion vs. contraction, we changed the growth rates of M2CD by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline. As can be seen in the figures, impacts of the monetary policies on outputs and prices are pretty small\(^5\) recently. Probably due to the zero bound, we also observe asymmetry between easy and tight money; easy money is less effective, constrained by the nominal rate lower bound.

In their empirical study on Japanese money demand, Nakashima and Saito (2002) found that demand curves with extremely high interest elasticity had been observed in Japan, since the BOJ started to guide overnight call rates below 0.5 in 1995. Since their finding seems to be echoed by the decline of monetary expansion effectiveness (Table 2), we examined the implications of a highly interest-elastic demand function by increasing the estimated elasticity 100 times. Figure 1-2-1 comparatively presents the results of the experiments. Though the elasticity increase reduces the policy effectiveness as expected, the changes after the elasticity increase are rather moderate, since the policies are not very effective from the beginning.

Radical monetarists often argue that the policy impacts to cope with the weakened policy effects should be magnified. Figure 1-2-2 reports the results from a case when the monetary impacts doubled on the 100-times-interest elastic model. As expected from the model linearity, outputs and prices respond significantly in proportion to the doubled policy impacts; the authors believe that we should not give too much credence to the model linearity, since it is just an approximation in the equilibrium neighborhoods, especially when extremely large policies are required to attain visible outcomes. In that sense, we would say that the effectiveness of Japanese monetary policy in influencing the economy had diminished (or lost) in the late 1990s, at least in the backward-looking

---

\(^4\) Saito (2002) plausibly claims that expansionary monetary policy can do no more in his book for lay readers.

\(^5\) The impacts of monetary expansion are virtually zero up until late 2002, after which the short-run rates in our baseline scenario depart from the zero bound.
settings.

IV. Forward-Looking Model and the Liquidity Trap

Observing the incompetence of monetary expansion in the traditional ESRI model, we now turn to our brand-new forward-looking version. To give a rough sketch of our modifications, we illustrate some of our forward-looking variable uses in the next subsection, and present several simulation results in the following subsections.

1. A Tentative Forward-Looking Model

Traditionally, the econometric models within the Japanese government have been backward-looking with adaptive expectations. This is partly because of the strong skepticism regarding rational expectations in Japanese society; absence of user-friendly software that can handle forward-looking simulations also caused the delay. In the case of the ESRI Short-run Model, its frequent use for short-run forecasting hindered adopting lead variables. However, since the seminal break by Lucas (1976), the tide of economic modeling turned, and model-consistent expectations became mainstream. Nowadays, everybody believes that forward-looking factors sometimes play important roles in certain economic phenomena, and we finally decided to develop a forward-looking version of the ESRI model (in parallel with the traditional backward-looking version) for policy analyses.

Since this is our tentative attempt, the use of lead variables in the model is limited to just some basic equations. As observed in the following simulation results, however, even limited use of forward variables sometimes changes the picture entirely. Some of the basic equations into which we incorporate forward-looking factors are as follows:

1) Human capital variable that appears in the consumption function

In the PIH-based consumption function, we used a human capital variable (HK) as a part of the error-correction term. HK at period t is defined as $HK_t = YD_t + HK_{t+1}/(1+\rho)$, where $YD_t$ is disposal income and $\rho$ denotes a discount factor. In our backward-looking version, we used a transformation of the above identity with a lag, i.e. $(HK_{t-1} - YD_{t-1})(1+\rho)$, to avoid the lead

---

6 To solve the forward-looking model in this paper, we used the portable TROLL from Intex Solutions Inc.
7 When using a model with lead variables, we must have reliable long-run forecasts even to make a short-run outlook.
8 The Asian Link Model, which was developed to analyze the East Asian Crises, is another example of ESRI’s efforts to develop forward-looking models.
9 In addition, we used a few more lead variables, and a typical fiscal (tax) policy reaction function in the following form: $\Delta \tau = \alpha(D - D^*) + \beta(d - d^*)$, in our forward-looking model, though it does not make a visible difference in this paper, which focuses solely on monetary policies.
variable. In the forward-looking version, of course, we can use the original identity with a lead.

2) User cost of capital that enters the investment equation

In the backward version, real interest rates in the user cost of capital were defined on an ex-post basis. In the forward version, we used ex-ante real rates, i.e. \( \eta_t = i_t - 100 \times (P_t - P_{t-1})/P_t \), instead. The forward-looking stock price defined as a present value of future corporate incomes also influences the investments through the user cost of capital.

3) Inflation expectation term in the expectations-augmented Phillips curve

In the backward version, we used an error-correction term reflecting the quantity theory of money and a few lags of past price movement as proxies of inflation expectation in the Phillips curve. In our forward-looking version, we replace part of them with a lead variable.

4) Short-term interest rate expectation that appears in the term structure of interest rates

We replace the backward-looking long-term rates equation with the forward-looking term structure model in the form:

\[
i_{tl} = i_{sl} + i_{tl+1} + i_{tl+2} + \ldots + i_{tl+39} + \theta_i
\]

where \( \theta_i \) denotes the term premium, which is treated as a constant in our simplistic model.

5) Exchange rate expectation in the uncovered interest rate parity

We use uncovered interest parity, i.e., \( \log_e (e_{t+1}/e_t) + (i_{s}^* - i_t) = 0 \) as an equilibrium relation to determine the level of exchange rates.

2. Monetary Expansion in the Forward-looking Settings

2.1 Permanent shocks vs. temporary shocks

Figure 2-1 compares the responses of GDP and private consumption deflator to monetary expansion/contraction in our forward-looking model with those in our backward-looking model. Shadowed areas denote the estimated effects of monetary policy in the backward-looking setting. Four lines in the figure correspond to the impacts of policies in the forward-looking model. As depicted by the two pairs of lines, impacts estimated by our forward model simulation branch off to two variants, i.e. permanent policy impacts and temporary policy impacts.\(^{10}\)
Lines for the permanent policy (the outer pair) positively illustrate that monetary policy may have powerful impacts on the economy in the forward-looking settings. This holds even with the interest rate constraint, as observed in the responses from 2001 to 2002, when the baseline short-run rates were virtually caught in the zero bound. However, lines for the temporary impacts (the inner pair), in which we raised/ lowered growth rates of M2CD by 0.5 percent for 10 quarters and then lowered/raised it over another 10 quarters to return to original levels,\(^\text{11}\) indicates that transitory monetary policies cannot effectively change outputs and prices.

Therefore, the first lesson from our forward-looking simulations is that monetary expansions may have powerful impacts on the economy even with zero interest rates, but, at least, the policy has to be permanent by its nature to be effective. In the following subsections, focusing only on permanent policy changes, we explore further qualifications for effective monetary expansions.

### 2.2 Forward-looking behaviors and the liquidity trap

Figure 2-2, which compares the responses to permanent policies in the forward model with those in the backward model, sheds light on the monetary transmission mechanisms in our forward-looking simulations. The zero bound constrain the nominal short-run rates (RCD) under expansionary policies in both of the two models, i.e. forward model vs. backward model, equally. However, price responses cause the different movements of real rates, and hence, those of the user cost of capital. Price increases in the forward-looking expansionary simulation lower the user cost of capital, and it boosts real outputs together with exchange rate depreciation.

Figure 2-3 turns on the issue of the liquidity trap in the forward-looking model. Matching with the backward-looking observation, increased elasticity (by 100 times) reduces policy effectiveness, as typically observed in the smaller responses of outputs and prices. The results of the trap stand out in the short-term rate rigidity; the economy sizably responds to the impacts, however, through the exchange rate channel. Therefore, the credible monetary policy seems to be effective in the forward-looking settings, even with extraordinary strong money demand.

The obvious question, then, is the source of the sudden depreciation/appreciation of exchange rates. The answer is practically in the model solving methodology.\(^\text{12}\) To solve a forward-looking model, we have to fix a certain set of terminal conditions, as well as initial conditions. In our permanent policy simulations presented in the Figure 2-1, 2-2 and 2-3, we transcendentally assumed that monetary neutrality holds in the long run, and adjusted the terminal

---

\(^{10}\) The distinction does not make any difference in the case of backward-looking simulations.

\(^{11}\) In our permanent simulations, we changed the level of money exogenously in the manner that applied to our backward-looking simulations, i.e. raised/lowered the growth rates of M2CD by 0.5 percent for 10 quarters until M2CD reaches the level five percent above/below the baseline.

\(^{12}\) Forward-looking models in this paper are all solved by the stack-time method.
conditions for impact cases. These adjustments cause an immediate jump in exchange rates, and lead the expansionary/deflationary effects of easy/tight money even when stuck in a liquidity trap.

3. Do You Believe in Long-run Monetary Neutrality? (Importance of Terminal Condition)

Since the terminal condition adjustments are obviously influencing the estimated policy effectiveness, we should be careful enough to do some sensitivity analyses. Figures 2-4 and 2-5 present a few simulation results that evaluate the permanent monetary policies without the adjustments, i.e. without the long-run neutrality assumptions.

Figure 2-4, which is simulated without the terminal adjustments, corresponds to Figure 2-2; that is, a permanent money expansion/contraction in our standard forward-looking model. As expected, the influence of monetary policies declines by omitting the neutrality adjustments to the terminal values. However, the monetary policies are still sizably effective, and outputs and prices increase/decrease in response to a real rate fall/rise and exchange rate depreciation/appreciation. That is, terminal adjustments are not a necessary condition for policy effectiveness in our estimated forward-looking model.

Figure 2-5, which corresponds to Figure 2-3 with terminal adjustments, reports the result of a monetary expansion/contraction in our liquidity-trapped forward-looking model (with the 100 times interest elasticity). In this case, with a liquidity trap (abnormally large interest elasticity) and without terminal adjustments, monetary policies become virtually ineffective. Therefore, we can say either the long-run neutrality assumption or the finite-interest elastic money demand are necessary conditions for effective monetary policies. That is, as long as people know and believe in long-run monetary neutrality, an easy money policy can be effective in boosting the economy, even when stuck in liquidity-trap-like situations.

V. Conclusion

In this paper, we tried to examine empirically the constraints to monetary policy posed by the zero-lower bound on nominal interest rates. To evaluate numerically the views expressed on policy effectiveness, we run several policy simulations, making full use of the two different versions of the ESRI Short-Run Macroeconometric Model, i.e. the backward-looking version and the forward-looking version.

Though the monetary transmission mechanisms in the real world may be far more complicated than those depicted in the compact model, the authors believe that we could learn (or obtain a new understanding of) the following lessons from our model simulations.

1) The effectiveness of monetary policy in Japan seems to have declined through the 1990s in its backward-looking settings, as suggested by the theory of the liquidity trap.
2) However, with forward-looking agents, monetary policy still may be effective in fighting
deflation.

3) Even extraordinarily interest-elastic money demand does not spoil the monetary policy effectiveness above, provided that agents believe that monetary neutrality will hold in the long run.

Our findings do not necessarily guarantee the effectiveness of an expansionary monetary policy in a real economy, even if agents in the economy were all forward-looking. For example, Saito (2002) argues that an expansionary monetary policy can do no more in his forward-looking setting. We may be able to interpret his setting as a forward-looking model without the long-run neutrality adjustments in our simulation context. That is, our model simulations seem to suggest that there are (at least) two distinct possible forward-looking responses to the permanent monetary expansions under zero interest rates, depending on the people’s knowledge or their belief in long-run monetary neutrality. Economists who argue for the use of easy money to fight deflation have to engage in propagating the knowledge of the long-run neutrality to the general public to make their policy proposal really effective.

References


13 Economists may take the monetary neutrality as an axiom; the neutrality does not necessarily take root in the minds of general public, however.


Table 2: Effectiveness of Monetary Expansion (Increase M2+CD by 1%) in the Estimated (Backward-Looking) Japanese Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Data Period</th>
<th>Real GDP</th>
<th>Nominal GDP</th>
<th>(C) Discount Rate Average (Min-Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA World Economic Model 5th version-Japanese Economy</td>
<td>1983-Q1-1992-Q4</td>
<td>0.20 0.62 0.50</td>
<td>0.18 0.68 0.76</td>
<td>4.20 (2.50-6.00)</td>
</tr>
<tr>
<td>EPA Short-run Macro Economic Model of Japanese Economy</td>
<td>1985-Q1-1997-Q4</td>
<td>0.22 0.41 0.47</td>
<td>0.23 0.48 0.66</td>
<td>2.90 (0.50-6.00)</td>
</tr>
<tr>
<td>The Model of Japanese Economy used in this article</td>
<td>1985-Q1-2001-Q4</td>
<td>0.08 0.13 0.11</td>
<td>0.08 0.14 0.16</td>
<td>2.31 (0.10-6.00)</td>
</tr>
</tbody>
</table>
Figure 1-1: Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Backward-Looking).

**GDP: Gross domestic product (real)**

- Backward(M2CD expansion)
- Backward(M2CD contraction)

**PCP: Private final consumption deflator**
Figure 1-2-1 Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Backward-Looking) [Compared with the 100-times interest elasticity case]
Figure 1-2-2  When the impacts of M2CD doubled (Backward-Looking)
[With the 100-times interest elasticity]
Figure 2-1  M2CD Expansion/Contraction

[The comparison between permanent and temporary policies]

GDP: Gross domestic product

PCP: Private final consumption expenditure deflator
Figure 2-2 Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) with the assumption of long-run monetary neutrality; Compared with the Backward-Looking Version
Figure 2-3  Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) [With the assumption of long-run monetary neutrality; Compared with the Backward-Looking Version] [With the 100-times interest elasticity]
Figure 2-4 Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) [Without the long-run monetary neutrality assumption; Compared with the Backward-Looking Version]
Figure 2-5 Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) [Without the long-run monetary neutrality assumption; Compared with the Backward-Looking Version] [With the 100-times interest elasticity]
Figure 2-6 When the impacts of M2CD doubled (Forward-Looking)
[Without the long-run monetary neutrality assumption]
[With the 100-times interest elasticity]
Appendix

Figure 1-1 Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) [With the assumption of long-run monetary neutrality; Compared with the Backward-Looking Version]
Figure 1-1 (Continued)
Figure 1-2  Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) [With the assumption of long-run monetary neutrality; Compared with the Backward-Looking Version] [With the 100-times interest elasticity]
Figure 1-2 (Continued)
Figure 1-3 Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) [Without the long-run monetary neutrality assumption; Compared with the Backward-Looking Version]
Figure 1-3(Continued)
Figure 1-4 Growth rate of M2CD is increased/decreased by 0.5 percent for 10 quarters until M2CD reaches a level five percent above/below the baseline (Forward-Looking) [Without the long-run monetary neutrality assumption; Compared with the Backward-Looking Version] [Without the 100-times interest elasticity]
Figure 1-4 (Continued)
Figure 1-5 When the impacts of M2CD doubled (Forward-Looking)
[Without the long-run monetary neutrality assumption; Compared with the Backward-Looking Version]
[With the 100-times interest elasticity]
Figure 1-5 (Continued)