ASD Macroeconomic Model of Japan on the Flow of Funds and National Accounts
– Work-in-Progress Report on the Small Version –

Kaoru Yamaguchi *
Yokei Yamaguchi

Social Sciences University of Ankara, Turkey
Japan Futures Research Center
Awaji Island 656-1325, Japan
E-mail: kaoru.yamaguchi@asbu.edu.tr
yokei.yamaguchi@gmail.com

1 Research Objectives

This on-going research has the following main objectives;

1. Simulating the Lost Decades of Japanese Economy
2. Simulation-based Policy Recommendations

Simulating the Lost Decades of Japanese Economy

Figure 1 below illustrates behaviors of key macroeconomic variables highlighting the peculiar experiences observed in Japan during the last three decades since the burst of massive asset price bubble during the early 1990s. Though we are not showing consumer price index, interbank interest rate and demographic changes due to space constraints, the economy has experienced anemic growth of GDP, low inflation and deflation, and aging population. Particularly the nominal GDP shown in black line has been hovering at around 500 trillion yen for three decades. While policy makers have failed to bring the economy back to its pre-bubble trend line, the country is seeing its debt-to-GDP ratio growing at an accelerating rate and it is now reaching roughly 230%, a historical high since the end of World War 2. In 1946 the country was forced to undergo a nation-wide freezing of bank deposits, rise in property tax rate to as much as 90% followed by conversion of the inconvertible Bank of Japan notes in an effort

*This report will be presented at the 39th International Virtual Conference of the System Dynamics Society, July 25 - 30, 2021. This research is partially supported by the Research Fund of the Japan Futures Research Center.

to stabilize post-war hyper inflation and reduce government debts to domestic and foreign creditors. Despite additional measures including fixed exchange rate against US Dollar, the inflation continued as late as the end of 1940s due largely to war causalities and devastation of production capitals. Though it is not the result of war this time, there is no question that the economy is facing another systemic crisis as the last one. Implications on global supply chain and international financial system would be by far significant than demand shocks caused by pandemic of SARS-CoV-2 and its variants throughout 2020-21.

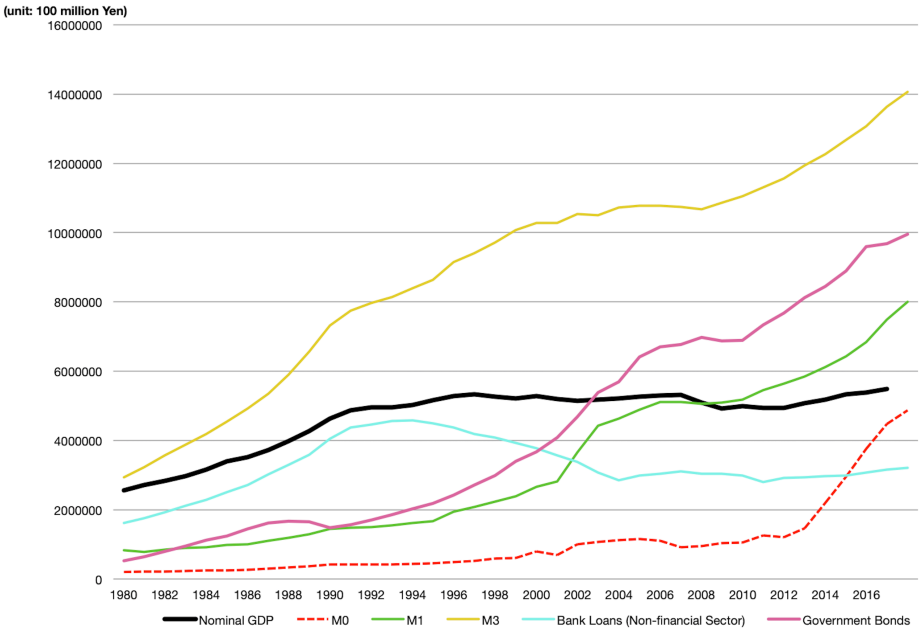

Figure 1: Lost Decades of Japan – Reference Behavior

More alarming is the fact that the country have used both monetary and fiscal policies but with no avail to redirect the economy. The administration has implemented expeditious fiscal spendings already in the late 1990s, and the economy has relied too long on low interest rates. Despite the negative rates introduced in 2016 by the Bank of Japan, the economic recovery is still sluggish. Some argues the reason for the weak economic performance is due to the declining population, while others argue that the increase in consumption tax in 2014 (from 5 to 8%) and 2019 (from 8 to 10%) have negated the potential effect of quantitative easing (QE) policy. In any cases current situation is nothing but the result of past policies that have turned out largely ineffective to manage the economy. Case of Japan accordingly is both theoretically and practically important as conventional models cannot explain and as we face such critical crisis.

The first main objective of our research is to develop a model that can sim-

ulate the decades long stagnation in feedback dynamic model. All economic and public policy arguments have certain assumptions, be it implicit or explicit, on underlying system structures, causal relations as well as human and institutional behaviors. Our primary research objective is to simulate behaviors of key variables including those shown above by making assumptions explicit so that it foster policy discussion in school and general public at large. To achieve this, we employed Accounting System Dynamics modeling framework (briefly explained in the next section) as our analytical basis.

Simulation-based Policy Recommendations

The current monetary system is based on fractional reserve banking where deposits (a.k.a. credits) are created out of thin air by private banking corporations as loans to non-banking sectors including the government. It is analyzed that this debt money system has fundamental design failures that caused (1) monetary and financial instability (boom-bust cycles), (2) government debt accumulation and (3) income inequalities [10, 2016]. To overcome these challenges ahead, the alternative system based on 100% reserve requirement on demand or checkable deposits have been proposed as *public money system* as a modern version of the Chicago plan proposed during the great depression in the 1930s [3, 1939] [2, 1945]. The pressing need for and feasibility of such transition is explicated by Yamaguchi [8, 2021]. The second objective of our research is to provide simulation-based policy recommendations, including transition to the public money system in Japan.

2 A Series of ASD Macroeconomic Modeling

Our current research has originated from the following papers:

(1) Principles of Accounting System Dynamics [5, 2003]
A new analytical method of Accounting System Dynamics (ASD) is proposed in this paper to model corporate financial reports using system dynamics. A system of double-entry bookkeeping method was formalized by Lucas Bartolommeo Paicioli (c.1447-1517) in 1494. The calculus was developed by Isaac Newton (1643-1727) and Gottfried Leibniz (1646-1716) in 1680s, and system dynamics was proposed by Jay Forrester (1913-2016) in [4, 1961]. ASD is an integrated method of these foundations enhanced by the modern information technology.[1]

(2) Generic Macroeconomic Model of Closed Economy (Flow Approach) [6, 2006]
The ASD method has been applied to a series of macroeconomic models. This paper completes a generic model of a closed economy. In terms of

[1] Similarities and differences between ASD and other macroeconomic modeling approaches such as the agent-based (AB) and stock-flow consistent modeling, are discussed in Yamaguchi (Chapter 4) [1, 2021]

monetary and banking system structure, it turned out later that it follows the *flow approach* of money creation where banks are assumed to act as intermediaries of existing central bank notes.

(3) Generic Macroeconomic Model of Open Economy (Flow Approach) [7, 2008]
This paper completes a generic open macroeconomic model based on the flow approach in (2).

(4) Generic ASD Macroeconomic Model of the Stock Approach [11, 2017]
A macroeconomic model with improved structure of monetary and banking system was proposed in this model. Specifically this research changed the generic closed economy model developed in (2) from flow approach to *stock approach* of money creation where banks supply money stock through loans. Yet, it is built as a closed economy model.

(5) Cross-Border Payments and Foreign Exchange Model [12, 2020]
This modeling completes the ASD modeling of cross-border payments structure with Nostro-Vostro deposit accounts across domestic and overseas banking sectors. We introduced this new correspondent banking structure to extend the generic model of the *stock approach* ASD model presented in (4) to open economy model. The model is kept as simple as possible at this stage to verify whether the approach is effective. The new framework turned out to be flexible to incorporate FX market intervention policy structure, non-linear feedbacks, and psychological factors. Its inclusivity allows integration of flow of funds, balance of payments, and international investment position.

Large Model Development in 2015

At the 33rd International System Dynamics Conference in 2015, we have reported the early stage development of ASD Macroeconomic Model of Japan (AMMJ) on the Flow of Funds and National Accounts [9, 2015]. This model was our first challenge to construct AMMJ based on the *stock approach* of money creation. This model have not yet reached a satisfactory level due to the following reasons:

(a) The Flow of Funds Accounts by the Bank of Japan consists of 45 macroeconomic sectors and 51 transactions items. Out of the large data set, we have selected essential part of 15 sectors and 23 transaction items for the period of 1980-2014. That is, 12,075 data points. The model in this phase consists of 191 stocks, 652 auxiliaries, 175 data variables and 511 constants. It later turned out to be in too much detail and complex with many exogenous structure for the initial attempt.

(b) We have started the modeling of Japanese economy without a guidance of generic ASD model of the stock approach of money creation.

(c) We have started an open macroeconomic model without a guidance of generic ASD model of cross-border payments between open economies.

We have faced with these inpediments along the way and could not finished the macroeconomic model of Japan started in 2015. In retrospect we began AMMJ project before sorting out clear ways to model monetary and banking system, and cross-border payments system in open economy model. The generic ASD model of the stock approach is later completed in 2017 (4), and cross-border payments structure is completed in 2020 (5) as explained above.

3 Small Model Development (Work-in-Progress)

With the completion of the generic Foreign Exchange Model (5) in the above list, we are now in a position to develop a ASD Macroeconomic Model of Japan. To avoid complexity of model structure explained in (a) above, our model has started with simple top layers of 6 sectors in the Flow of Funds such as 1. Financial Institutions, 2. Non-financial Corporations, 3. General Government, 4. Households, 5. Private Nonprofit Institutions Serving Household, and 6. Overseas. In the large model, we previously had sub-sectors under the general government sector. However, for a comprehensive analysis of debt money creation and government debts, only the financial sector is further divided into three sub-sectors such as 1-1. Central Bank, 1-2 Depository Corporations (Banks), and the remaining sub-sectors (called Financial Institutions of non-Banks) such as Securities, Insurance, etc. Additionally, Fiscal Loan Fund (sub-sector) is now integrated into the General Government.

Compared with the previous large model, the more aggregated downsized model we are building now is called *small model*. At this stage of development, it consists of 134 stocks, 522 Auxiliaries, 205 data variables and 257 constants. To import the whole Flow of Funds data set (45 sectors and 51 transactions), we have used the Vensim sub-model developed originally for the large model. Data from System of National Accounts such as GDP, and population cohorts etc. are directly imported into the small model as reference modes of behavior.

Money As Debt - Monetary System Structure

One of our research objective is to understand system structure that caused the so-called Japan's Lost Three Decades, including failures of Quantitative Easing policies observed as early as 2001-2006 (series 1). As one of recent findings, we have obtained causal relations that determine GDP since 1980 through 2019 such that

$$\text{GDP} = 128224 + 0.47 * \text{Loans by Banks} + 0.108 * \text{Gov Debts} \qquad (R^2 = 0.9034)$$

This is a kind of simple reasoning popular in econometric papers, yet it provides a good intuition that GDP of Japan has been influenced by bank loans

to produces and households, but the fiscal policy, though unprecedented in scale, failed to stimulate GDP against a general belief in Keynesian demand-side policies. Currently we are exploring key drivers and feedback loops underlying the last three decades comprehensively.

References

[1] Robert Y. Cavan, Brian Dangerfield, Oleg V. PJavlov, Michael Joseph Radzicki, and David I. Wheat, editors. *Feedback Economics – Economic Modeling with System Dynamics*. ISSN 1568-2846. Springer International Publishing, 2021.

[2] Irving Fisher. *100% Money*. The City Printing Company, New Haven, third edition, 1945. First edition (1935) available through ThaiSunset Publications, 2011.

[3] Irving Fisher, Paul Douglas, Frank D. Graham, Earl J. Hamilton, Willford I. King, and Charles R. Whittlesey. A program for monetary reform (mimeograph), July, 1939. Included in the Editor's Appendix to "100% Money by Irving Fisher", ThaiSunset Publications, 2011.

[4] Jay W. Forrester. *Industrial Dynamics*. Pegasus Communications, Inc.,Originally published by MIT Press, Waltham, MA, USA, 1961.

[5] Kaoru Yamaguchi. Principle of accounting system dynamics– modeling corporate financial statements –. In *Proceedings of the 21st International Conference of the System DynamicsSociety*, New York, 2003. System Dynamics Society.

[6] Kaoru Yamaguchi. Integration of real and monetary sectors with labor market: Sd macroeconomic modeling (3). In *Proceedings of the 24th International Conference of the System Dynamics Society*, Nijmegen, The Netherlands, 2006. The System Dynamics Society.

[7] Kaoru Yamaguchi. Open macroeconomies as a closed economic system: Sd macroeconomic modeling completed. In *Proceedings of the 26th International Conference of the System Dynamics Society*, Athens, Greece, 2008. The System Dynamics Society.

[8] Kaoru Yamaguchi. *Money and Macroeconomic Dynamics – Accounting System Dynamics Approach*. Japan Futures Research Center, Awaji Island, Japan. Edition 5.2 is available at http://www.muratopia.org/Yamaguchi/MacroBook.html, 2021.

[9] Kaoru Yamaguchi and Yokei Yamaguchi. Asd macroeconomic model of japan on the flow of funds and national accounts – report on its early stage development. *Proceedings of the 33rd International Conference of the System Dynamics Society, Cambridge, Massachusetts, USA*, July 2015.

[10] Kaoru Yamaguchi and Yokei Yamguchi. Heads and tails of money creation and its system design failures – toward the alternative system design –. *Proceedings of the 34th International Conference of the System Dynamics Society, Delft, The Netherlands*, July 18th, 2016.

[11] Yokei Yamaguchi. Developing an asd macroeconomic model of the stock approach - with emphasis on bank lending and interest rates. Master's thesis, System Dynamics Group, Dept. of Geography, University of Bergen, Norway, June 2017.

[12] Yokei Yamaguchi and Kaoru Yamaguchi. Modeling cross-border payments and foreign exchange dynamics – correspondent accounts framework. JFRC Working Paper No. 01-2020, 2020.

Appendix: Making Macroeconomic Models of Japan