Local Robustness Between Macrodynamic Data and Microdynamic Context in the Economy

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Abstract

We introduced a scheme of predicting the dynamic development of the monetary economy. Upon the observation of the robustness between the macrodynamic data and the microdynamic context generating the data, the most likely trajectory of the dynamic development in the near future could be the one that can remain most robust against fluctuations generated from within. The most robust trajectory towards the future is the one smoothly connected to the trajectory retracing, most faithfully, the macrodynamic data registered in the record so far. The present scheme was applied to the prediction of the foreign exchange rate between the Japanese Yen and the US Dollar during the year of 2001 retrospectively. Our prediction of the exchange rate four days in advance was found to coincide with the actual data, as for whether up or down in four days, with the statistical accuracy of 59% upon more than 1000 independent samplings.

Keywords: Economy, Exchange Rate, Macrodynamic data, Microdynamic context, Robustness

1 Introduction

The central bank as monetary authority of the economy assumes both accountability and responsibility to the decisions on setting the level of the discount rate, the magnitude of selling and buying operations in the bond market, and the size of intervention into the foreign exchange market. Accountability for a decision prior to its actual implementation requires a reliable referential standard to evaluate the decision in advance. Empirical judgement of a decision prior to its implementation has to have recourse to a synthetic comprehension of what has happened to the economy so far as keeping the intrusion of theoretical artifacts as little as possible.

One standard for evaluating the decisions to be made may be a causal scheme inducing changes in the manipulative variables such as the discount rate set by the central bank, while precipitating a quantitative figure representing a dynamic property of the monetary economy as a whole that is empirically accessible. If the macroscopic figure derivable from the causal dynamics is also directly retrievable from the empirical record of the economy, the figure can be used not only as a reference for analyzing and diagnosing the recorded dynamics, but also as a guiding post for regulating the monetary economy. The existence of causal dynamics precipitating such a macroscopic figure makes it feasible for us to regard the figure as a factor towards which the monetary economy drives itself from within. The macroscopic figure as a guiding post now provides the central bank and other major participants in the economy with the

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policy tool of assessing and helping to form accountability to their decisions in advance.

We shall introduce into the monetary economy a macroscopic quantitative figure called the rate of monetary flow disequilibration that develops as following the causal dynamics of the economy and that is also empirically retrievable from the record (Matsuno, 2001). The rate of monetary flow disequilibration as a derivative of the causal dynamics will turn out to serve as a means to assess and regulate whatever dynamic situations the economy may generate from within. To begin with, we review the causal dynamics underlying the monetary economy.

2 Causal Microdynamics

One necessary premise on the causal microdynamics of the monetary economy is the condition of monetary flow continuity to be met at any economic agent except at the central bank. Monetary flow equilibration as the activity for fulfilling the condition of monetary flow continuity drives the economy from within (Matsuno, 1978).

Imagine, for instance, that a wageworker happens to lose the current job and to decrease the monthly income because of the forced change of the income solely to the unemployment benefit. The unemployed worker is then forced to change the expenditure behavior in order to meet the balance of monetary flow between the reduced income and the intended expenditure, that is the activity of monetary flow equilibration. The unemployed worker first comes to experience the imbalance or disequilibrium of monetary flow momentarily and then to commit himself to monetary flow equilibration immediately afterward. Since the change in the expenditure behavior of the unemployed worker is then going to affect the sales of a nearby grocery store, monetary flow equilibration at the worker subsequently induces monetary flow disequilibrium at the grocery store. Monetary flow disequilibration in the latter in turn necessarily comes to induce further activity of monetary flow equilibration since no one can issue bank notes except the central bank.

Monetary flow disequilibration thus reverberates in the monetary economy in a ceaseless manner. Although every economic agent constantly acts for eliminating the disequilibrium between the incoming and the outgoing monetary flow, monetary flow disequilibration does not disappear altogether from the monetary economy because of the locally causal nature of each bilateral transaction.

Monetary flow equilibration necessarily followed by the subsequent disequilibration and equilibration is microdynamic locally and quite stochastic since there is available no means of simultaneous coordination among all the participating agents globally on the spot. In contrast, the activity of the monetary economy registered in the completed record is macrodynamic in specifying its global regulation and organization, though frozen in the record. The thread connecting the microdynamic stochastic behaviors in progress to the macrodynamic data identified in the completed record must be the robustness of the economy towards monetary flow equilibration from within without having recourse to the presumed notion of global equilibrium.

The robustness of the economy is twofold. One is about the context of the microdynamics specifying how the microscopic stochastic behaviors on the part of the participating agents are regulated in the economy. The microdynamic context has to be

robust enough against the observed macrodynamic data, otherwise one cannot specify what the microdynamics is all about. Another robustness is about the macrodynamic data registered in the completed record towards the actual microdynamic context. Unless the robustness is guaranteed, the macrodynamic data could not be identified as such in the record. Mutual enforcement of the robustness between the microdynamic context and the macrodynamic data is accordingly operative in the economy. This exhibits a sharp contrast to the equilibrium stochastic process, in which the microdynamic context of generating individual stochastic events is conceived independently of the macrodynamic data it generates.

In order to further examine the mutual enhancement of the robustness between the microdynamic context and the macrodynamic data in the economy, we shall consider the monetary economy consisting of five aggregated agents; Corporations, Households, Financial Institutions, the Government, and the Central Bank for simplicity (Matsuno, 1978, 2001; Hirano and Paton, 1999). Monetary inflow to Corporations $\dot{y}_1^{(in)}$ consists of several subcategories as

$$\dot{y}_1^{(in)} = \dot{y}_{21} + \dot{y}_{31}^{(\ell)} + \dot{y}_{31}^{(s)} + \dot{y}_{41} \tag{1}$$

in which $\dot{y}_{21}$ is Households payment for purchasing the commodities produced at Corporations, $\dot{y}_{31}^{(\ell)}$ is the loan to Corporations from Financial Institutions, $\dot{y}_{31}^{(s)}$ is the interest payment by Financial Institutions to the time deposits and savings made by Corporations, and $\dot{y}_{41}$ is the Government s payment for purchasing the commodities produced at Corporations. The dot appeared in variable $\dot{y}$ in the above does not and will not imply time derivative in what follows. It is just an integral part of the variable so designated. Monetary outflow from Corporations $\dot{y}_1^{(out)}$ consists of

$$\dot{y}_1^{(out)} = \dot{y}_{12} + \dot{y}_{13}^{(\ell)} + \dot{y}_{13}^{(s)} + \dot{y}_{14} \tag{2}$$

in which $\dot{y}_{12}$ is the wage payment to Households from Corporations, $\dot{y}_{13}^{(\ell)}$ is the interest payment by Corporations to the loan from Financial Institutions, $\dot{y}_{13}^{(s)}$ is the time deposits and savings at Financial Institutions made by Corporations, and $\dot{y}_{14}$ is the tax payment to the Government by Corporations.

Monetary inflow to Households $\dot{y}_2^{(in)}$ is the resultant of $\dot{y}_{12}$, the interest payment $\dot{y}_{32}^{(s)}$ by Financial Institutions to the time deposits and savings made by Households, the loan $\dot{y}_{32}^{(\ell)}$ from Financial Institutions, the taxable wage payment $\dot{y}_{42}^{(x)}$ to Households by the Government, and the nontaxable transfer income $\dot{y}_{42}^{(nx)}$ to Households processed by the Government. Monetary outflow from Households $\dot{y}_2^{(out)}$ is the resultant of $\dot{y}_{21}$, the time deposits and savings $\dot{y}_{23}^{(s)}$ at Financial Institutions made by Households, the interest payment $\dot{y}_{23}^{(\ell)}$ by Households to the loan from Financial Institutions, and the tax payment $\dot{y}_{24}$ to the Government by Households.

The similar analysis applies to monetary inflow to Financial Institutions $\dot{y}_3^{(in)}$ and outflow $\dot{y}_3^{(out)}$ from there, and also to monetary inflow to the Government $\dot{y}_4^{(in)}$ and outflow $\dot{y}_4^{(out)}$.

Since no economic agent except the Central Bank can issue or destroy bank notes, the continuity of monetary flow

$$\dot{y}_j^{(in)} = \dot{y}_j^{(out)} (j = 1,2,3,4) \tag{3}$$

has to hold in the completed record compiled by an external observer, say, the monetary authority. Internally, however, monetary flow disequilibrum

$$\Delta\dot{y}_j \equiv \dot{y}_j^{(in)} - \dot{y}_j^{(out)} \tag{4}$$

does not vanish altogether in a synchronous manner because there is no global means for total synchronization to be applied to all of the concerned parties exactly at the same instant (Matsuno, 1978).

Monetary flow disequilibrium $\Delta\dot{y}_j(t)$ (j=1,2,3,4) at each agent at a given instant t is immediately subject to monetary flow equilibration by the same agent. The consequence of each act however does not fail to induce further monetary flow disequilibrium $\Delta\dot{y}_j(t+\tau)$ to be eliminated at the immediately following instant $t+\tau$, in which τ is the time interval for updating the decisions on the part of the participating agents. The updating process is summarized as

$$\Delta\dot{y}_j(t+\tau) = \sum_{k=1}^{4} B_{jk}\Delta\dot{y}_k(t) \tag{5}$$

in which $\{B_{jk}\}$ is the transfer matrix representing the activity of monetary flow disequilibration. While it actualizes monetary flow continuity right in the middle of the transfer process, each agent comes to suffer monetary flow disequilibrium after experiencing the concurrent acts of monetary flow equilibration at the other agents. Monetary flow disequilibrium $\Delta\dot{y}_j(t)$ cannot be frozen in the completed record. Instead, the transfer matrix $\{B_{jk}\}$ is real in the sense of leaving monetary flow continuity to be read out from the record as such by the external observer, e.g., the overseeing monetary authority, while carrying with itself monetary flow disequilibration forward.

One can in fact measure the development of the transfer matrix as consulting the pattern of decision making that all of the concerned agents update successively. Among many alternatives, a most significant figure characterizing the transfer matrix $\{B_{jk}\}$ is its maximum eigenvalue measuring the resultant rate of monetary flow disequilibration, that is, the relative growth rate of monetary flow disequilibrium per unit time for the monetary economy as a whole. In particular, the rate of monetary flow disequilibration as a macroscopic derivative from the microscopic causal dynamics can serve as a parameter for diagnosing the monetary economy as a whole.

3 Rate of Monetary Flow Disequilibration

One can determine the transfer matrix of monetary flow disequilibration as consulting the record of the flow of funds accounts complied by and released from monetary authority. The time series of the observed variables as the macrodynamic data we referred to include the total currency outstandings issued by the Central Bank, the total outstandings of Government bonds issued by the Government, the total amount of Government bonds possessed by the Central Bank, the loan to Financial Institutions from the Central Bank, the current deposit at the Central Bank made by Financial Institutions, the discount rate set by the Central Bank, the interest rate to Government bonds, the interest rate to the loan from Financial Institutions, and the interest rate to time deposits and savings at Financial Institutions.

We ran the monetary dynamics of flow equilibration and disequilibration, and tried to simulate the observed time series of these nine different kinds of variables as closely as possible upon random search (Matsuno, 1978, 2001). Even the time interval τ for updating each decision was taken as a parameter to optimally be determined through the random search. The time series of the nine variables were retrieved from the records of the flow of funds accounts compiled by and released from both the Bank of Japan and the Federal Reserve Board of the United States at every ten days starting from January 1950 through December 1999 (BOJ, 1949-2001; FRB, 1949-2001). When the first hand data at every ten days were not available, the linear interpolation was employed just for the purpose of data acquisition. The rate of monetary flow disequilibration measured in units of percents per day was equated to and read from the maximum eigenvalue of the transfer matrix of monetary flow disequilibration. The typical sample trajectories of the rate of disequilibration for the Japanese and the United States monetary economy are presented elsewhere (Matsuno, 2001).

The observed nonvanishing rate of disequilibration reveals that the microdynamic context of generating individual stochastic events would develop and change in time. If the microdynamic context remains stationary and independent of the macrodynamic data to be precipitated, the rate of disequilibration would remain either positive or negative, or zero because the transfer matrix of monetary flow disequilibrium is now taken to be rate-independent. If the rate of disequilibration remains positive, the monetary flow disequilibrium would eventually diverge and end up with the collapse of the total economy. In contrast, if the rate remains negative, the flow disequilibrium would totally disappear in the end with the consequence of no economic activities in the economy. If the rate vanishes, on the other hand, there would be no dynamic development in the economy. The actual economies of both Japan and the United States we examined over the last fifty years demonstrate that the rate of disequilibration in fact varied in time and changed its sign frequently. This observation comes to imply that the microdynamic context of generating individual stochastic events was dynamically interdigitated with the macrodynamic data to be precipitated.

Our empirical confirmation of the adaptable coupling between the microdynamic context and the macrodynamic data in the monetary economy certainly demonstrates a mutual enhancement of the robustness between the two. The actual microdynamic context is the one that can counteract upon any perturbations originating in the changes in the macrodynamic data; otherwise it would lose the likelihood of its realization. The

similar counteracting also applies to the actual macrodynamic data. The mutual enhancement of the robustness is however not rigid enough as to freeze the microdynamic context of generating individual stochatic events, for instance, as seen in the fixed pattern of generating stationary Gaussian noises. The inexhaustible adaptation between the microdynamic context and the macrodynamic data originates in the under-completeness of internal measurement on the part of every economic agent making the viewpoint necessarily its own blind spot (Matsuno, 1989, 1999, 2000a). Internal measurement driving monetary flow equilibration from within, inevitably conditioned on a finite horizon both in space and time on the part of the internal participant/observers, is constantly precipitating the macrodyanmic data to be identified by the external observer, say, the overseeing sector of the monetary authority. Constant reverberations of monetary flow equilibration and disequilibration in the economy guarantee the presence of the room for the mutual enhancement of the robustness between the microdynamic context and the macrodynamic data.

4 Generating Macrodynamic Data Towards the Future

The robust coupling between the microdynamic context of generating individual stoachstic events and the macrodyanmic data now suggests the presence of a tool for generating the macrodynamic data towards the future to some limited extent. We have determined the microdynamic context so as to retrace the observed macrodynamic data as closely as possible. Rather, the closest retracement of the observed macrodynamic data is a sine qua non of the microdynamic context of generating individual stochastic events. Since the identified microdynamic context remains robust against slightest changes in the observed macrodynamic data and since the data also remain robust against slightest changes in the microdynamic context, the macrodynamic data to be generated in the subsequent time to come in the real economy would meet the condition of enhancing the mutual robustness (Matsuno, 2000b, 2001).

Suppose that the daily-based observed macrodynamic data, say, the nine different kinds of variables we have considered, have been available up to today (day0), and then try to generate the most likely macrodynamic data for tomorrow (day1). One procedure to find out the most likely data for day1 within day0 will be to examine the extent of the robustness of the extrapolation made towards day1 from day0.

First, prepare the trajectory t(1) of the macrodynamic data from day0 to day1 by means of whatever extrapoplation method one may think of, and then determine the microdynamic context that can retrace the trajectory t(1) of the macrodynamic data from day0 to day1 as closely as possible. Also, prepare a quantitative figure mc[t(1)] measuring the degree of the faithfulness of the retracement that the microdynamic context imparts upon trajectory t(1). Secondly, prepare a trajectory t(2) of the macrodynamic data from day0 to day1, which is only slightly perturbed from t(1), and then determine the microdynamic context that can retrace the trajectory t(2) as closely as possible. If the quantitative figure mc[t(2)] measuring the degree of the faithfulness of the retracement for t(2) is greater than mc[t(1)], prepare the trajectory t(3) from day0 to day1 by applying slight perturbations to t(2) and repeat the same procedure. Otherwise, prepare the trajectory t(3) by applying slight perturbations to t(1) and repeat

the same procedure. Then, the trajectory t(N) with integer N far greater than unity would satisfy the extremum condition such that the microdynamic context retracing the trajectory t(N) from day0 to day1 as closely as possible is most robust in yielding the highest degree of the faithfulness of the retracement among t(1), t(2), t(N). At the same time, the trajectory t(N) is most robust in making the microdynamic context retracing t(N) as closely as possible to be highest in the degree of the faithfulness of the retracement among the conceivable contexts.

Once the robust trajectory of the macrodynamic data from today to tomorrow has been generated within today, a similar procedure can naturally apply to the data generation from tomorrow to the day after tomorrow, and so on even from the perspective from today. The present scheme of generating the macrodynamic data towards the future may provide the monetary authority and the participants in the economy with a tool to estimate the current conditions of the economy and to plan how to participate in it from now on.

5 Predicting and Regulating the Economic Trajectories

5.1 The 1987-1989 Episode

The Japanese monetary economy experienced an enormous enhancement of the rate of monetary flow disequilibration from late 1986 through early 1989 as demonstrated in Figure 1. That was seen as a crisis inducing a positive burst of the rate of disequilibration. In contrast, the United States economy did not exhibit the enhancement of the rate of disequilibration during the corresponding period as much as Japan experienced. One background underlying the enormous enhancement of the rate of disequilibration for Japan was the decisions made by the Bank of Japan to cut the discount rate five times down to 2.5% per year within the period starting from early 1986 through early 1987. Needless to say, we would not imply that the successive cutting of the discount rate was the major cause of the anomaly. Rather, what should be focused upon is simply that the enormous enhancement of the rate of disequilibration coincided with the occurrence of BOJ s successive cutting of the discount rate. The anomaly was then followed by BOJ s reversed decisions on increasing the discount rate from 2.5% through 3.25% up to 3.75% during the period over May 1989 through October 1989. The aftereffect of the sudden increase of the discount rate was seen in the sudden fall of the rate of disequilibration.

The rate of monetary flow disequilibration cannot remain either positive or negative indefinitely. Monetary flow disequilibrium should neither be exploded nor be faded away, otherwise the sustainable monetary economy would get into trouble. It would then seem quite natural that BOJ would have made an empirical judgment that it could not tolerate such an enhancement of the rate of disequilibration any more by early 1989 or much earlier. The pressing issue was how the policy making board or BOJ s monetary policy meeting could come to reach a decision collectively as identifying and diagnosing the current conditions of the economy in terms of, say, the rate of monetary flow disequilibration. Of course, although those macroeconomic figures such as the unemployment rate, the total income to the households and the total shipping of the products from the industrial corporations are the representative factors indicating the

current conditions of the economy, their causal analysis is extremely complicated compared to the rate of disequilibration because of their highly aggregated nature. In addition, those macroeconomic figures take some time, say, two weeks or more, for their compilation because of the involvement of current technical complications in data acquisitions through various channels of the government.

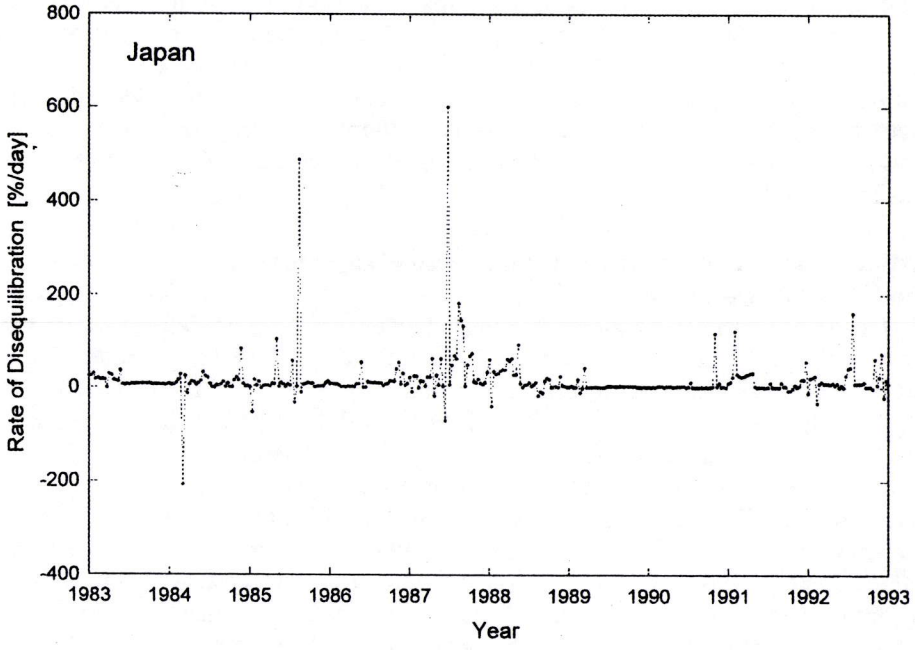

Figure 1: The rate of monetary flow disequilibration for Japan over the period of 1983-1993.

One advantage in paying attention to the rate of monetary flow disequilibration as a macroeconomic figure is seen in the aptness and quickness in its compilation. The nine different kinds of the macroeconomic data we referred to for estimating the rate of disequilibration are available to the monetary authority on the daily base. The rate of disequilibration can be updated every day. We are now facing such a situation that the policy making board of the monetary authority may be knowledgeable about today s conditions of the economy with the help of the rate of monetary flow disequilibration. The pressing agenda is then how to reach a reasonable decision towards tomorrow s conditions of the economy among the board members. At this point enters our scheme of generating the macrodynamic data towards the future as appealing to the underlying causal microdynamics.

One strategy for using the rate of monetary flow disequilibration for a regulative purpose is to try a what-if scenario. As addressing the 1987-1989 episode of the

Japanese monetary economy, one can raise a question of what would have happened if the hike of the discount rate from 2.5% to 3.25% annually occurred one, three or six months earlier than the actual happening in May 1989 or if BOJ decided to additionally sell government bonds 5%, 10% or 20% more than the amount of the actual transaction during the period over December 1988 through May 1989. The sole objective of this what-if scenario will be to examine the extent to which our scheme of generating the macrodynamic data towards the future could be perceived as being tolerable and objective by the concerned parties. In particular, if there is a need to change a previous decision, the policy making board will definitely require a reason for the change because of its accountability to the general public. Underlying this endeavor of a what-if scenario is our intention to provide the policy making board of the monetary authority with a tool to facilitate accountability to its decisions to be updated even every day.

We have generated the macrodynamic data under the conditions that the hike of the discount rate from 2.5% to 3.25% occurred one, three or six months earlier than the actual happening in May 1989 and that all of the macrodynamic data developed as following the mutual enhancement of the robustness between the microdynamic context of generating individual stochastic events and the macrodynamic data to be precipitated. The corresponding rates of monetary flow disequilibration are displayed in Figure 2. The rate of disequilibration decreased significantly as with the shift of the timing of the hike of the discount rate to earlier than the actual happening. The similar decrease in the rate of disequilibration was also observed with the increase of government bonds sold by BOJ by 5%, 10% or 20% more of the amount of the actual transactions during the period over December 1988 through May 1989.

The implication of the what-if scenario should not, however, be overemphasized as compared to the actual historical development. Instead, what the 1987–1989 episode has revealed in relation to the additional what-if scenarios is that the macroeconomic figure called the rate of monetary flow disequilibration is quite sensitive to the monetary policy figured out by the monetary authority and that the aftereffect of the policy changes onto the monetary economy as a whole lasts long. One significant aspect in this regard is that the macroeconomic consequence of changes in the monetary policy will soon appear in the economy in the form of changes in the rate of disequilibration. Compared to other macroeconomic indicators such as the unemployment rate, the total income to the households and the total shipping of the products from the industrial corporations, the rate of monetary flow disequilibration can be identified as a means to detect systemic risks, if any, lurking in the monetary economy as a whole even on the day-to-day basis. If they are willing to formulate what they would like to accomplish tomorrow in the form of the rate of monetary flow equilibration, the policy making board of the monetary authority can examine its likelihood even within today as appealing to the macrodynamic data generation upon the mutual enhancement of the robustness between the microdynamic context and the macrodynamic data.

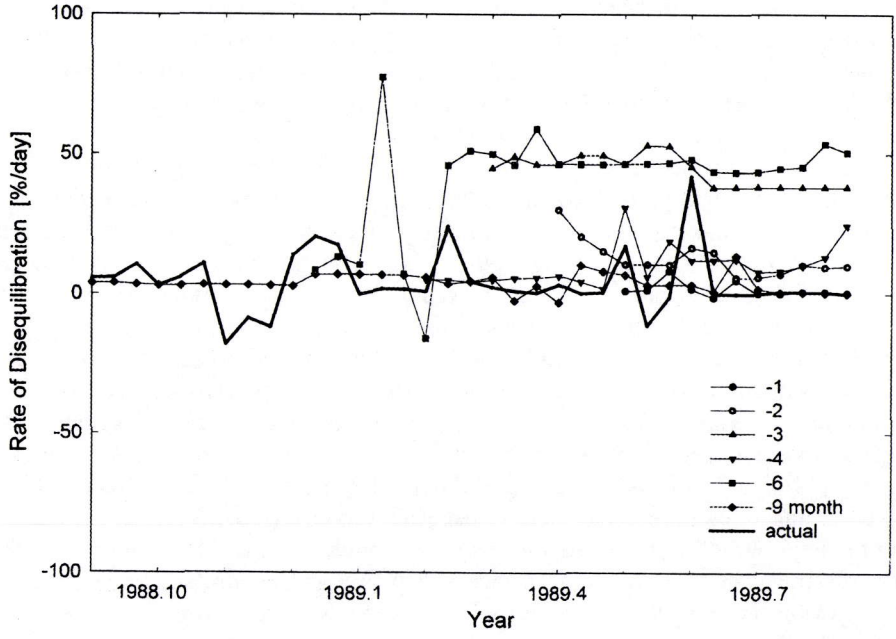

Figure 2: The rate of monetary flow equilibration for the what-if scenarios for Japan. The hike of the discount rate from 2.5% to 3.25% annually was supposed to occur one, two, four, six and nine months earlier than the actual happening on May 1989. The actual rate of disequilibration recorded in the real economy is shown in bold line.

5.2 The 1997–1998 Episode

The period over 1997 through 1998 was unique in the occurrence of an Asian systemic crisis starting with the collapse of the Thai currency in the foreign exchange markets. Japan was also not immune to the crisis. The rate of monetary flow disequilibration for the Japanese monetary economy covering the same period was then observed. What was peculiar in this observation was that the rate of disequilibration became negative to a significant extent even though during a limited period lasting over roughly from 10 to 20 days in late 1996. In comparison, the United States monetary economy did not make the rate of monetary flow disequilibration to go down below zero over the same covering period. As far as the Japanese economy was concerned, the period 1997–1998 was characterized by an incident inducing a negative burst of the rate of monetary flow disequilibration, just quite an opposite to the case of the period 1987–1989 characterized by a crisis inducing a positive burst of the rate of disequilibration.

The negative burst of the rate of monetary flow disequilibration is abnormal and literally exceptional in that the negative rate of disequilibration would come to eventually eliminate from the monetary economy an occurrence of monetary flow

disequilibrium as a prime factor driving the economy from within. In fact, the negative burst of the rate of disequilibration coincided with the two big incidents of economic failure. One was a failure of a major commercial bank, and the other was that a major securities firm voluntarily closed its operation as facing the danger of liability exceeding asset. The Japanese economy soon recovered its positive rate of disequilibration. However, if the recovery was not sufficient enough to offset the systemic failure incurred during the preceding period, the failure could endure in the economy under an invisible and disguised form and would transform potential next failure into a visible form more easily. The policy making board of the monetary authority badly needs a means to assess and to figure out the extent and the scope of enduring potential failures before it becomes too late. In this regard, the rate of monetary flow disequilibration provides the policy making board with a quantitative figure in reference to which the board could make a judgment on the well-being of the economy quantitatively.

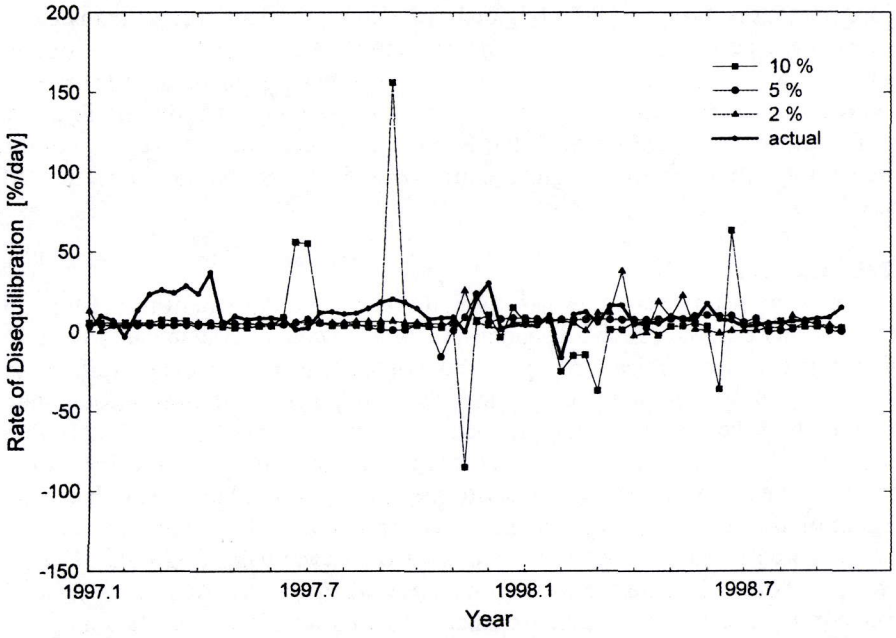

Figure 3: The rate of monetary flow disequilibration for the what-if scenarios for Japan. The amount of government bonds possessed by BOJ was supposed to suddenly increase by 2%, 5% and 10% more on January 1997. The actual rate of disequilibration recorded in the real economy is shown in bold line.

Just for the sake of simplifying our discussion, we examined a what-if scenario during the period 1997-1998. Our scenario was that BOJ suddenly increased the magnitude of the buying operation of the bonds soon after it recognized the negative

burst of the rate of monetary flow disequilibration in late 1996 slightly more than the size of the actual buying operations. All of the macrodynamic data were generated as following the dynamic scheme of the mutual enhancement of the robustness between the microdynamic context of generating individual stochastic events and the macrodynamic data to be precipitated. If we are interested in the conditions of the economy one year later to estimate the extent to which the failure occurred in late 1996 could endure in a disguised form over one year, the rate of disequilibration can present us a quantitative reference.

Figure 3 demonstrates how the rate of monetary flow disequilibration would develop in the economy under the what-if scenarios. It then turned out that if BOJ increased the magnitude of the buying operation 2%, 5% or 10% more than the actual one at the beginning of 1997 soon after the crisis, the expected rate of disequilibration since then responded accordingly. In particular, the 2% to 5% increase could regulate fluctuations in the rate of disequilibration to a considerable extent, while the 10% increase exhibited an adverse effect of overshooting in the rate of disequilibration.

The policy making board of the monetary authority is always sandwiched between the two dangers, that is to say, over-fueling and over-killing the economy. In many cases, the two dangers are separated only too closely. The 1997-1998 episode seems to suggest how sensitive and difficult it could be for the policy making board to draw a safe demarcation line between the two activities of over-fueling and over-killing the economy. The difficulty would come to the fore even if the board has recourse to the single-handed regulation of the magnitude of the selling and buying operation of government bonds.

5.3 The 2001 Episode

The Japanese monetary economy has come to enter into an extraordinary stage in 2001 due to the fact that the official discount rate hit as low as 0.25% annually because of its unique historical complications up to that point. Regulatory means available to BOJ would have to be sought in other than the manipulation of the discount rate especially in fueling the economy. In particular, the policy making board announced on the 15th of June 2001 that BOJ shall maintain the current deposit on the level of 5 trillion Yens as a means of supplying money to the economy and the decision has been put into effect on the very same day. The new level has been slightly above the amount of reserve stipulated by laws. This policy change would eventually imply that BOJ is going to supply money through the buying operation of the bonds. At issue is how to evaluate the consequence of such a policy change before its actual implementation.

Our means of evaluating such a what-if scenario will again be the robust dynamics between the macrodynamic data and the microdynamic context for generating the data. Figure 4 demonstrates how the amount of the bonds possessed by BOJ would develop since 15th of June 2001 upon our scheme of the robust dynamics. The prediction was made as of 11th of June 2001, just four days before the actual policy change to be implemented, on condition that the current deposit as a macrodynamic datum is going to be maintained on the level of 5 trillion Yens after 15th of June. All of the other macrodynamic data were generated from the microdynamic context that is taken to

mutually be robust against the data thus generated. Since the robustness alone cannot guarantee the uniqueness of the historical development of the economy, there could be many different trajectories of the development of the bonds possessed by BOJ while the prediction to be made started from the same initial day, as demonstrated there. The actual data of the bonds possessed by BOJ in the real economy were also appended to the extent they were available. For comparison, we made a prediction of the development of the bonds at BOJ under the condition that there would have been no such policy change in regulating the current deposit. The prediction was made as of 11th of June. The explicit difference of the macrodynamic data between a change and no change in the policy rests upon the fact that the those figures controlled by the central bank can be both causative and responsive. The amount of the reserve deposit is causally dynamic in influencing the activities of other economic agents in the economy. At the same time, the current deposit which the central bank eventually accepts is generated as a macrodynamic datum as responding to others activities.

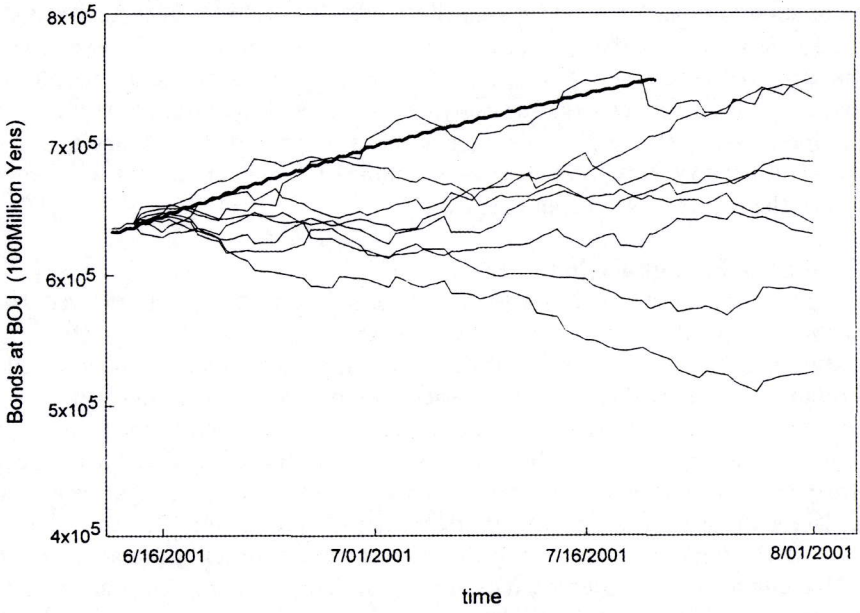

Figure 4: The amount of government bonds possessed by BOJ estimated by the prediction on the mutual enhancement of the macrodynamic data and the microdynamic context generating the data (see the text). The policy change made on the 15th of June 2001 for setting the reserve deposit on the level of 5 trillion Yens was implemented. The prediction was made as of 11th of June 2001, just four days prior to the actual implementation of the policy change. The actual development of the reserve deposit in the real economy is shown in bold line.

One characteristic of our dynamic scheme upon the mutual enhancement of the

robustness between the macrodynamic data and the microdynamic context generating the data could appreciate a consequence of the policy change in advance, compared to the cases otherwise. At the same time, there is no way in predicting the future uniquely. If there is any use of making a model for predicting the activities of the economy, one requirement would be to appreciate the occurrence of historical contingencies within the very model. Historical contingencies to be appreciated within the practice of predicting the economic activities would be equivalent to dynamically making an ensemble of their developmental trajectories on condition that each of them is taken to start from the same historical date identifiable in the record. Once the ensemble of such trajectories becomes available, one can estimate upon it the probabilistic nature of each sample trajectory. At this point, it should be emphasized that such a probabilistic nature is a consequence of the dynamics, but by no means the other way around.

Of course, the future development of the Japanese economy already subjected to the BOJ s decision on the current deposit made on the 15th of June 2001 certainly remains to be seen. This does not, however, imply that the development would solely be left to historical contingencies. What is at stake would be a sort of risk management. Once the ensemble of sample trajectories addressing the actual development of the economy can be prepared in advance by whatever means, can one make a probabilistic assessment of a desirable or undesirable event before its actual occurrence. Our scheme of enhancing the mutual robustness between the macrodynamic data and the microdynamic context generating the data is just one example intended for this kind of task. A sine qua non of risk assessment is within how to prepare an ensemble of contingent events without prior knowledge of the nature of such contingencies.

5.4 Predicting the Foreign Exchange Rate

One figure of merit evaluating the proposed prediction of the economic development will be the one referring to a quantitative figure directly. One of the representative quantitative figures could be the foreign exchange rate. We applied the present robust dynamics between the macrodynamic data including the foreign exchange rate and the microdynamic context generating such data to the prediction of the foreign exchange rate between the Japanese Yen and the US Dollar for the year of 2001 retrospectively. We predicted the foreign exchange rate four days ahead based upon the data available up to the date of attempting the prediction. The procedure was first to prepare the temporal sequence of the microdynamic context generating the most faithful retracement of the observed data up to the date of attempting the prediction. Then, we tried to figure out both the macrodynamic data and the microdynamic contenxt that can maximize the mutual robustness between the two in the direction towards the future, namely, four days ahead for each attempt of prediction. The predicted foreign exchange rate could be read from the macrodynamic data thus generated, though each trial was contingent upon the historical development that it was inevitably subject to.

One typical result we observed was on the coincidence factor between the actual data and the prediction as for whether the foreign exchange rate four days ahead would increase or decrease compared to the rate available on the date of attempting such

prediction. As far as the observed record is concerned, we can determine whether the foreign exchange rate four days ahead increased or decreased unambiguously in the record. The coincidence factor we came up with was about 59% statistically upon more than 1000 independent samplings. In other words, we tried to predict whether the foreign exchange rate four days later would be up or down compared to the actual rate observed today. Our scheme upon the mutual enhancement of the robustness between the macrodynamic data and the microdynamic context could predict the ups and downs of the rate four days ahead correctly with the statistical accuracy of 59%.

6 Concluding Remarks

Accountability required to the central bank is a double-edged sword. If the central bank is required to explain to the general public its policy change prior to its actual implementation, the standard tool to rely upon would be an analytical judgment based upon the historical facts frozen in the record. It could be conceivable to get the general agreement on the analytical judgment to the extent that everybody agrees upon the facts registered in the frozen record. If the development of the real economy is slow and steady, the policy figured out upon such an analytical judgment could work in reality. This analytical scheme, however, could not work effectively if the economy suffers its vicissitudes frequently as being subject to various systemic risks of endogenous origin. It may turn out to be too little and too late in the real economy. On the other hand, if the central bank were relieved of accountability to the general public, it would certainly lose its robustness in the economy including the monopoly of issuing bank notes.

A more concrete issue on approaching the accountability required to the central bank is how the policy making board constituting the inner core of the central bank can reach and update their decisions swiftly and unanimously, if ever possible, in accord with the actual pace of the real economy. For this purpose, we need an everybody-agreed-upon tool to identify and diagnose the conditions of the total economy of the most recent times. The rate of monetary flow equilibration we have tried is just one candidate for identifying the most recent conditions of the economy. As a matter fact, the monetary authority can technically evaluate today s rate of monetary flow disequilibration as consulting today s macrodynamic data being made available to them. Once the rate of monetary flow disequilibration joins in the macroeconomic figures to be consulted, it can also serve as a control parameter for how to regulate the monetary economy with the help of the scheme of generating the macrodynamic data through the mutual enhancement of the robustness between the causal microdyanmic context and the madrodynamic data to be precipitated. If it becomes feasible for the policy making board to afford them with the diagnosis of the monetary economy up until today and to generate the macrodynamic data towards the future even to some limited extent within today, the board can enhance the extent of accountability also among the board members. Accountability is not necessarily restricted to analytical perspicuity. Even frequent reproducibility of a similar empirical judgment on the predictive basis can enhance its accountability in the empirical domain.

Underlying the present scheme of quick decisions and enhanced accountability by the decision making body of the central bank is the recognition that there is clear

separation between the microdynamic context of generating individual stochastic events on the part of the participating economic agents and the macrodynamic data to be identified as such by the overseeing sector of the central bank. Both the participating agents and the overseeing sector of the central bank are the observers. However, they are different. The participating agents are involved in internal measurement conditioned on the stipulation that their viewpoints necessarily become their blind spots (Matsuno, 1989, 2000a), while the overseeing sector of the central bank partakes in external measurement as suffering from no blind spot of its own. Internal measurement is causal in passing any inconsistencies imputed to the presence of the blind spots constantly forward, while external measurement is globally consistent though not causal in itself. The decision making body of the central bank in fact takes advantage of both internal and external measurement. This aspect of maneuvering both internal and external measurement makes the role of the central bank literally unique in the economy in that no other economic agents can accommodate with themselves such a competency.

In short, some speculators can attack a weak currency in the foreign exchange market for their own sake. The central bank of each sovereign country tends to do whatever countermeasures it can figure out. Put differently, the central bank is required to hedge the discount rate against hedge funds circulating on the global scale. At issue is how the central bank can quicken its decisions and at the same time can enhance its accountability to the general public. The rate of monetary flow disequilibration presents a suggestion towards the well being of the economy.

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