Chapter 3 Credit flows: T-account matrix analysis

The 'T-account matrix' has been developed as a stock version of social accounting matrices (SAMs)[1] to explore mechanisms such as the direction and amount of flow of funds, and the knock-on effects of the reflexive (self-perpetuating but converging) repercussions in monetary economics. Originating from the T-account perspective, which consists of a parallel of one dimension with debit and credit, the 2-dimensional T-account matrix has raised its power of analysis with matrix algebra.

In an economy with only one currency, i.e., only one unit of account, the 2-dimensional T-account matrix presents a simple model to analyze the entire flow of funds. The 2-dimensional matrix analysis comprises the matrix of 'credit coefficients' and the inverse of 'interdependence coefficients of multipliers.' The former is a set of coefficients to show the supply of and demand for credit flows by sector. The latter, which can be derived from the matrix inversion, is a set of coefficients of multipliers to show the ultimate repercussions of entire credit flows in the economy. In the following model 1 and model 2, we will make use of the 2-dimensional T-account matrix to show multi-sectoral general equilibrium and its simulation.

3-dimensional T-account matrices will be used for the integral analysis of credit flows with plural currencies, i.e., at least two or more currency units of account, in economies of freely mobilized capital. It has the multi-layered structure of the 2-dimensional matrices for the respective unit of account, which are mutually connected

[1] A social accounting matrix (SAM) is defined as "the presentation of SNA accounts in a matrix which elaborates the linkages between a supply and use table and institutional sector accounts" (United Nations et al., 1993, par. 20.4). The SAM approach is further elaborated in the 1993 SNA to record all the transactions (i.e., flows) that place in a national economy during one year. See United Nations et al., chap. XX; Keuning, 1996, pp. 9-16.

through foreign exchange cross-rates. The following model 3 will demonstrate the power of the 3-dimensional T-account matrices analysis.

3.1 Model 1: Static circular flow

3.1.1 Model building: 2-dimensional T-account matrix

In order to construct a model of the entire credit flows in an economy, monetary stages that are classified by sector might be useful. Now, we will transform a parallel of one dimension of debit and credit by sector into the two-dimensional structure of a matrix. For analytical simplicity here, we may divide the whole economy into six representative sectors, i.e., central bank, banks, financial intermediaries, government, corporate business and individuals.

Table 3.1 is the 2-dimensional T-account matrix. In the Table 3.1, x_{ij} represents the outstanding amount of liabilities (in the form of credit instruments) issued by sector j that is held by sector i as one of its financial assets. Namely, on one hand, each sector issues credit instruments to finance its demand for credit. For example, the central bank mainly issues reserve money, banks issue deposit money, and the others issue credit securities. These are the financial debts of each sector. On the other hand, these sectors supply credit by holding these credit instruments as financial assets. In addition, they hold real assets in such forms as real estate, equities in physical capital, and foreign assets.

The 2-dimensional T-account matrix is constituted from empirical information on the credit-flows structure of the various sectors of an economy. Each of X_{1-6} represents the total outstanding amount of assets and liabilities in the six sectors. As a natural result of the double-entry rule for the T-account, assets and liabilities of each sector are equalized. In addition, it is important to note the corresponding relationship

between 'broad net worth' and 'broad real assets.' The former, i.e., broad net worth, takes the form of the liability items of each sector, comprising narrow net worth (i.e., accumulated wealth from the past),[2] corporate shares, and foreign debts to foreign entities such as foreign governments or enterprises. Broad net worth is the ultimate and final source of credit to others, and here is classified by the forms and entities of credit supply. On the other hand, the latter, i.e., broad real assets, takes the form of the asset items of each sector, comprising narrow real assets (i.e., real estate), equities in physical capital (i.e., corporate ownership), and foreign assets in whatever form, such as foreign currencies or bonds. Broad real assets are the ultimate and final use of credit from others, and here are classified by the forms and entities of credit demand.

Among the items of broad net worth on the Table 3.1, $W_{1\text{-}6}$ represent the nominal values of narrow net worth (i.e., the present value of accumulated wealth from the past) of the six sectors. In the same fashion, $S_{1\text{-}6}$ represent the repurchase (mark-to-market) values of corporate shares, and $FD_{1\text{-}6}$ represent the mark-to-market values of foreign debts that are held by non-residents. Among the items of broad real assets on the Table 3.1, $R_{1\text{-}6}$ represent the replacement values of narrow real assets (i.e., real estate) that are held by the six sectors. Similarly, $C_{1\text{-}6}$ represent the replacement value of equities in physical capital (i.e., corporate ownership), and $FA_{1\text{-}6}$ represent the mark-to-market values of foreign assets in whatever form, whether foreign currencies, bonds or the like.

[2] The total amount of narrow net worth (i.e., accumulated wealth from the past) adds up to the national wealth in the System of National Accounts (SNA).

3.1.2 Equilibrium of the model

3.1.2.1 Credit supply coefficients

For the purposes of mathematical manipulation, the total replacement value of broad real assets by sector would be represented by $R^b_{1\text{-}6}$. It is the aggregate of narrow real assets ($R_{1\text{-}6}$), equities in physical capital ($C_{1\text{-}6}$) and foreign assets such as foreign currencies and securities ($FA_{1\text{-}6}$). Hence, the vector $\mathbf{R^b}$ (3.1) and $\mathbf{X}$ (3.2) are shown as follows:

$$\begin{pmatrix} R^b_1 \\ R^b_2 \\ R^b_3 \\ R^b_4 \\ R^b_5 \\ R^b_6 \end{pmatrix} = \mathbf{R^b}.(3.1) \qquad \begin{pmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \\ X_6 \end{pmatrix} = \mathbf{X}.(3.2)$$

The amount of credit supply in the sector i that is absorbed by the sector j per unit of its total liability X_j is described by the symbol a_{ij}. We can define them as the 'credit supply coefficients matrix' of the sector i into the sector j. We introduce the matrix $\mathbf{A}$ as follows (3.3):

$$\begin{pmatrix} \frac{x_{11}}{X_1} & \frac{x_{12}}{X_2} & \frac{x_{13}}{X_3} & \cdots & \frac{x_{16}}{X_6} \\ \frac{x_{21}}{X_1} & \frac{x_{22}}{X_2} & \frac{x_{23}}{X_3} & \cdots & \frac{x_{26}}{X_6} \\ \frac{x_{31}}{X_1} & \frac{x_{32}}{X_2} & \cdots & \cdots & \frac{x_{36}}{X_6} \\ \vdots & \vdots & & & \vdots \\ \frac{x_{61}}{X_1} & \frac{x_{62}}{X_2} & \cdots & \cdots & \frac{x_{66}}{X_6} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} \\ a_{41} & a_{42} & a_{43} & a_{44} & a_{45} & a_{46} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{pmatrix} = \mathbf{A}.(3.3)$$

Thus, we have reached the matrix equation as follows (3.4):

$$\mathbf{A} \cdot \mathbf{X} + \mathbf{R}^{b} = \mathbf{X}. \quad (3.4)$$

Table 3.2 is the complete set of the credit coefficients of all sectors of a given economy arranged in the form of a rectangular table, which corresponds to the 2-dimensional T-account matrix of the same economy. Each coefficient (a_{ij}) explains what amount of credit supply from sector i is needed in order to increase (or decrease) one unit of mark-to-market value of the asset holding (i.e., it is also equal to one unit change of liability held) by sector j. The structure of matrix **A** is determined partly by the relative costs of credit supplies, which are mainly dependent upon the interest rates of various credit instruments, and partly by the direction and scale of the credit flows themselves.

3.1.2.2 Interdependence coefficients of multipliers

From the credit coefficient matrix equation (3.4), we can mathematically transform it into the inverse matrix. Consequently, we can define the inverse matrix $(\mathbf{E}-\mathbf{A})^{-1}$ as the 'interdependence coefficients of multipliers matrix,'[1] and substitute the simplified matrix **B** for it. The inversion of the matrix is processed into the matrix equation (3.5), where the letter **E** represents the unit matrix in the mathematical transformation. The matrix **B** is equal to the inverse matrix $(\mathbf{E}-\mathbf{A})^{-1}$ as shown in the matrix equation (3.6):

$$\mathbf{A} \cdot \mathbf{X} + \mathbf{R}^{b} = \mathbf{X}$$

$$(\mathbf{E} - \mathbf{A}) \cdot \mathbf{X} = \mathbf{R}^{b}$$

$$\therefore \mathbf{X} = (\mathbf{E} - \mathbf{A})^{-1} \cdot \mathbf{R}^{b}. \quad (3.5)$$

[1] A sufficient condition for this transformation is that, in the credit coefficient matrix A, the sum of the coefficients of each column (or of each row), i.e., Σa_{ij}, be not larger than 1 and that at least one of these column (or row) sums be smaller than 1.

$$(\mathbf{E}-\mathbf{A})^{-1} = \mathbf{B} = \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} & b_{36} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} & b_{46} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & b_{56} \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} \end{pmatrix} \quad (3.6)$$

Table 3.3 is the set of multiplier-coefficients of all sectors in a given economy, which corresponds to the 2-dimensional T-account matrix of the same economy. The coefficient of multiplier b_{ij} in the Table 3.3 indicates how much the total credit supply by sector i would increase (i.e., how much the total value of asset holding $[X_i]$ by the sector i would increase), if the credit demand of sector j had been increased by one unit (i.e., the sector j had increased its liabilities by one unit).

Some examples of multiplier-coefficients can help us understand their meaning. In the Table 3.3, the coefficient b_{21} stands for the 'money multiplier,' which is commonly known in the following equation: Money stock (≡ deposit money + liquid liabilities of deposit money banks) = Monetary base (≡ Reserve money + liquid liabilities of monetary authorities) × Money multiplier. That is, the coefficient b_{21} indicates how much the banking sector would ultimately supply credit, i.e., by what amount deposit money would increase in accordance with the growth of assets and liabilities of the banking sector, if the central bank had increased its liabilities, i.e., the issue of reserve money, by one unit. Similarly, the coefficient b_{14} represents how much reserve money would increase, if the government had issued bonds (i.e., governmental credit securities) to the value of one unit. The coefficient b_{26} represents how much deposit money would increase, if individuals had increased their borrowings through the issue of credit securities by one unit. That is why we can call

it the table of multiplier-coefficients, which illustrates the entire credit flows in an economy.

In Table 3.3, the aggregates of each column (Σb_{i1}, Σb_{i2}, . . . Σb_{i6}) are expressed by the symbols B_{i1}, B_{i2}, . . . B_{i6} respectively. Each aggregate, B_{i1}, B_{i2}, . . . B_{i6}, indicates how much credit supply would increase in the whole economy by sector, if the sector j had increased its liabilities through the issue of credit instruments by one unit. For instance, B_{i1} represents all the repercussions on credit supply at any level of the monetary stages when the central bank increased the issue of reserve money by one unit; B_{i2}, represents the impact should the banking system increase the issue of deposit money, and so on.

3.1.3 Applied manipulation of the model

3.1.3.1 Division of matrices

From the matrix equation (3.5) and (3.6), we can integrate them into (3.7) as follows:

$$\mathbf{X} = \mathbf{B} \cdot \mathbf{R}^{b} \quad (3.7)$$

The matrix equation (3.7) represents the knock-on effects of the reflexive repercussions caused by the change in prices of broad real assets. That is, what level the credit supply (**X**) of each sector would reach, or in other words, to what sum the total value of asset holding (**X**) by sector would grow, if the mark-to-market values of broad real assets ($\mathbf{R}^{b}$) that are held by sector increased by one unit.

Now, we can go a step further, through mathematical manipulations, to divide the vector of broad real assets ($\mathbf{R}^{b}$) in the matrix equation (3.7) into factors such as the narrow real assets (**R**: real estates and properties), equities in physical capital (**C**) and

foreign credit securities (**FA**: foreign assets in foreign-currency denominations). Each matrix equation is shown as follows in (3.8), (3.9), and (3.10):

$$\mathbf{X}_{(R)} = \mathbf{B} \cdot \mathbf{R} \quad (3.8)$$

$$\mathbf{X}_{(C)} = \mathbf{B} \cdot \mathbf{C} \quad (3.9)$$

$$\mathbf{X}_{(FA)} = \mathbf{B} \cdot \mathbf{FA} \quad (3.10)$$

where vector $\mathbf{X}_{(R)}$ represents the incremental portions of credit supply, or in other words, the total value of asset holding (both of financial and real assets) of each sector that arise from the growth of property prices (**R**). Similarly, vectors $\mathbf{X}_{(C)}$ and $\mathbf{X}_{(FA)}$ represent the incremental portions of credit supply or the total value of asset holding that arise from the growth in repurchase value of physical capital (**C**) and the mark-to-market value of foreign assets (**FA**).

Thus, the matrix equation (3.8) stands for how much the credit supply, i.e., the total value of both financial and real asset holdings $\mathbf{X}_{(R)}$ by sector would be influenced by changes in property prices (**R**). In the same way, the matrix equation (3.9) represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(C)}$ would be influenced by changes in repurchasing value of physical capital (**C**). The matrix equation (3.10) also represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(FA)}$ would be influenced by the revaluation of foreign assets (**FA**) that are denominated in a national currency, or changes in foreign asset holdings (**FA**) in its international investment position.

3.1.3.2 Transposition of matrices

With regard to the changes in property prices (**R**), we can measure how far the repercussions for credit flows would go, or in other words, how the total value of both

financial and real asset holdings $\mathbf{X}_{(R)}$ by sector would be ultimately influenced by the matrix equation (3.8). In the same way, can we calculate how much the repercussions for credit flows would be if other asset prices such as the mark-to-market value of corporate shares changed? Under the circumstances of the Asian financial crisis, drastic inflows of short-term capital caused asset inflation that led to the bubble phenomena across Asian economies as a whole. Can we measure the ultimate influence of foreign capital inflows over asset pricing in the denomination of the domestic currency?

Now we introduce the mathematical manipulation to transpose the matrix. The transposed matrix **A** is denoted by **A'**. The rows of **A** are the columns of **A'**, while the columns of **A** are the rows of **A'**. That is, if $\mathbf{A} = [a_{ij}]$, then $\mathbf{A'} = [a'_{ij}]$, where $a'_{ij} = a_{ji}$. From the 2-dimensional T-account matrix of Table 3.1, and similar to the model building of the matrix equation (3.4), we have the matrix equation (3.11) as follows:

$$\mathbf{A}' \cdot \mathbf{X} + \mathbf{W}^b = \mathbf{X}. \quad (3.11)$$

where the total mark-to-market value of broad net worth by sector would be represented by the vector $\mathbf{W}^b$. It is the aggregate of narrow net worth (**W**: national wealth by sector in the System of National Accounts), mark-to-market value of corporate shares (**S**), and foreign debts that are owed to non-residents (**FD**). We then mathematically transform it into the matrix equation (3.12) as follows:

$$\mathbf{A}' \cdot \mathbf{X} + \mathbf{W}^b = \mathbf{X}$$

$$(\mathbf{E} - \mathbf{A}') \cdot \mathbf{X} = \mathbf{W}^b$$

$$\mathbf{X} = (\mathbf{E} - \mathbf{A}')^{-1} \cdot \mathbf{W}^b$$

$$\mathbf{X} = |(\mathbf{E} - \mathbf{A})^{-1}|' \cdot \mathbf{W}^{b}$$

$$\therefore \mathbf{X} = \mathbf{B}' \cdot \mathbf{W}^{b}. (3.12)$$

where the matrix **B'** is the transposition of inverse matrix **B**. The matrix equation (3.12) represents to what level the credit supply (**X**) of each sector would rise, or in other words, to what amount the total value of asset holding (**X**) by sector would grow, if the mark-to-market value of broad net worth ($\mathbf{W}^{b}$) by sector increased by one unit.

Furthermore, we can mathematically divide the vector of broad net worth $\mathbf{W}^{b}$ in the matrix equation (3.12) into factors such as the narrow net worth (**W**), mark-to-market value of corporate shares (**S**), and foreign debts that are owed to non-residents (**FD**). Each matrix equation is shown as follows in (3.13), (3.14), and (3.15):

$$\mathbf{X}_{(W)} = \mathbf{B}' \cdot \mathbf{W}. (3.13)$$

$$\mathbf{X}_{(S)} = \mathbf{B}' \cdot \mathbf{S}. (3.14)$$

$$\mathbf{X}_{(FD)} = \mathbf{B}' \cdot \mathbf{FD}. (3.15)$$

where, the vector $\mathbf{X}_{(W)}$ represents the incremental portions of credit supply, or in other words, the total value of asset holding (both of financial and real assets) of each sector that is brought about by the growth of net worth value (**W**). Similarly, the vectors $\mathbf{X}_{(S)}$ and $\mathbf{X}_{(FD)}$ represent the incremental portions of credit supply or the total value of asset holding that are brought about by the growth of mark-to-market value of corporate shares (**S**), and those of foreign debts (**FD**).

Thus, the matrix equation (3.13) stands for how much credit supply, i.e., the total value of both financial and real asset holdings $\mathbf{X}_{(W)}$ by sector would be influenced by changes in net worth value (**W**). In the same way, the matrix equation

(3.14) represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(S)}$ would be influenced by changes in mark-to-market value of corporate shares (**S**). The matrix equation (3.15) also represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(FD)}$ would be influenced by the revaluation of foreign debts (**FD**) that are denominated in a national currency, or the changes in foreign debts (**FD**) in its international investment position.

3.2 *Model 2: Dynamic development*

3.2.1 Disequilibrium and economic development

In this study, we will use the term 'economic development' to mean the total asset accumulation (both financial and real assets) in an economy. Economic development in that sense is financed by "the creation of new purchasing power out of nothing—out of nothing even if the credit contract by which the new purchasing power is created is supported by securities which are not themselves circulating media—which is added to the existing circulation" (Schumpeter, 1989, p. 73). The dynamic development of the economy is triggered by the disequilibrium of credit flows in the system.

In order to analyze the disequilibrium of the system and its process of adjustment towards a new equilibrium, we can mathematically transform the matrix

$$\begin{pmatrix} dX_1 \\ dX_2 \\ dX_3 \\ dX_4 \\ dX_5 \\ dX_6 \end{pmatrix} = d\mathbf{X}.(3.16) \qquad \begin{pmatrix} dR^b{}_1 \\ dR^b{}_2 \\ dR^b{}_3 \\ dR^b{}_4 \\ dR^b{}_5 \\ dR^b{}_6 \end{pmatrix} = d\mathbf{R}^b.(3.17) \qquad \begin{pmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{pmatrix} = \mathbf{I}.(3.18)$$

equation $\mathbf{X}=\mathbf{B}\cdot\mathbf{R}^b$ (3.7) into the total differential equation. Let the increment to vector **X**, i.e., the set of the value changes of total asset holding by sector, be denoted by $d\mathbf{X}$ as in vector (3.16), which stands for economic development as the asset accumulation of the economy. Let the increment to vector $\mathbf{R}^b$, i.e., the set of the value changes of broad real assets by sector, be denoted by $d\mathbf{R}^b$ as in vector (3.17). If stock variables ($\mathbf{X}$, $\mathbf{R}^b$) are differentiated, the dimensions are reduced to flows ($d\mathbf{X}$, $d\mathbf{R}^b$) in a given period of time. In particular, the increments to real asset accumulation ($d\mathbf{R}^b$) correspond to the amounts of investments (**I**) by sector as in vector (3.18).

Consequently, we have the total differential equation (3.19) and its transformation (3.20):

$$d\mathbf{X} = (\partial \mathbf{X} / \partial \mathbf{R}) \cdot d\mathbf{R} = (\partial[\mathbf{B} \cdot \mathbf{R}] / \partial \mathbf{R}) \cdot d\mathbf{R}$$

By the definition of partial derivative of matrices, $\partial(\mathbf{B} \cdot \mathbf{R}) / \partial \mathbf{R} = \mathbf{B}$,

$$\therefore d\mathbf{X} = \mathbf{B} \cdot d\mathbf{R}. \quad (3.19)$$

$$d\mathbf{R} \cong \mathbf{I}$$

$$\therefore d\mathbf{X} \cong \mathbf{B} \cdot \mathbf{I}. \quad (3.20)$$

The matrix equation (3.20) represents how much the total value of asset accumulation would increase, if the amount of investment by sector grew by one unit. Therefore, it is reasonable to suppose that the inverse matrix **B** represents the set of the investment multiplier for asset accumulation. We can call it a 'dynamic model for economic development.'

At the same time, we must draw attention to the source of funds to finance investments. If investments can be compared to the engine of economic growth, funds would be the fuel. In the commonly utilized flow of funds analysis, the convention is to treat increases in assets as a use of funds, and increases in liabilities or net worth as a source of funds. We have identical equations for flow of funds (see Scott, 1995, p. 25) as follows (3.21):

$$\Delta \textit{ net worth} + \Delta \textit{ liabilities} \equiv \Delta \textit{ real assets} + \Delta \textit{financial assets}$$

$$\therefore \textit{Saving} + \textit{Borrowing} \equiv \textit{Investment} + \textit{Lending}. \quad (3.21)$$

In the identical equation (3.21), the left side is the source of funds, which consists of saving and borrowing. Because of these two sources of funds, there are two ideal types of economic development. In order to finance economic development, one is primarily dependent on domestic savings, and the other dependent on either internal or external borrowings. Roughly speaking, the economic growth of Asian countries in the early 1990s was mainly attributed to, and financed by, the high rates of domestic savings. In contrast, the high growth of the US economy in recent years could be attributed to the United States, as the largest debtor in the world, having been financed through huge external borrowings.

On the other hand, the right side of the identical equation (3.21) represents the use of funds. The increments to the values of real and financial assets correspond to investment and lending respectively. According to the theory of mercantilism in international trade and exploitation, the accumulation of movable properties, i.e., precious metals such as gold and silver, were deemed indispensable to a nation's wealth. If a nation did not possess mines or access to them, precious metals had to be obtained by trade. In order to accumulate foreign assets, it was believed that trade balances must be favorable, meaning an excess of exports over imports. Colonial possessions served as both markets for exports and suppliers of raw materials to the home country.

3.2.2 Boom and bust of a bubble economy

As already pointed out in the previous chapter, in spite of decades or even centuries of study, asset pricing is still the most challenging area to be explored.[4] Yet, to say the least, according to the standard discussions of monetary economics, we can define an

[4] For reference, see Tanioka, 1992a.

'asset bubble' as the excessive gap between mark-to-market value and the theoretical price of an asset (Noguhi, 1991, pp. 25-50; 1992, pp. 49-67). The theoretical price of an asset is called its 'fundamental value,' which is denoted by the discounted-cash-flow (DCF) model. All future flows generated by any asset, discounted by the market rates, should be equal to the fundamental value as follows (3.22):

$$V = \sum_t [F_t/(1+r_t)^t] \quad (3.22)$$

where V is the fundamental value, r_t a market discount rate, and F_t the flow generated by the asset at time t. For real estate, future flows are rent flows plus expected resale value at the end of the horizon. For a share, future flows are dividends plus expected resale value at the end of the horizon. For a bond, future flows are interest flows plus the repayment of capital. For credit, the mark-to-market value is also the discounted value of future payments, interest and capital, despite the credit not being listed in any market.

However, the mark-to-market values of both financial and real assets are volatile with a broad variance. They are dependent upon not only the fundamental values that are inferred from discounted cash flows but also the confidence in market value. Once the adjustment of an asset bubble begins, the credit flows would be spun into a deflationary spiral. The processes and reflexive effects of the explosion of a bubble can be explained by the above-mentioned matrix equations. As for a decline in property prices, the matrix equation $\mathbf{X_{(R)}=B \cdot R}$ (3.8) stands for how much the credit supply, i.e., the total value of both financial and real asset holdings $\mathbf{X_{(R)}}$ by sector would be influenced by the change in property prices ($\mathbf{R}$). With regard to the redemption of non-performing loans of the banking system, the value of net worth shrinks through the settlement of the account. The matrix equation $\mathbf{X_{(W)}=B' \cdot W}$ (3.13) stands for how much the credit supply, i.e., the total value of both financial and real

asset holdings $\mathbf{X}_{(W)}$ by sector would be influenced by the changes of net worth value (W). In the same way, the matrix equation $\mathbf{X}_{(S)}=\mathbf{B}'\cdot\mathbf{S}$ (3.14) represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(S)}$ would be influenced by the changes of mark-to-market value of corporate shares (S). As for the outflows of short-term capital, it leads to a sharp decline in outstanding foreign debts. The matrix equation $\mathbf{X}_{(FD)}=\mathbf{B}'\cdot\mathbf{FD}$ (3.15) represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(FD)}$ would be influenced by changes in foreign debts (FD).

3.2.3 Law's system

3.2.3.1 Bubble phenomena in retrospect

Bubble phenomena are by no means novel in the economic history of mankind.[5] One of the earliest and most extraordinary speculative manias, which occurred in the Netherlands in the 1630s, was dubbed "tulip-mania." Tulips were introduced into Holland from the Ottoman Turk Empire in 1593 and soon met with much favor among the Dutch. In 1633, a great rush to buy tulip bulbs began, for everyone thought that it would be possible to get rich from the cultivation of these tubers. In the absence of bank credit at that stage of financial development, down-payments were frequently made in kind. They pawned their jewelry, mortgaged their homes, and sold productive enterprises in order to buy bulbs. In one case, for a pound of White Crowns (which were sold by weight because of the ordinariness of the variety), 525 florins were to be paid on delivery, but there was an immediate down-payment of four cows. Other down-payments consisted of tracts of land, houses, furniture, silver and gold vessels, paintings, a suit and a coat, a coach and dapple-gray pair of horses; and for a single

[5] The subsequent description owes much to the following works on economic history: Clough, 1959, pp. 192-217; Galbraith, 1998; Kindleberger, 1996; Noguchi, 1992, pp. 69-93.

Viceroy (a rare variety), valued at 2,500 florins, two *lasts* (a measure which varies by commodity and locality) of wheat and four of rye, eight pigs, a dozen sheep, two oxheads of wine, four tons of butter, a thousand pounds of cheese, a bed, some clothing, and a silver beaker. Eventually, on February 4, 1637, the collapse came suddenly, bringing ruin to the uncanny greedy and a rich harvest to the canny few.

Also in the Netherlands came the second example of speculation, this time, however, in hyacinth bulbs. This was called "hyacinth-mania" in the 1730s, and was exactly the same as the boom and bust of a century before. The collapse came in 1739, when the prices of bulbs sharply declined to the levels of only 1/10 or 1/20 compared with the peak record in 1734.

In the second decade of the eighteenth century, there was a great wave of speculation, this time centered in France and England. In France, the movement was connected with the name of John Law. He established a central bank with the privilege to issue bank notes, and in addition, Law attempted other ambitious projects through joint-stock companies enjoying many privileges of monopoly. It was called the "Mississippi Scheme" or, after him, "Law's system," which collapsed in 1720. During the early enthusiasm for John Law following his first success, the French, particularly the Parisians, got the notion that Law was a financial wizard and believed in his Midas' touch. Further details of his financial scheme and the credit flows in it will be explained later in the framework of the T-account matrix model.

While these events were taking place in France, England was also having a paroxysm of speculation. The "South Sea Company" was established in 1710 as a joint-stock company. The Company sold stock to raise capital and took government securities in payment for the shares. As a result of the Treaty of Utrecht in 1713, the Company received an extraordinary windfall, in which the *Asiento* privilege, i.e., the

right to the slave trade in Spanish America, was bestowed upon the Company. In 1719, the Company decided to take over government debts, by which the government effected a reduction in the rate of interest to be serviced. Moreover, in exchange for the government bonds, the holders could obtain South Sea Company stock, which was increasing in price. On top of that, the Company realized a sizable profit on that deal. The entire operation was so successful that the Company soon agreed to take over the entire public debts of England that were owed to the Bank of England and the East India Company. The favorable issue of this gigantic undertaking hinged upon the rise in price of South Sea Company stock, so that holders of government bonds would exchange their bonds for stocks. The price of the stock increased from £129 at the end of January, 1720, to £1,050 on June 24, 1720. This extaordinary rise carried the entire list of stocks into a raging bull market. What was worse, the wave of speculation brought into being a host of "bucket operators," who founded all manner of fly-by-night concerns in order to get into the stock-selling act. Some of these phony operators were of the most brazen kind, such as a company for making gold out of sea water, one for improving the fortune of children, another for bringing fire from hell, and still another for "purposes which shall hence forth be disclosed." The South Sea Company objected strenuously to this kind of competition and got a bill through Parliament, called the "Bubble Act (1720)," which forbade the founding of stock companies without an act of the legislature. In spite of such measures, the price of the shares of the remaining companies continued to soar, although their earnings did not warrant these increases. Finally, when the South Sea Company won a law suit against four companies which were misusing their charters, and thereby aired some of the worst abuses to which the corporate form was being subjected, speculators began to run for cover. In August, prices began to fall, with South Sea stock going down to

£120 in December and the shares of other concerns falling precipitously, some of them, indeed, vanishing with the companies themselves.

In the first half of twentieth century, we have witnessed the boom and bust of a bubble economy in the Great Depression, the economic slump in North America, Europe and other industrialized areas of the world that began in 1929 and lasted until about 1939.[6] It was the longest and most severe depression ever experienced by the industrialized world. Although the US economy had gone into depression six months earlier, the Great Depression may be said to have started with a catastrophic collapse of stock-market prices on the New York Stock Exchange in October 1929. During the next three years stock prices in the United States continued to fall, until by late 1932 they had dropped to only about 20% of their 1929 value. Besides ruining many thousands of individual investors, this precipitous decline in the value of assets greatly strained banks and other financial institutions, particularly those holding stocks in their portfolios. Many banks were consequently forced into insolvency; by 1933, 11,000 of the United States' 25,000 banks had failed. The failure of so many banks, combined with a general and nationwide loss of confidence in the economy, led to much-reduced levels of spending, demand, and hence of production, thus aggravating the downward spiral. The result was drastically falling output and drastically rising unemployment; by 1932, US manufacturing output had fallen to 54% of its 1929 level, and unemployment had risen to between 12 and 15 million workers, or 25-30% of the work force. The Great Depression began in the United States, but quickly turned into a worldwide economic slump owing to the special and intimate relationships that had been forged between the United States and European economies after World War I. The United States had emerged from the war as the

[6] For more details on the Great Depression, see Hayashi, 1988; Galbraith, 1998.

major creditor and financier of postwar Europe, whose national economies had been greatly weakened by the war itself, by war debts, and, in the case of Germany and other defeated nations, by the need to pay war reparations. So once the American economy slumped and the flow of American investment credits to Europe dried up, prosperity similarly collapsed there. The Depression hit hardest those nations that were most deeply indebted to the United States, i.e., Germany and Great Britain. In Germany, unemployment started rising sharply in late 1929 and by early 1932, it had reached 6 million workers, or 25% of the work force. Britain was less severely affected, but its industrial and export sectors remained seriously depressed until World War II. Many other countries had been affected by the slump by 1931. Almost all nations sought to protect their domestic production by imposing tariffs, raising existing ones, and setting quotas on foreign imports. The effect of these restrictive measures was greatly to reduce the volume of international trade: by 1932 the total value of world trade had fallen by more than half as country after country took protectionist measures against the importation of foreign goods.

The Japanese boom and bust of 1988-1990 is a complex story with gradual deregulation of financial controls, large Japanese outward investments and foreign inward investments in Japan, an exchange rate that appreciated as the yen went from 260 to the dollar in 1982 to a peak of 80 before receding slightly to 100, and an effort by the Japanese monetary authorities to cooperate with those of the G-7—finance ministers of Britain, Canada, France, Germany, Italy, Japan, and the United States—in lowering interest rates in the mid-1980s as a stimulus to world recovery. The reduction in the Bank of Japan's discount rate, especially from 1986, which sparked the bubble, was taken simultaneously with similar action by the Federal Reserve System in the United States and the Bundesbank in the Federal Republic of Germany.

In reverse, however, first the United States in the middle of 1987 and then Germany in 1988 began inching their rates upward. The Bank of Japan waited until a new governor, Mieno Yasushi, took over in December 1989, to change direction. This precipitated a crash in January 1990. The blow to financial institutions was heavy, which has significantly enhanced the estimates of the bad loans of banks and financial institutions. Commercial and industrial enterprises are going bankrupt at a steady rate of more than 1,000 a month. The Japanese economy is on the verge of a deflationary spiral on top of the decade-long recession of the 1990s.

Among these bubble phenomena, we would like to take Law's system as a model case for analysis. Firstly, because it was not only the boom and bust of asset prices but also the entire bubble phenomenon of credit flows based upon its financial scheme with spiral reflexivity. Secondly, due to the limited number of participating agents, the model can be highly abstracted.

3.2.3.2 Financial scheme of Law's system

John Law was born on April 21, 1671, in Edinburgh, Scotland. He studied mathematics, commerce, and political economy in London. After killing an adversary in a duel, he fled to Amsterdam, where he studied banking operations. A decade later Law returned to Scotland, and wrote his best-known work, Money and trade considered, with a proposal for supplying the nation with money (1720). He shared with his mercantilist contemporaries a belief that money is a creative force in economic development, and that an increase in its quantity would stimulate a larger national product and augment national power. He, however, differed from other mercantilists in looking on a central bank as an agency for manufacturing money in the form of bank notes that would circulate in place of gold and silver, which were scarce.

Law submitted his banking reform plan to the Scottish parliament, but it was rejected. After several other rejections, he received permission in 1716 to try his plan in France, by whom he was given a charter for a bank modeled on the Bank of England. At that time, the French government was heavily in debt because of the extensive wars of Louis XIV, who had died in 1715, and Law's program, which promised to reduce the public debt, held obvious appeal. In Paris, he founded a bank at once, and began to accept deposits, to transfer funds, to make loans, to accept bills of exchange, to discount promissory notes, and most significantly of all, to issue bank notes. However, from the very outset, the Bank was on shaky ground, for only one-fourth of its capital was paid in and much of this was in the form of government securities of dubious value. The Bank then became a royal institution with the King as sole stockholder in 1718, and after this, heavy investments were made in government securities. But, far worse, the Bank went overboard in issuing bank notes and investing in wild speculations. Then bank notes were issued in such volume that the whole experience provided a classic example of overissue: notes to the amount of 148,560,000 livres were issued in the first two and a half years, and 2,696,000,000 livres worth of notes were outstanding in May 1720.

In addition to the Bank, Law attempted other ambitious projects. The first of these was the 'Mississippi Company,' which was founded in 1717, a year after the opening of the bank. The plan for this institution was actually devised by others rather than Law, in order to mop up the floating debt obligations of the country by selling stocks in a company, which eventually would profit from privileges granted it by the government. From the outset, the Company was given the exclusive right of trading with Louisiana, of developing mining interests there, and of importing a certain number of slaves. Then a year later, it was granted a monopoly of the beaver trade in

Canada. With these privileges in hand, the Company appeared a good investment and its stocks sold well from the outset. Its initial popularity went to the heads of its sponsors, however, and they immediately began expanding the scope of the enterprise. In 1718, they bought the tobacco monopoly in France. In 1719, when the name of the Company was changed to 'Company of the Indies,' they took over other French trading companies, such as the French East India Company, the Guinea Company, the Company of Santo Domingo, the China Company, and the African Company. They even obtained the privilege of collecting those taxes which were farmed out, of minting coins, and of managing the public debt.

This extraordinary concentration of commercial and financial power was made possible by a simple but ingenious financial scheme. The Company's capital was raised by selling shares in exchange either for government securities or for bank notes issued by the Bank. In the case of payment by government securities, the Company received the interest payment serviced by the government, which the Company could use to finance other productive investments. At the same time, the absorption of the public obligations in such a manner could strengthen the credit standing of these government securities, which also formed a large part of the Bank's portfolio. In the case of payment by bank notes, the Company could use them to make loans to the government. Furthermore, it could even improve the liability position of the Bank, because, with the Company holding large amounts of bank notes, the danger of a run on the Bank was reduced. More importantly, the excessive supply of money stock could be alleviated to no small extent through the absorption of bank notes by the Company. To sum up, there was a reflexive mechanism of credit flows in the monetizing processes of government debts; (a) the Company issued shares as credit securities to raise funds, which were collateralized by government securities and the

bank notes issued by the Bank and (b) the Bank issued bank notes as deposit money, which were collateralized by government securities and the shares issued by the Company.

People began to bid up the price of the Company shares until a raging bull market in the Mississippi stock developed. This was facilitated by the fact that the shares, made out to the bearer rather than to a specified person, were transferable from person to person, and by Paris already having an active money market. By December 1719, the Company stock with a par value of 1,000 livres was selling at 10,000 livres, and Law was selling more and more shares. In January 1720, when the Company and the Bank merged, people actually rioted in the Rue Quincampoix (the location of the Paris Bourse) in their efforts to buy stock. Again, individuals liquidated their possessions in order to get title to a part of Law's enterprises. Under such pressure, prices of shares kept climbing, but they finally reached resistance points, beyond which buyers would not go. Suddenly, people lost confidence in Law's schemes and in his bank notes. Law tried to stop the avalanche of selling by forbidding speculation in the Rue Quincampoix and by throwing much of his personal fortune into the breach. However, his efforts were to no avail. By July, the 'Mississippi bubble' had burst ignominiously. Law was forced to flee France, and he died in Venice a poor man on March 21, 1729.

3.2.3.3 A model: the boom and bust in Law's system

Let us begin our analysis by building a model of Law's system. First, in order to construct a T-account matrix model, we need to prepare the T-account (i.e., a socially combined balance-sheet) by sector in the economy, which consists of credit instruments with various monetary stages. Second, we should synthesize them into the

2-dimensional T-account matrix by filling each cell with the values of corresponding assets and debts by sector.

Table 3.4 is the T-account matrix model, which represents the state of affairs in Law's system. Following the above-mentioned financial scheme, the model consists of four sectors, i.e., the government, the Bank, the Company, and the public. The figures in each cell stand for the imaginary values of assets and debts. It should be noted that, for simplicity, the broad real assets consist of only the investments in Mississippi by the Company, and that the broad net worth, which corresponds to the value of broad real assets, represents the accumulated savings of the public from the past. Moreover, also for simplicity, we regard the shares issued by the Company as non-financial public credit securities here.

Based on the T-account matrix model, we can use mathematical manipulation for the next step in the process. The matrix **A** (3.23), which represents the credit supply coefficients, can be obtained in the same way by manipulation of the matrix (3.3):

$$\mathbf{A} = \begin{pmatrix} 0 & 2/5 & 2/7 & 0 \\ 1/2 & 0 & 3/7 & 0 \\ 1/2 & 2/5 & 0 & 0 \\ 0 & 1/5 & 2/7 & 0 \end{pmatrix} \quad (3.23)$$

Then, similarly to the inversion of the matrix in the matrix equation (3.5) and (3.6), we can obtain the inverse matrix $(\mathbf{E}-\mathbf{A})^{-1}$, which is equal to the interdependence coefficient of multiplier matrix **B**, as shown in the matrix equation (3.24):

$$\mathbf{E}-\mathbf{A} = \begin{pmatrix} 1 & -2/5 & -2/7 & 0 \\ -1/2 & 1 & -3/7 & 0 \\ -1/2 & -2/5 & 1 & 0 \\ 0 & -1/5 & -2/7 & 1 \end{pmatrix}$$

$$\therefore (\mathbf{E}-\mathbf{A})^{-1} = \mathbf{B} = \begin{pmatrix} 29/12 & 3/2 & 4/3 & 0 \\ 25/12 & 5/2 & 5/3 & 0 \\ 49/24 & 7/4 & 7/3 & 0 \\ 1 & 1 & 1 & 1 \end{pmatrix} \quad (3.24)$$

Finally, we reach Table 3.5 from matrix **B** (3.24), which represents the set of multiplier-coefficients of all sectors in Law's system. The coefficient of multiplier b_{ij} in the Table 3.5 indicates how much the total credit supply by sector i would increase (i.e., how much the total value of asset holding by sector i would increase), if the credit demand of sector j increased by one unit (i.e., sector j increased its liabilities by one unit).

The meaning of the figures could be interpreted as follows. For example, when we look at the column of credit demand by government, we see that the knock-on effects of the reflexive (self-perpetuating but converging) repercussions of credit flows shows that, when the government issued bonds (i.e., governmental credit securities) amounting to one unit, the government itself would increase its total asset holdings by 2.4167 units (b_{11}), meaning conversely the additional issue of 1.4167 units of government bonds; the Bank would increase its total asset holdings by 2.0833 units (b_{21}), meaning conversely the same increase in the issue of bank notes; the Company would increase its total asset holdings by 2.0417 units (b_{31}), meaning conversely the same increase in the issue of shares; the public would increase asset holdings from their accumulated savings by only one unit (b_{41}); and in the economy as a whole, total asset holdings (i.e., the credit supply) would increase by 7.5417 units (B_{11}).

Now looking at the credit demand column of the Bank, we see a similar effect of the reflexive repercussions showing that, when the Bank issued bank notes (i.e.,

reserve money) by one unit, the government would increase its total asset holdings by 1.5 units (b_{12}), meaning conversely the same increase in the issue of government bonds; the Bank itself would increase its total asset holdings by 2.5 units (b_{22}), meaning conversely the additional issue of 1.5 units of bank notes; the Company would increase its total asset holdings by 1.75 units (b_{32}), meaning conversely the same increase of the issue of shares; the public would increase the asset holdings from their accumulated savings by only one unit (b_{42}); and in the economy as a whole, total asset holdings (i.e., the credit supply) would increase by 6.75 units (B_{i2}).

Likewise, if we examine the credit demand column of the Company, we see an end result of the reflexive repercussions showing that, when the Company issued shares (i.e., non-financial public credit securities) amounting to one unit, the government would increase its total asset holdings by 1.3333 units (b_{13}), meaning conversely the same increase in the issue of government bonds; the Bank would increase its total asset holdings by 1.6667 units (b_{23}), meaning conversely the same increase in the issue of bank notes; the Company would increase its total asset holdings by 2.3333 units (b_{33}), meaning conversely the additional issue of 1.3333 units of shares; the public would increase the asset holdings from their accumulated savings by only one unit (b_{44}); and in the economy as a whole, total asset holdings (i.e., the credit supply) would increase by 6.3333 units (B_{i4}). In this model, there might seem to be a bias with the multiplier-coefficients appearing much bigger than the normal and actual cases. This could be explained by the high degree of spiral reflexivity in this financial scheme. By making use of this model, we can explore the entire credit-flow mechanism, and end results of the reflexive (self-perpetuating but converging) repercussions in the system, in which the bubble grew at such a rate that the impact of its implosion was so great.

Furthermore, we can explain the processes of the boom and bust in Law's system by utilizing the T-account matrix model. In order to measure the impact of the value-changes of real assets on the whole economy, we need to recall the matrix equation (3.19):

$$d\mathbf{X} = \mathbf{B} \cdot d\mathbf{R} \quad (3.19)$$

From Table 3.4 of the T-account matrix in Law's system, we can obtain the vector $d\mathbf{R}$ (3.25), which represents the change by one unit in the replacement (mark-to-market) value of the real assets held by the Company in Mississippi:

$$d\mathbf{R} = \begin{pmatrix} 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} \quad (3.25)$$

If we substitute the matrix **B** (3.24) and the vector $d\mathbf{R}$ (3.25) for those in the matrix equation (3.19), we can obtain the vector $d\mathbf{X}$ as follows (3.26):

$$d\mathbf{X} = \begin{pmatrix} 1.3333 \\ 1.6667 \\ 2.3333 \\ 1.0000 \end{pmatrix} \quad (3.26)$$

Thus, we have finally arrived at vector $d\mathbf{X}$ (3.26), which represents the changes in total value of asset holding (both financial and real assets) of each sector that are brought about by changes in property prices in Mississippi.

So, in the expanding process of the economy, when the replacement (mark-to-market) value of investments by the Company in Mississippi increased by one unit, the ultimate effect on the total value of the asset holding by sector would be as follows: for the government, the total value of asset holding would increase by 1.3333 units; for the Bank, it would increase by 1.6667 units; for the Company, it would

increase by a further 1.3333 units, arising from the initial expansion of one unit; for the public, it would increase by one unit. This was the speed of expansion of the economy. Once people had lost confidence in Law's system and the economy was in reverse, credit flows would spin into a deflationary spiral at the same speed.

3.3 *Model 3: International credit flows*

3.3.1 International currency

3.3.1.1 Definition

We can define 'international currency' as a specific national currency or liquidity that can be used and stored for the purposes of international transactions and foreign exchange (Iwami & Kawai, 1990a, p. 74; Kawai, 1994, p. 325). It must be endowed with such attributes as 'convertibility'[7] in both current and capital accounts,[8] stability of purchasing power, international acceptance, convenience for use and store, and the like.

3.3.1.2 Functions

Similar to monetary functions for domestic use, it has been recognized that international currency also possesses three major monetary functions in international transactions and foreign exchange: (a) international liquidity as a means of payment—or medium of exchange, (b) external reserve as a store of value, and (c) convertibility as a unit of account—or measure of value.

The 'liquidity' function means the ability of an asset to discharge debt through canceling out both sides of the T-account, which corresponds to monetary function as

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[7] With regard to the definition of 'convertibility,' there seems to be little agreement. For example, McKinnon defined it independently of the exchange rates with foreign currencies that a government may be obliged to maintain, while Triffin identified it with the elimination of all quantitative restrictions on trade and payments on current account. See Triffin, 1961, p. 23; McKinnon, 1979, p. 6.

[8] Considering the huge amount of cross-border capital flows and its rapid growth, the convertibility in current account for trade of goods and services is not enough for the definition of international currency. It should better include, in addition, convertibility in capital account for transactions of assets.

a means of payment—or medium of exchange. Thus, we recognize that 'international liquidity' is essential for the settlement of all international transactions (in both current and capital accounts). With regard to a means of payment—or medium of exchange, international currency can be called a 'vehicle currency,' functioning as a hub for international transactions and foreign exchange. This pivotal role of the vehicle currency is supported by high availability of large-scale funds, easy access to relevant transaction markets, and the reliable stability and large variety of hedging means in those markets.

The 'external reserve' function of international currency corresponds to that of store of value. The monetary authorities are responsible for maintaining adequate external reserves of international currencies (in particular, a key currency) through the management of balance-of-payment adjustments. With regard to store of value, international currency is called 'reserve currency' or 'intervention currency,' in order to make provision for unforeseen expenses in international liquidity in such cases as deficits in the balance of payments or some international financial crisis. Reserve currency constitutes the cross-border financial portfolios held by the private sector and the foreign reserves of monetary authorities. While the financial portfolios held by the private sector reflect the function of a store of value, that of official foreign reserves seems to reflect mixed functions of international currency, i.e., a means of payment for intervention purposes and a store of value for asset management purposes in short-term investment.

The 'convertibility' function of international currency is the modified expression of the stability of value of national currency, which corresponds to monetary function as a unit of account—or measure of value. We must note that convertibility is the most essential precondition for international currencies. Thus, the

suspension of the convertibility of a national currency means the realization of the credit risk of that currency in the international financial system. From the aspect of a unit of account—or measure of value, international currency is called 'invoice currency,' providing an invoicing or billing currency unit for international trade of goods and services and capital transactions. This function of international currency may reflect the balance-of-power relationships between exporters and importers in negotiations to avert exchange rate risks, which are determined by the probability variance of such risks, the difference in risk preference, the levels of negotiating skills and so forth.

3.3.1.3 Key currency

We use the term 'key currency' for an international currency that possesses all these functions of international currency most effectively as an anchor in a currency area (Iwami & Kawai, 1990a, p. 77). More generally, there are some conditions which must be met both to be a key currency and to keep this position, and include: (i) the relative size of financial markets (both medium- and long-term bond markets as well as short-term treasury bonds and money markets), (ii) the relative size, availability, and level of derivative facilities, (iii) exchange rate reliability in connection with current account positions, (iv) the international presence and competitiveness of one particular economy and its financial institutions providing the original currency funds, and (v) the effect of inertia (the invoicing practice of crude oil and other primary products and the pricing practice of international products).

In the real world of international finance, the role of US dollar as a key currency must be examined within this framework. In particular, concerning condition (iii) above, we may recall that the international financial community did not always demonstrate complete trust in the US dollar during several periods in the 1970s and

1980s. It may be extremely difficult to explain why the currency issued by the United States, i.e., a net debtor country vis-à-vis the rest of the world, has long kept its position as a key currency. However, an analysis of the dollar's position will be suggestive of the international role of both the emerging euro and the yen in the future.

3.3.1.4 Seigniorage

'Seigniorage'[9] has been used to mean a claim over something arising from the exercise of sovereign prerogative. In a historical context, the term 'seigniorage' was used to refer to the share, fee or tax, which the 'seignior' i.e., the lord of a manor who had jurisdiction over territory, or sovereign took to cover the expenses of minting coins and for profit. With the introduction of paper money, larger profits could be made, because bank notes cost much less to produce than their face value. When central banks came to be monopoly suppliers of bank notes, seigniorage was reflected in their profits, and ultimately remitted to their major or only shareholder, the government. Accordingly, so long as non-interest-bearing notes circulate as currency, the government continuously earns the interest that it would otherwise have to pay, if it borrowed the money. Thus, seigniorage can be calculated by multiplying notes and coin outstanding (non-interest-bearing central bank liabilities) by the long-term rate of interest on government securities (a proxy for the return on central bank assets).

Similarly, under a pluralist regime, the anchor state that issues a key currency (henceforth, known as the key-currency state) can benefit from their monopoly of seigniorage in the sense that internationally held assets denominated in the key currency might bring about the same effects as profiting by free or low cost finance

[9] See BIS, 1996, p. 15; Scott, p. 96.

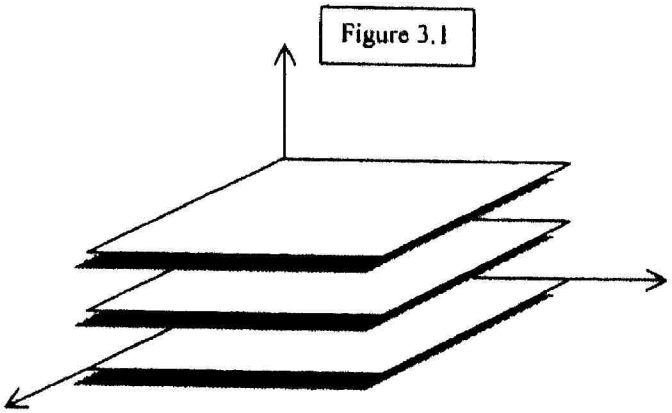
from overseas.[10] In respect of the benefits generated by the internationalization of a currency, seigniorage refers to the spread between the rate of return on longer-term investments and the low cost of short-term financing both denominated in their own key currency, which an issuer of an international currency undertakes as a banker to the world. (Kawai, 1994, p. 331; MOF, Japan, 1999, References, pp. 13-15).

3.3.2 Equilibrium and disequilibrium in the pluralist regime

3.3.2.1 3-dimensional T-account matrices model

For the integral analysis of entire credit flows in open economies of freely mobilized capital, we will introduce here the 3-dimensional T-account matrices model for a pluralist regime, i.e., an economy with at least two or more currency units of account. The model constitutes a multi-layered structure with the 2-dimensional matrices for respective currency units of account, which are mutually connected through the foreign exchange cross-rates. Figure 3.1 illustrates the 3-dimensional structure of the model:

Figure 3.1



[10] The assets held by non-residents do not usually take the form of cash or demand deposits, but that of interest-bearing short-term financial assets such as money market instruments with a sufficient degree of liquidity.

Table 3.6 shows the simplest model of international credit flows, which consists of two sets of the T-account matrices of countries A and B, where the latter represents the T-account matrix of the rest of the world excluding country A. In the model, country A has its own currency unit A, and similarly, country B has its currency unit B. Each of the T-account matrices is denominated in currency unit A and B respectively. Inside both matrices, the columns are classified into two categories: domestic assets that were originally denominated in the local currency unit; and the local currency value of foreign assets that are converted through the foreign exchange cross-rates. In the same fashion, the rows in both matrices are classified into two categories: domestic creditors, whose credit supplies are denominated in the local currency unit; and foreign creditors, whose credit supplies were originally denominated in a foreign currency unit, then converted into local currency value through the foreign exchange cross-rates.

The respective T-account matrices are interconnected through the foreign exchange cross-rates, which represent the mechanism of cross-border credit flows as expressed in the following identical equations (3. 27) and (3.28):

$$\sum_{i=1}^{n} FA_i \equiv FD^b .(3.27)$$

$$\sum_{j=1}^{n} FD_j \equiv FA^b .(3.28)$$

where the left side of the equation (3.27) represents the total value of foreign assets (ΣFA_i) held by country A, which exactly equals the right side, i.e., the total value of foreign debts (FD^b) that country B (the rest of the world) owes to country A. Symmetrically, the left side of the second equation (3.28) represents the total value of foreign debts (ΣFD_j) that country A owes to country B (the rest of the world), which

exactly equals the right side, i.e., the total value of foreign assets (FA^b) held by country B (the rest of the world).

3.3.3 Four financing models of economic development

Based on the T-account matrix model, we can roughly classify financing models of economic development as total (i.e., both financial and real) asset accumulation (**X**) into the four following patterns. In the dynamics of the real world, of course, these financing patterns are usually combined to achieve broad economic development, but the particular combinations among them will characterize their own models of economic development.

3.3.3.1 Domestic asset accumulation (domestic saving) model

We will recall that the matrix equation (3.13) stands for how much credit supply, i.e., the total value of both financial and real asset holdings $\mathbf{X}_{(W)}$ by sector would be influenced by changes in net worth value (**W**), which is conceptually deemed equivalent to the present value of accumulated savings from the past:

$$\mathbf{X}_{(W)} = \mathbf{B}' \cdot \mathbf{W} \quad (3.13)$$

In this model, domestic savings will work as the main resource to finance economic development. For instance, we can regard the extraordinary high growth of the Japanese economy in the 1960s, which was financed by the high rate of national savings, as a typical example of this model. The Asian economies in the early 1990s (i.e., before the crisis) could also be placed under this model, which enjoyed excellent economic fundamentals, particularly high saving rates, to finance their high economic growth.

3.3.3.2 Domestic borrowing (asset inflation) model

We recall that the matrix equation (3.8) stands for how much credit supply, i.e., the total value of both financial and real asset holdings $\mathbf{X}_{(R)}$ by sector would be influenced by changes in property prices (**R**), and that the matrix equation (3.14) represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(S)}$ would be influenced by changes in mark-to-market values of corporate shares (**S**):

$$\mathbf{X}_{(R)} = \mathbf{B} \cdot \mathbf{R}. (3.8)$$

$$\mathbf{X}_{(S)} = \mathbf{B}' \cdot \mathbf{S}. (3.14)$$

Asset inflation reflects a high level of domestic borrowing to finance economic development. Based on the spiral reflexivity in the T-account matrix model, it is clearly explained that the high growth of credit supply and demand will logically and inevitably lead to the high growth of property prices and corporate shares. All the bubble phenomena in human history could be classified under this category. Economic development in this model cannot be sustained indefinitely.

3.3.3.3 Foreign asset accumulation (export driven) model

Under a pluralist regime, we should focus on this model. We recall that the matrix equation (3.10) represents how much the total values of both financial and real asset holdings $\mathbf{X}_{(FA)}$ would be influenced by the revaluation of foreign assets (**FA**) that are denominated in the national currency, or changes in foreign asset holdings (**FA**) in its international investment position:

$$\mathbf{X}_{(FA)} = \mathbf{B} \cdot \mathbf{FA}. (3.10)$$

Under the free trade system, a country with competitive advantage can utilize the current account surplus, i.e., the growth of foreign asset holdings, to finance its economic development. From this, we can understand that laissez-faire was a popular ideology in Great Britain during the nineteenth century, because it greatly contributed to the country's economic interests, while fully utilizing overwhelming strength in international trade at that time. Similarly, in the era of mercantilism from the sixteenth to the eighteenth century, the naked desire to accumulate foreign assets such as gold and silver, was deemed indispensable to the accumulation of national wealth and taken for granted. It was the same during the imperialist era in the early twentieth century with its exploitation of the natural resources in the colonies. However, this model of economic development, which is financed at the expense of other countries' economic interests, has often given rise to serious frictions among them. Even today, trade imbalances always become a major issue in international economic relations.

This model also explains the so-called "beggar-thy-neighbor effect" through competitive depreciation policies. In the matrix equation (3.10), the mark-to-market value of foreign assets (**FA**) will increase in the national currency denomination, when the national currency depreciates. Thus, although it might seem paradoxical, it is true that the weaker the currency, the stronger the power to finance economic development, which will lead to a richer total asset accumulation (**X**) for that country.

3.3.3.4 Foreign borrowing (capital import) model

Under a pluralist regime, we should also focus on this model. We can recall that the matrix equation (3.15) represents how much the total value of both financial and real asset holdings $\mathbf{X}_{(FD)}$ would be influenced by the revaluation of foreign debts (**FD**) that are denominated in a national currency, or changes in foreign debts (**FD**) in its international investment position:

$$\mathbf{X}_{(FD)} = \mathbf{B}' \cdot \mathbf{FD} \quad (3.15)$$

For instance, this model explains the effects of long-term loans under official development assistance (ODA) on the economic development of recipient countries from the standpoint of international credit flows. Capital inflows have the effect of increasing the level of both credit supply and demand in domestic circular flows. However, economic development in this model is totally dependent upon confidence in the recipient country. Once confidence is lost, the flight of short-term funds will cause reverse contraction of the economy. We can regard the Asian financial crisis in the mid-1997 as a typical example of this model in its reverse effects.

Table 3.1

2-Dimensional T-Accounts Matrix

Liabilities of: (Credit demand of:)

Assets of: (Credit supply of:)		Financial Assets and Debts						Broad Real Assets			
		Central Bank	Banks	Financial Intermediaries	Government	Corporate Business	Individuals	Real Assets	Equities in Physical Capital	Foreign Currency & Bonds	Total Assets
Financial Assets and Debts	Central Bank	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	R_1	C_1	FA_1	X_1
	Banks	x_{21}	x_{22}	x_{23}	x_{24}	x_{25}	x_{26}	R_2	C_2	FA_2	X_2
	Financial Inter-mediaries	x_{31}	x_{32}	x_{33}	x_{34}	x_{35}	x_{36}	R_3	C_3	FA_3	X_3
	Govern-ment	x_{41}	x_{42}	x_{43}	x_{44}	x_{45}	x_{46}	R_4	C_4	FA_4	X_4
	Corporate Business	x_{51}	x_{52}	x_{53}	x_{54}	x_{55}	x_{56}	R_5	C_5	FA_5	X_5
	Individuals	x_{61}	x_{62}	x_{63}	x_{64}	x_{65}	x_{66}	R_6	C_6	FA_6	X_6
Broad Net Worth	Net Worth =National Wealth	W_1	W_2	W_3	W_4	W_5	W_6				
	Corporate Shares	S_1	S_2	S_3	S_4	S_5	S_6				
	Foreign Gov't & Enterprises	FD_1	FD_2	FD_3	FD_4	FD_5	FD_6				
	Total Liabilities	X_1	X_2	X_3	X_4	X_5	X_6				

Table 3.2
Credit Supply Coefficients Matrix

		Credit demand of:					
		Central Bank	Banks	Financial Inter-mediaries	Govern-ment	Corporate Business	Individ-uals
Credit supply of:	Central Bank	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}
	Banks	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}	a_{26}
	Financial Inter-mediaries	a_{31}	a_{32}	a_{33}	a_{34}	a_{35}	a_{36}
	Govern-ment	a_{41}	a_{42}	a_{43}	a_{44}	a_{45}	a_{46}
	Corporate Business	a_{51}	a_{52}	a_{53}	a_{54}	a_{55}	a_{56}
	Individ-uals	a_{61}	a_{62}	a_{63}	a_{64}	a_{65}	a_{66}

Table 3.3
Interdependence Coefficients of Multipliers Matrix

		Credit demand of:						
		Central Bank	Banks	Finan-cial Interme-diaries	Govern-ment	Corpo-rate Business	Individ-uals	Total
Credit supply of:	Central Bank	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}	B_{1j}
	Banks	b_{21}	b_{22}	b_{23}	b_{24}	b_{25}	b_{26}	B_{2j}
	Financial Inter-mediaries	b_{31}	b_{32}	b_{33}	b_{34}	b_{35}	b_{36}	B_{3j}
	Govern-ment	b_{41}	b_{42}	b_{43}	b_{44}	b_{45}	b_{46}	B_{4j}
	Corporate Business	b_{51}	b_{52}	b_{53}	b_{54}	b_{55}	b_{56}	B_{5j}
	Individ-uals	b_{61}	b_{62}	b_{63}	b_{64}	b_{65}	b_{66}	B_{6j}
	Total	B_{i1}	B_{i2}	B_{i3}	B_{i4}	B_{i5}	B_{i6}	B_{ij}

Table 3.4

Law's System

Assets of: (Credit supply of:)		Liabilities of: (Credit demand of:) Financial Assets and Debts					
		Govern-ment	Royal Bank	Mississippi Company	Public	Real Assets	Total Assets
Financial Assets and Debts	Government		Bank-notes 100	Shares 100			200
	Royal Bank	Gov't bonds 100		Shares 150			250
	Mississippi Company	Gov't bonds 100	Bank-notes 100			Missis-sippi 150	350
	Public		Bank-notes 50	Shares 100			150
Net Worth					Accumu-lated Savings 150		
Total Debts		200	250	350	150		

Table 3.5
Interdependence Coefficients of Multipliers Matrix of Law's System

Credit supply of:	Credit demand of: Govern-ment	Royal Bank	Mississippi Company	Public	Total
Government	2.4167 b_{11}	1.5000 b_{12}	1.3333 b_{13}	0.0000 b_{14}	5.2500 B_{1j}
Royal Bank	2.0833 b_{21}	2.5000 b_{22}	1.6667 b_{23}	0.0000 b_{24}	6.2500 B_{2j}
Mississippi Company	2.0417 b_{31}	1.7500 b_{32}	2.3333 b_{33}	0.0000 b_{34}	6.1250 B_{3j}
Public	1.0000 b_{41}	1.0000 b_{42}	1.0000 b_{43}	1.0000 b_{44}	4.0000 B_{4j}
Total	7.5417 B_{i1}	6.7500 B_{i2}	6.3333 B_{i3}	1.0000 B_{i4}	21.6250 B_{ij}

- These numbers are rounded up to the fourth decimal point.

Table 3.6
3-Dimensional T-Accounts Matrices of Pluralist Regime

Country A

Liabilities of: (Credit demand of:)

Assets of: (Credit supply of:)		Domestic Assets				Foreign Assets					
		Central bank	Banks	Public	Real assets	Central bank	Banks	Public	Real assets	Sub-total	Total Credit Supply
Domestic Creditors	Central bank	x_{11}	x_{12}	x_{13}	R_1	Cur-rency		Gov't bonds		FA_1	X_1
	Banks	x_{21}	x_{22}	x_{23}	R_2	Cur-rency	Depos-its	Loans Bonds	Equity	FA_2	X_2
	Public	x_{31}	x_{32}	x_{33}	R_3	Cur-rency	Depos-its	Gov't bonds Bonds	Land Equity	FA_3	X_3
	Net Worth	W_1	W_2	W_3							
Foreign Creditors		FD_1	FD_2	FD_3							
Total Credit Demand		X_1	X_2	X_3							

Country B

Liabilities of:

Assets of:	Domestic Assets	Foreign Assets
Domestic Creditors		FA^b
Foreign Creditors	FD^b	