This book brings together in a single coherent framework a research programme begun by the author over 40 years ago. The main model around which the analysis is built is Hicksian in character having been drawn in large part from John Hicks *Value and Capital*. The model is extended so as to include money and securities. In respect of the theory of the firm the model focuses on demand and supply plans, on inputs and outputs, on inventories, and on the dependencies between them. The stability of temporary equilibrium is discussed for linear and non-linear cases. Because the concept of structural stability is important for understanding non-linear cases, it is defined and applied to the case of economic motion generated from the temporary equilibrium analysis. The addenda focus on developments in economic theory following the publication of the main model.

Dynamic economic theory

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Preface

1 To publish a translation of a book which was published nearly half a century ago in an academically local language we need convincing justifications. This volume originally entitled *Dogakuteki Keizai Riron* (*DKR*) was published in Japanese in 1950, by Kobundo, Tokyo. Soon after the war, I returned from the military service to the university and completed my undergraduate study at Kyoto University in 1946. *DKR* is a thesis written as a report on my graduate research work supported by the Ministry of Education Special Scholarship. The topic suggested by my supervisor, Professor Hideo Aoyama, was the 'mathematization of Hicks' *Value and Capital* (*VC*)', so that *DKR* is more or less parallel to it. However, there are a few substantial differences.

First, in *VC* it is assumed that output equals supply and input equals demand. This basic assumption enables us to use the production theory of the firm as the tool to explain its behaviour in the market. Moreover, this assumption implies that the stocks of input and output commodities do not change. In *DKR* I was concerned with firms whose inputs and outputs may deviate from the demands for the factors and the supplies of the products, respectively. I had, therefore, to construct a theory of the firm which could explain its production, trading, and inventory consistently.

Secondly, once this line of approach is adopted, it is clear that we cannot be satisfied with a physical input–output theory of the firm of the *VC* type. Money and securities are close substitutes for inventories of physical commodities. The theory of the firm, therefore, has to be extended so as to explain its behaviour of liquidity preference. This means that the economy should not be dichotomized into the real and monetary subeconomies. The indifference analysis for consumers' behaviour must be extended such that it can derive the demand for monetary goods, money, and securities.

Thirdly, stability was one of the most fashionable subjects of the late 1940s. In addition to those conditions for stability provided by Samuelson, Sono offered another condition. Unfortunately it was incomplete in the

sense that it was not obtained from a dynamic analysis of the system. In *DKR* I 'dynamized' Sono's condition and found that stability is obtained whenever a function which resembles the Liapounoff function diminishes at every point except the equilibrium. Moreover, the structural stability was discussed. Under the assumption of this kind of stability it was shown that any stable temporary equilibrium point of a non-linear economy has its own stability zone. This led to the conclusion that provided that tatonnement starts from a point within a stability zone, the temporary equilibrium corresponding to the zone will be established when the tatonnement finally terminates.

Fourthly, *DKR* states that there are two types of stability which are important in developing dynamic theory. First, the *stability of* the temporary equilibrium *point* has to be examined. In the case of successive temporary equilibrium points all being stable, we have a sequence of equilibrium points, in terms of which economic fluctuations and development are described. Thus the stability of the equilibrium point is the unavoidable requisite for dynamic analysis. Instability has to be ruled out, in order for the economy to be workable through time without meeting any deadlock. Even though the equilibrium point is stable in each period (say, Hicks' 'week'), the second kind of stability remains to be discussed. That is to say, it has to be found out whether the actual sequence of temporary equilibria is stable or not with respect to an exogenous change in the data.

Thus we have two stability problems; the stability of the equilibrium point and the *stability of motion* or path. These have usually been associated with respectively two groups of economists: the first to general equilibrium theorists and the second to growth economists. They have often been confused, because the latter has usually been developed as the stability theory of the long-run equilibrium point, despite the fact that the existence of a long-run equilibrium point is doubtful, so we should examine the stability of the growth path rather than a long-run state of affairs. Moreover, whereas stability is the target of analysis in the first problem, instability should not be ignored in the second. In fact, in some cases such as technological innovations, they are carried out with the intention to launch the economy into a new orbit by using the power of instability working in the neighbourhood of the path of motion that the economy is following.

2 It seems to me that the four points above would justify publishing *DKR* in English nearly fifty years after its first appearance. It is of course true that in these years the theory of general equilibrium has been advanced greatly and put in a very modern form. Therefore, it would be necessary to reassess *DKR* from the contemporary advanced theory point of view. I have expressed my own present view in *Capital and Credit* (*CC*), 1992. When

comparing this, the reader will find outlined a number of shortcomings of *DKR*; it is, in fact, no more than a book which has to be criticized in *CC* together with those other books with which I disagree there.

Part II, called 'Addendum', is compiled in order to reexamine *DKR* from various points of view developed in other theorists' works in the period of 1950–90. It is a kind of survey of these works, but it is not comprehensive since it is a collection of my published or unpublished papers written for various purposes. It may, nevertheless, be useful for clarifying my views on these problems, developed after my writing of *DKR* and for connecting it to current economic theory in the West.

The Addendum consists of eight articles. The first two are concerned with what I call 'truncated' tatonnement procedures. According to the so-called 'Walrasian' tatonnement, transactions are not actually carried out until general equilibrium is established. To achieve this, it takes, generally speaking, an infinitely long time. The temporary equilibrium method of Hicks tacitly assumes that tatonnement is carried out extremely intensively in each week such that general equilibrium is realized at its end. It also assumes that transaction, consumption, and production are made instantly or within a very short time span at that point. Such an assumption (or consideration) is absent in Walras' (1954) *Elements of Pure Economics*; he assumes that tatonnement is truncated so as to make effective transactions at a point in time when general equilibrium has not yet been realized. Then individuals' or firms' endowments change, which initiates a new tatonnement. Thus, contradicting the so-called Walrasians, the real Walras is a *dis*equilibrium economist, at least in the field of dynamics.

After having established this view in Article I, Article II applies the idea of 'truncation' to the tatonnement in terms of quantities. In this system, prices are fixed, and adjustments are made to quantities. This is a system which Hicks later calls the 'fixprice' system. If we call the number of times of groping (or tatonnement) actions carried out until they are truncated 'the effective length of tatonnement', we find that it is assumed to be 1 in the usual macro-quantity adjustment mechanism, such as Marx's reproduction scheme, so that the rate of growth of output is different between sectors, unless some special assumption is made.[1] However, when the demand schedules are perfectly flexible, so that the effective length is very large, sectors of the economy grow at a uniform rate. This may be a hidden assumption behind von Neumann's theory of balanced growth equilibrium.

When *DKR* was published, there was no non-linear theory of the trade

[1] In fact, Marx made such an assumption, so that the sectoral rates of growth obtained from his 'extended reproduction scheme' converge quickly (i.e., at the beginning of the next period) to a uniform one. See Morishima, 1973, *Marx's Economics*, Cambridge University Press, pp. 117–28.

cycle, except Kalecki, 1937 and Kaldor, 1940, both lacking a complete mathematical proof of the existence of a limit cycle. However, those works which appeared soon after the publication of *DKR* belong to the field of macrodynamics and are not works of general equilibrium analysis. Their equations are of the van der Pol and Payleigh types respectively, depending upon the forms of investment function. Article III is concerned with a consolidation of their equations so as to include both elements of investment. In Article IV I try to apply the non-linear theory of oscillations to the theory of tatonnement. For this purpose I aggregate several periods, say m periods into one, and show that there are fixed points of the aggregated system. They are called fixed points of order m. Where m equals 1, fixed points give Arrow–Debreu equilibria. Where $m > 1$, they give stationary solutions only in the case in which we ignore movements within the aggregated period. They may represent cycles of m periods if they are analysed into successive states of the short periods before the aggregation. In generalizing the Arrow–Debreu existence theory in this direction we find that the tatonnement theory for general equilibrium is connected with the newly developed theory of chaos. For an appropriate combination of parameters, we may easily obtain chaotic tatonnement behaviour.

In the comparative statics and dynamics analyses, *DKR* assumes absence of complementarity. After its publication, I tried to accommodate complementary goods in the system. I could work on a special case only, that is sometimes called the Morishima case. Articles V and VI are published and unpublished works of mine in this field. In Article VII (with M. Majumdar) the tatonnement approach is compared with other approaches, such as Cournot's arbitrage theory and Debreu's neo-Edgeworthian approach. Although it is true that Debreu's work has greatly contributed to the economic interpretation of the theory of core, it is shown that this way of establishing competitive equilibrium is much more expensive, in terms of the cost of psychological pressure upon the participants in trading, than the tatonnement procedure, especially when their number and the number of commodities are large.

Finally, Article VIII is concerned with the most fundamental features of the models of general equilibrium theory, all of which assume that each market has a price which is adjusted such that its market is cleared. This is, notwithstanding, an assumption that is inadequate for treating durable goods. Each durable good has at least two markets, a commodity market where a durable good newly produced is sold and a rental market where services from the commodity are dealt with. (In addition, it has a market of used goods.) The ratio of the rental price determined in the second market to the commodity price in the first must be equal, in equilibrium, to the sum of the rate of interest (or profit) and the rate of depreciation of the durable

good. But the market prices determined so as to clear the excess demands do not necessarily satisfy the equations of equal profitabilities. This dilemma is called 'the dilemma of durable goods'.

Unlike past general equilibrium models developed by Ricardo, Marx and Walras, as formulated in three of my volumes (1989, 1973 and 1977), which explicitly take account of the conditions of equal profit rates, but like most of modern general equilibrium models, such as those by La Volpe (1993, originally published in Italian in 1936), Hicks, Arrow, Debreu, etc., the *DKR* model does not confront this dilemma properly. If the conditions of equal profitability, which are equivalent to Keynes' condition that the marginal efficiency of each capital good is equal to the rate of interest, are rightly taken into account, we do not have a state of general equilibrium where demand equals supply in each of the markets of consumption goods, capital goods, capital services, and other factors of production including labour and land. The only way to avoid this collapse is to introduce Say's law, as in fact the masters of the old regime of general equilibrium mentioned above explicitly or implicitly assumed it, but it is not an acceptable solution because the law is hardly considered to be realistic. Thus the general equilibrium theorists should accept Keynes' prescription: admit the equal profitability for capital goods, deny Say's law, and be confronted with the impossibility of the full-employment–full-utilization equilibrium. This approach was adopted in my *CC*, into which *DKR* is finally merged in this way.

3 Finally, it is made clear that one of two appendices and one of three mathematical notes contained in the original Japanese version of *DKR* are replaced by my 1952 *Econometrica* paper and my 1974 paper which I wrote with Takao Fujimoto, respectively. The former replacement is made because it does not create any essential change in the argument and the same sorts of issues are dealt with more neatly in the *Econometrica* paper. Also this replacement makes the original mathematical note I redundant so that it is deleted in the present volume.

The second replacement is made because the original mathematical note III on the Frobenius theorem is now explained in a more convenient and simpler way by the paper with Fujimoto; the previous note was more or less along the lines of Frobenius' article, and was less elegant. The original mathematical notes II and III appear as I and II in the present volume.

In a summer in the middle of the 1970s *DKR*, originally published in 1950, was put into English. I dictated most of its text to Marie Williams (then my secretary) and she afterwards polished up the style. The manuscript was mimeographed in 1980 and distributed among a limited number of LSE

students who belonged to my group. I also acknowledge professional comments made by Frank H. Hahn on a part of the Addendum. In 1994 a group of graduate students of Kyoto University attended a series of seminars organised by Ayumu Yasutomi for examination of *DKR*. I want to note in this place his contribution together with those made by Takanori Ida and Kohki Hirose.

Finally, I am grateful to the editors of the following publications for granting permission to reproduce in this volume the articles that were originally published by them: *Econometrica* for Appendix I, *Journal of Mathematical Economics* for Mathematical Note II, *Metroeconomica* for Article II, *Zeitschrift für nationalökonomie* for Article III, *Review of Economic Studies* for Article V and *Hommage a François Perroux* for Article VII.

M. Morishima