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A DYNAMIC SIMULTANEOUS MODEL OF TAIWAN: IS-LM, AS-AD, DYNAMIC MULTIPLIER ANALYSIS, BUSINESS CYCLE, FORECAST, SIMULATION, AND POLICY EXPERIMENTS

The University of Oklahoma PH.D. 1984

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

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A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

By

BEEN-KWEI HWANG

Norman, Oklahoma

1984

A DYNAMIC SIMULTANEOUS MODEL OF TAIWAN: IS-LM, AS-AD,

dynamic multipler analysis, business cycle,

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A DISSERTATION

APPROVED FOR THE DEPARTMENT OF ECONOMICS

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Acknowledgment

The author wishes to express his sincere appreciation to Dr. Chong K. Liew, his committee chairman, and to Dr. A. J. Kondonasis, his committee co-chairman and chairperson of the Division of Economics, University of Oklahoma, for their encouragement, support, and guidance. A particular debt of gratitude is owed to Dr. Liew for his many hours of assistance in helping to solve the difficulties encountered in this study.

Appreciation is also extended to the other members of the dissertation committee, Dr. Kirker Stephens, Dr. Duane R. Stocks, and Dr. Eden S. H. Yu for their helpful comments and suggestions in the preliminary draft.

The author is also indebted to Dr. Harry Benham and Dr. Charlie Turner for their useful suggestions in strengthening the theoretical framework of this study.

Acknowledgments are also extended to Dr. Chen Sun and Dr. C. C. Chao of the Council for Economic Planning and Development, Taipei, and to Dr. Y. S. Lee and Mr. S. C. Hsaio of the Central Bank of China, Taipei, for their help in collecting and mailing the data and copies of previous work related to this study. Their generous assistance has made this study possible.

The author also wishes to express his appreciation to Mr. Duane J. Rosa and Mr. Bod Stegemann for their editorial assistance in the preparation of this dissertation.

Sincerest thanks are given to the author's wife, Rosalyn Min-Li, for her continued encouragement and assistance. A special acknowledgment is also given to the author's daughters, Louisa Yi-Yann and Diana Mei-Yann, for their great patience and excellent self-discipline during the period of this study.

Finally to the author's parents, Mr. and Mrs. Yeong-Shan Hwang, and the author's parents-in-law, Mr. and Mrs. Tzong-Yau Tu, deepest gratitude and respect are given for their abiding love, support, and encouragement.

ABSTRACT

Various econometric models of Taiwan have been constructed since 1964. All of these shared the same common shortcomings. Their periods of annual data were too short to maintain a satisfactory degree of freedom. Their estimators were determined by the ordinary least squares method. The models were highly demand-oriented. The theoretical framework of the models and the effects of exports and imports on economic development were barely discussed.

A new equilibrium model of the Taiwan economy is formulated in this study. The primary objective of this study is to analyze the economy of Taiwan and determine useful policy implications. Another purpose of this study is to eliminate the weaknesses of previous models. In particular the data have been made current in an attempt to enlarge the degree of freedom. In order to take care of the simultaneous bias, the 2SLS and 3SLS methods are applied in the estimation procedure. A dynamic simultaneous model is introduced in which the approaches of IS-LM, AS-AD, multiplier analysis, business cycle, and policy experiments are utilized to enrich the findings.

The Taiwan equilibrium model is capable of predicting turning points and has a very good fit. It takes into account the important features of the economy of Taiwan. Exports are a major contributor to economic growth and employment. Monetary policy and/or fiscal policy actions cause inflation. Price stability is vulnerable to the price fluctuation of Taiwan's trading partners. Fiscal policy is more effective in Taiwan than monetary policy. Taiwan has a business cycle of about 16 years. The Okun's law and the Phillip's curve can be applied.

A disequilibrium model for Taiwan is also constructed for comparison in this study. This model confirms the results of the equilibrium model. Moreover, wage increases significantly reduce labor demand, but stimulate labor supply. The relationship between Taiwan's exports and the U.S. GNP is positive, but negative between the Taiwanese exports and the Japanese GNP.

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INTRODUCTION

1.1 INTRODUCTION

The approach of a simultaneous econometric model has been widely used by economists and government agencies for the purposes of determining the relationships among economic variables, planning, forecasting, and simulating policy. Examples can be found in the central bank policy analysis, the forecasting, and the economic planning done in countries such as Australia, Canada, the Republic of China, Indonesia, Japan, Korea, Malaysia, New Zealand, the Phillipines, Singapore, Thailand, the United States,[1] Pakistan,[2] and Bangladesh.[3]

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[1] For the models of these 12 Pacific Basin Countries presented to the The Pacific Basin Central Bank Conference On Econometric Modeling in 1974 and 1975, see <u>Central Bank Macroeconometric Modeling in Pacific Basin Countries</u>, by the Federal Reserve Bank of San Francisco, 1974, and <u>Proceedings Of The Second Pacific Basin Central Bank Conference On Econometric Modeling</u>, by The Bank of Korea, 1975.

[2] For the model of Pakistan, see "Economic Growth Model for Pakistan", by M. Nayyer, <u>Pakistan Economic and Social Review</u>, Vol. XIX, summer 1981.

[3] For the model of Bangladesh, see "A Macro-Econometric Model of Bangladesh", by M. Ali Rashid, <u>The Bangladesh Development Studies</u>, Vol. IX, Bangladesh, 1981.

In most of the less developed countries (LDCs), the application of econometric models for the above-mentioned purposes was delayed anywhere from 10 to 24 years after Klein had published in 1950 his famous model, known as the Klein Model I. As indicated by Lin (1974, p272) and Wong (1974, p285), Malaysia and Singapore had no formal econometric models, and only a little work had been done in this regard before 1974—24 years after Klein had published his pioneering work. Lin and Wong also pointed out that the deficiency of data and the lack of qualified econometricians were the major drawbacks in building econometric models for these countries and other LDCs. In addition to these problems, the author would like to point out that the lack of computer facilities was another difficulty encountered by most LDCs, particularly during the sixties and early seventies.

Today, these problems of building econometric models either no longer exist or have become less burdensome for most LDCs due to the fact that more econometricians are working in this area, more computers are being used, and data bases have been greatly improved. Because of the growing usefulness of econometric models, together with improving computer technologies and diminishing restraints on data bases, it is generally agreed that the study and application of such models will become increasingly popular in both the developed and less developed countries of the world.

Taiwan is one of the LDCs that are now using computers in macroeconometric models for general economic planning.

In 1953 the Government of the Republic of China (hereafter referred to as Taiwan for convenience) promulgated and implemented its first four-year economic plan. The first application of a simultaneous model in economic planning for Taiwan was, however, introduced in 1964 by Ta-Chung Liu of Cornell University. This was 14 years after Klein (1950) had published his Klein Model I. Since the appearance of Liu's initial work in this area, various econometric models of Taiwan have been constructed by economists and by policy makers who have realized the usefulness of the simultaneous model. Most models built in the sixties and seventies were highly demand-oriented and estimated by the ordinary least squares (OLS) method.[4] Because Taiwan has been a highly trade-oriented and foreign-exchange-controlled country, exports and imports are the major factors determining its economic growth and its money supply. However, model builders in Taiwan have concentrated upon the impacts of world-wide economic variables, such as world trade volume, and the GNP and price indices of other countries. Exports have been treated as an endogenous variable and huge models were established thereon. These model builders-- such as Yu (1969, 1971a and b), Li (1975), the Central Bank of China (1976),

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[4] For more details about the features of those existing models for Taiwan, see next section— Review of Literature.

the Council for Economic planning and Development (1980, 1981), Hsiech, Chow, and Liu (1983), Lee and Shea (1983), among others— have only presented the specifications and the results of estimation of their models. Not only has little analysis been made of the theoretical framework, the static and dynamic nature, and the interpretations and policy implications of their models, but the disputed subject of the effects of international trade upon economic development has also been insufficiently discussed.

Unlike the aforementioned models, the present study aims at setting up a dynamic simultaneous model for Taiwan under the assumption that product, labor, and money markets are all at equilibrium. It deals with several key elements of the macroeconomy in a compact form and is designed to achieve the following four purposes:

1. Capture the main features of the Taiwan economy;
2. Determine the effects of exogenous variables on the endogenous variables, particularly the effects of exports upon the GNP;
3. Serve as a trial model for economic planning; and,
4. Act as a tool for policy experiments.

Furthermore, once the equilibrium model has been successfully constructed, the equilibrium assumption will be relaxed and a larger disequilibrium model established. This disequilibrium model will demonstrate that the compact equilibrium model can be expanded into a larger one if other purposes require this. It will also prove to be a valuable source of information about the economy of Taiwan which is not available to us in the equilibrium model.

Having given a brief history of macroeconometric models applied in Taiwan and having summarized the purposes of this study, the author will conclude this section by summarizing the organization of this study.

Part II of Chapter I will review the relevant literature regarding the application of macroeconometric models and previous work documented both in the U.S. and in Taiwan.

In Chapter II, an equilibrium model of Taiwan will be developed and its theoretical foundation, variables, and the linkage between sectors introduced. How Taylor's Theorem can be used to linearly approximate the logarithmical equations for obtaining better interactions among the variables and sectors will also be presented. Because the Taiwan equilibrium model is specified with lagged endogenous variables, the dynamic nature of this model and the theoretical framework of dynamic multiplier analysis will be discussed as well.

Chapter III, a short chapter, will be devoted to the sources of the data to be applied in this study.

In Chapter IV, the results of 2SLS and 3SLS methods, and textbook type IS-LM, dynamic IS-LM, and long-run IS-LM models, and AS-AD curves will be presented and interpreted.

Chapter V will present the results of forecast and simulation of the Taiwan equilibrium model.

Chapter VI will deal with multiplier analysis and business cycle. The features of Taiwan's highly trade-oriented economy are well evidenced by the multipliers.

In Chapter VII, a time-trend ex ante simulation and some other policy experiments will be completed and explained.

Chapter VIII will be devoted to developing a disequilibrium model. The findings of the previous equilibrium model will be thereby confirmed and additional information about the Taiwanese economy obtained.

Chapter IX, the final chapter, will present the conclusions and policy implications of this study.

1.2 REVIEW OF LITERATURE

Since Klein published his well-known Klein Model I in 1950, the theoretical development and the empirical application of simultaneous macroeconomic models have long created intense research and heated debates among economists in the United States. Klein's model, though including only three behavioral equations and three identities, demonstrated its powerful capacity to describe the behavior of consumption, investment and the demand for labor at that time. In the sixties, several large models appeared. For example, "The Federal Reserve-MIT Econometric Model" was developed by de Leeuw and Gramlich (1968), "The Brookings Quarterly Econometric Model of the United States" by Duesenberry, Fromm, Klein, and Kuh (1965), and "The Wharton Econometric Forecasting Model" by Evans and Klein (1968). The models established in the sixties remained attractive bases for further modification and discussion during the seventies. Some small but well-known models also appeared in the seventies. For example, the "St. Louis Model" was built by Andersen and Carlson (1970), and "A Short-run Forecasting Model of the United States Economy" by Fair (1971). In the early eighties, a new topic, the so-called "supply-side economics", was introduced into the model building process by Sheinin (1981), Klein (1982), and others.

Many econometric models for the Taiwanese economy have been developed since Liu's (1964) pioneering model. Some were developed for the purpose of economic forecasting, while others were used for economic planning and budgeting. Prior to 1975, a bulk of the published macroeconomic models of Taiwan were developed by T.S. Yu (1969, 1971a and b) and S.Y. Li (1975). However, these models suffered from certain deficiencies as pointed out in a publication by the Central Bank of China:

> There is a noticeable feature in most [earlier] models ... that aggregate real outputs are totally demand-determined, whereas money sector and price sector are either completely left out or only barely mentioned. The same is true for the problem of financial repercussions going through money, prices, and incomes (Central Bank of China, 1976, p. 132).

In view of the deficiencies in the models built prior to 1975, the later model builders—e.g., the Central Bank of China (1976), the Council for Economic Planning and Development (1980,1981), Hsiech, Chow, and Liu (1983), and Lee and Shea (1983)—successfully introduced money and price sectors and foreign transactions into their models. Nevertheless, these later models still share the same weaknesses of their forerunners. First, all of these models are ambitiously large, and the periods of annual data applied are too short to maintain a satisfactory degree of freedom. Second, the estimators are determined by the ordinary least squares (OLS) method. More efficient approaches, such as the two-stage least squares (2SLS), three-stage least squares (3SLS), and limited information maximum likelihood methods are more appropriate. Third, the models are still demand-oriented and ignore supply-side constraints. However, the economic growth of an island economy such as Taiwan is particularly subject to the supply of energy and labor.

In order to eliminate the deficiency of the degrees of freedom in previous models, Huang (1978) recently used the Taiwan quarterly data of 1962-I to 1977-II in his development of a quarterly model for Taiwan. Nonetheless, it is still notable that the OLS method was used and that the data were insufficient and unreliable.[5]

The impact of trade on the operation of an economy has long been recognized by economists. Marshall (1920) argued that international trade brings economic progress to a nation. Myint (1954) and Myrdal (1957) argued that foreign trade results in a "backwash effect" rather than in a "spread effect". Johnson (1955), and Bhagwati (1958a,b) proposed that deterioration in the terms of trade results in an immiserizing growth, which in turn brings a welfare-reducing rather than a welfare-increasing growth. Prebisch (1964) and Singer (1953) found that LDCs produce and export primary products and inevitably suffer declining terms of trade.

Haberler (1959), Cairncross (1962), Emery (1967), Maizels (1968), and Kravies (1970) all corroborated the idea that foreign trade contributes greatly to economic development. Recent empirical studies have confirmed the correlation between trade and output. For example, Michaely (1977) applied the Spearman rank correlation scheme to the cross-sectional time series data of 41 countries for the period 1950-73, and he found that exports and GNP are positively correlated; he

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[5] As indicated by Huang (1978,P134), some important variables were discarded and some proxies were used in his study because of the limitations of data.

further discovered that growth is affected by export performance only after countries have achieved a minimum level of development. In addition, Balassa (1978) found that policies of export expansion lead to better growth performance than do policies that favor import substitution. Using the Spearman rank correlation and the Cobb-Douglas production function, Tyler (1981) confirmed the results by Michaely and Balassa.[6] Mohammad (1981) found employment to be a link between growth and income equality and concluded that trade brings higher levels of production and employment while it reduces income inequality.

Taiwan has experienced rapid economic development since 1965. Kuo, Ranis and Fei (1981), Kuo (1983), and Gregor, Chang and Zimmerman(1981) all found that the economic success of Taiwan is largely due to correct government policy and the collaboration of diligent people. Furthermore, they asserted that Taiwan is a good example of economic success which other LDCs may follow. The economic success of Taiwan in the past several decades does not necessarily mean that Taiwan has been without economic problems. As indicated by Kuo (1983), the economy in Taiwan is now in the course of transition and is consequently encountering several challenging problems— e.g., more expensive labor; more competition in the export market from Japan, Korea, Singapore, and

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[6] The studies by Michaely, Balassa, and Tyler did include Taiwan.

Hong Kong; and heavier reliance on an outside energy supply. She also suggested that both the government and the people of Taiwan respond quickly to these new problems so as to ensure continued success.

Chapter II

AN EQUILIBRIUM MODEL OF TAIWAN

2.1 THEORETICAL FOUNDATION

Conventional macroeconomic theories are concerned with the analysis of various aggregate economic variables. Among these are the level of employment, real income and its components (consumption, investment, government spending, exports and imports), the supply of money, the demand for money, rate of inflation, and interest rates. These variables of an economic system can be aggregated into four principal markets:

(1) the output market,

(2) the money market,

(3) the bond market, and

(4) the labor market.

However, Walras' law asserts that only three of these four markets are independent. Any one of them can be eliminated since the equilibrium of any three markets can assure the equilibrium of the fourth. The bond market has been eliminated in this study as is usually done in studies of this type. Another reason for the elimination of the bond market is that Taiwan does not have an active bond market.

A bold assumption that the economy of Taiwan is in a state of equilibrium is first made, and then a dynamic simultaneous equilibrium model is developed under this hypothesis of equilibrium. Before 1965 the unemployment rate was about 6%, but it dropped rapidly after 1965 due to successful economic development and labor absorption. It has remained at the low rate of 2% since 1971, and is regarded as full-employment by Kuo, Ranis, and Fei (1981), and others. Money demand is not directly observable or measurable, and therefore, in following the approach by Goldfeld (1973) and Boorman (1980), the money market is first assumed to be at equilibrium. The observable money supply is then used to replace money demand in formulating the equation of money demand. Full-employment in Taiwan and the nature of indirectly observable money demand provide sound reasons why the assumption of equilibrium in the economy of Taiwan is not naive. Later, this assumption will be relaxed , and a disequilibrium model will be formulated for comparison.

A more complete macroeconomic model would include the effects of wealth and government budget constraint.[7] However, as suggested in section 1.1, Chapter I, the Taiwan equili-

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[7] For previous work on the wealth effects, see Pigou (1947), Patinkin (1965), Meyer (1974), Branson (1976), Yu (1980), and Hwang and Yu (1984), and others. Research on the budget constraint has also been well documented by Modigliani (1963), Ott and Ott (1965), Christ (1967,1968), Silber (1970), Meyer (1975), Blinder and Solow (1976), Infante and Stein (1976), Yu (1980), Hwang and Yu (1984), among others.

brium model deals only with the key elements of the macro-economy in a compact form; therefore, the effects of wealth and government budget constraint are not included in this model for the purpose of simplification.

2.2 INTRODUCTION OF THE VARIABLES

The main three-market dynamic equilibrium model consists of 8 behavioral equations and 2 identities. These 10 equations can be classified into 4 blocks:

(1) the output market (real values),

(2) the labor market (real values),

(3) the money market (real values), and

(4) the price system (nominal values).

The output market consists of the identities of product demand and increment in consumption, as well as the functions of consumption, investment, and imports. The labor market consists of one equilibrium equation which equates labor supply and labor demand. The money market also consists of only one equation which equates money supply and money demand. Finally, the price system consists of the functions of wholesale price, consumer price, and the implicit GNP deflator. In addition to the 10 endogenous variables, the model contains 20 predetermined variables including the intercept. Among these 20 predetermined variables, 6 are lagged endogenoous variables and 16 are exogernous variables in which 4, i.e., G, R, W, and X, are policy variables.

The variables are listed and explained as follows:

A) Endogenous Variables

1. CON: private sector consumption, in billions of 1976 New Taiwan Dollars (NT$).
2. DCON: the increment in CON, i.e., DCON=CON-LAGCON, in billions of 1976 NT$.
3. I: investment, equal to gross fixed capital formation plus increase in stock, in billions of 1976 NT$.
4. L: labor employed or labor supply, in millions of persons.
5. LOGMS: money supply or money demand in logarithmic form and billions of 1976 NT$.
6. LOGCPI: consumer price index in logarithmic form.
7. LOGP: implicit GNP deflator in logarithmic form.
8. M: imports, in billions of 1976 NT$.
9. WPI: wholesale price index, 1976=1.
10. Y: GNP in billions of 1976 NT$.

B) Predetermined Variables

1. G: government spending on consumption, in billions of 1976 NT$.
2. INT: intercept, denoted by a0, b0...etc. in the equations.
3. K: capital stock, in billions of 1976 NT$.

4. LAGCON: consumption lagged in one period.
5. LAGI: investment lagged in one period.
6. LAGM: imports lagged in one period.
7. LAGY: GNP lagged in one period.
8. LAGWPI: WPI lagged in one period.
9. LGLNMS: LOGMS lagged in one period.
10. LOGMON: the logarithmic form of the ratio of the nominal money stock to real GNP, i.e., MON = nominal money stock/Y.
11. LOGR: real short-term loan interest rate in logarithmic form.
12. LOGNW: nominal proxy wage rate index in log form.
13. LOGWPI: wholesale price index in log form.
14. LOGY: GNP in log form.
15. NFP: net foreign payment, in billions of 1976 NT$.
16. PM: import price index.
17. T: time (1960=1).
18. W: proxy wage rate index, 1976=1, where the proxy wage rate = the national income distributed as a wage bill divided by the total labor employed.
19. X: exports, in billions of 1976 NT$.
20. R: real short-term loan interest rate.

The data for Y, CON, I, X, M, NFP, L, MS, K, T, W, R, P, WPI, CPI, and some other key variables, such as UY (U.S. GNP), and JY (Japanese GNP), which will appear in Chapter VIII, are listed in Appendix A for reference.

2.3 SPECIFICATION OF THE MODEL

A) Product Demand Identity

The product demand identity is defined as:

Y=CON+I+G+X-M+NFP ----------------------------(2.3.1)

The first five terms of the right-hand side of the equation are the components of domestic gross product (DGP). NFP, as defined in Dornbusch (1980, p21), is the net factor payment (or receipts) from abroad.

B) Consumption Function

The original Keynesian hypothesis states that consumption expenditures depend on income, but increase proportionally less than income. In the classic model, hours of work, and therefore household income, can be expressed as a function of the real wage rate, so that consumption can also be expressed as a function of the real wage rate. The Keynesian hypothesis is followed but is revised by adding lagged consumption into the equation. The purpose of the introduction of a Koyck's (1954) distributed lagged of dependent variable into this model is to specify a dynamic formation with which to take into account the adjustment process toward equilibrium. Thus consumption is expressed as:

CON=a0+a1*Y+a2*LAGCON+e1----------------------(2.3.2)

C) The Identity of the Increment in Consumption

The increment in consumption (DCON) is defined as:

DCON=CON-LAGCON ------------------------------(2.3.3)

The increment in consumption implies that the demand momentum is pulled by consumption.

D) Investment Function

Samuelson (1939) specified the investment function in his dynamic model as I=a+b(CON-LAGCON), assuming that investment is pulled up by the additional demand in consumption. Samuelson's concept is adopted and revised by introducing the real interest rate (R), capital stock (K), and the lagged investment (LAGI) into the function. The proportional replacement hypothesis states that replacement investment is proportional to the existing capital stock, and a constant rate of depreciation is technologically imposed. This hypothesis suggests that the sign for the coefficient of K is positive and less than one. The investment function is therefore specified as:

I=b0+b1*DCON+b2*R+b3*K+b4*LAGI+e2 -------------(2.3.4)

E) Import Function

The import function is similar to the consumption function and therefore is also related to income. However, in order to specify the feature of the heavily trade-oriented economy of Taiwan, exports are introduced into the function of imports and a Koyck-type lag is used to specify the dynamic nature of the model. Therefore, the import function can be written as:

M=c0+c1*Y+c2*X+c3*LAGM+e3 ---------------------(2.3.5)

F) Labor Demand

The profit maximizing firms will continue to employ workers up to the point where the marginal physical product of labor (MPP(L)) equals the real wage rate. However, MPP(L) is hardly observed in the real world. The GNP is therefore introduced to replace MPP(L). The relationship between the labor demand and the GNP is theoretically positive as specified by the production function. In addition, real wage (W), time trend (T), and the wholesale price index (WPI) are introduced. The demand for labor depends on the final demand for output, and therefore the increase in the output price (reflected by WPI) increases the demand for labor. The increase in the real wage implies that it is more costly to hire an additional unit of labor; thus, the coefficient for real wage is expected to be negative. Due to the assumption of equilibrium in the labor market, the labor supply is set up to equal the labor demand. The equilibrium equation for the labor market is specified as:

L=d0+d1*Y+d2*W+d3*T+d4*WPI+e4 -----------------(2.3.6)

G) Money Demand (Supply)

The transaction demand for money has a long tradition in classic economics. Fisher (1911), Pigou(1917), Hicks(1935), Baumol(1952), Tobin (1958), among others, formulated money balance as a function of either income or wealth. The concept of the speculative demand for money was first introduced by Keynes (1936) and later formalized by Tobin (1958). Their demand for money was formulated as a function of interest rate. Friedman (1956,1959) reconciled both sides and formulated money demand as a function of interest rate, permanent income, and non-human wealth. The desired money balance demanded was not directly observed. But both "partial adjustment" and "adaptive expectation" mechanisms can overcome this obstacle.[8] Both mechanisms generate a Koyck's distributed lag formation. Empirically, the actual money demand is not directly observed. The observed M1, M2, or the money supply balances were used to substitute for the money demand in the empirical studies by Laidler (1966a,b), de Leeuw and Gramlich (1968), Brunner and Meltzer (1964), Goldfeld (1973), Dickson and Starleaf (1972), among others. Both sides of classic and Keynesian versions are reconciled in this study and the money market equilibrium equation is specified as:

LOGMS=f0+f1*LOGY+f2*LOGR+f3*LGLNMS+e5 ---------(2.3.7)

H) Wholesale Price

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[8] For details of "partial adjustment" and "adaptive expectations" mechanism in the study of money demand, see Boorman, "The Evidence on the Demand for Money :Theoretical Formulations and Empirical Results", Current Issues In Monetary Theory and Policy, edited by Havrilesky and Boorman, AHM Inc., Illinois, 1980.

Because Taiwan is a highly trade-oriented country, the prices of imported goods should have a significant impact on its production cost and in turn should spread the effects over to wholesale prices. The wholesale price function is formulated as:

WPI=g0+g1*PM+g2*LAGWPI+e6----------------------(2.3.8)

I) Consumer Price

Consumer price is specified as a function of the wholesale price and nominal wage rates:

LOGCPI=h0+h1*LOGWPI+h2*LOGNW+e7----------------(2.3.9)

J) GNP Deflator

The GNP deflator is specified as a function of the wholesale price, consumer price, and money pressure. Money pressure is defined as a logarithmic ratio of nominal money to real GNP. It is assumed that the product market is near equilibrium; demand pressure[9] is consequently eliminated in this model. But demand pressure will be introduced into the later disequilibrium model. Money pressure can be derived from either Fisher's (1911) equation of exchange, MV=PY, or Pigou's (1917) Cambridge equation, M=kPY. By assuming that the velocity of the circulation of money (k) is constant, price is approximately the function of the

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[9] Demand pressure can be defined as the ratio of potential GNP and actual GNP. In the St. Louis Model, Andersen and Carlson (1974) defined demand pressure as D = (Y-LAGY)-(FX-LAGX), where Y = nominal GNP, LAGY = lagged nominal GNP, FX = potential (full employment) real GNP, LAGX = lagged real GNP.

ratio of nominal money supply and real GNP. The implicit GNP deflator can be written as:

LOGP=i0+i1*LOGMON+i2*LOGWPI+i3*LOGCPI+e8 -----(2.3.10)

2.4 THE IDENTIFICATION OF THE MODEL

To validate a simultaneous model each structural equation in the model should be either identified exactly or overidentified. When structural equation parameters can be uniquely determined, the equation in question is said to be exactly identified. When more than one set of parameter estimates for one or more parameters can be determined, the equation is said to be overidentified. Underidentification arises when the parameter estimates are impossible to determine for a given structural equation.

Because a simultaneous model can be expressed in a reduced form (see Section 2.7), the most general conditions for identification involve some matrix-related conditions associated with the solution of a system of equations. One of the most useful rules for the purposes of identification is called the order condition. The order condition states that if an equation is to be identified (or overidentified), the number of predetermined variables excluded from the equation under the test must be equal to (or greater than) the number of included endogenous variables minus one. The order condition can be mathematically expressed as:

$(k-k(i)) \geq (p(i)-1)$ ------------------------------(2.4.1) where k = total number of the predetermined variables in the model system,

k(i) = the number of the predetermined variables in the ith equation,

p(i) = the number of the endogenous variables in the ith equation.

For an equation with one or more linear combinations,[10] equation 2.4.1 can no longer hold. But equation 2.4.1 can be revised into a somewhat different form to deal with the linear combination. This revised order condition states that a necessary condition for an equation to be identified (or overidentified) is that the sum of the number of all the variables excluded from the equation in question plus the number of linear combinations[11] must be equal to (or greater than) the number of endogenous variables in the system minus one.[12] In terms of mathematical expression it can be written as:

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[10] If equation 2.3.2 is introduced into equation 2.3.4, then the investment function becomes an equation with one linear combination of (CON-LAGCON) and can be expressed as I=b0 + b1(CON-LAGCON) + b2*R + b3 * LAGI.

[11] The number of linear combinations is counted as the number of variables in the linear combination minus one. In the case of an equation without linear combination, it is counted as zero.

[12] Most of the concepts in this section came from the notes taken by the author from the lectures in Econometrics I and II taught by Liew at the University of Oklahoma. For more discussion on the identification of a simultaneous model, see Econometrics, a forthcoming book by C.K. Liew (1984), University of Oklahoma, and Econometric Models and Economic Forecasts, by Pindyck and Rubinfeld (1981).

$(m-m(i))+q \geq (p-1)$ ---------------------------------(2.4.2)

where m = total number of the variables in the system,

m(i) = total number of the variables included in the ith equation,

q = the number of the linear combination,

p = total number of the endogenous variables in the system.

By using either equation 2.4.1 or equation 2.4.2 to test the identification, each stochastic equation in the equilibrium model system is found to be overidentified. Taking our money market equation 2.3.7 as an example, the result generated by equation 2.4.1 is $(20-4)=16 > (1-1)=0$, and by equation 2.4.2 is $(30-5) + 0 = 25 > (10-1)=9$, demonstrating that the money market equation is overidentified.

2.5 THE INTERFLOW AND LINKAGE OF THE MODEL

In the classical models, a dichotomy between real and nominal variables has always been assumed. Real values are decided in the output, and labor markets and prices are decided in the money sector. In this study, all output, money, and labor markets are treated as real sectors and the variables are assigned real values. A special price system is developed to determine prices. The variables in this price system are assigned nominal values unless they are in terms of indices. Although prices are primarily decided by the price system, they are also heavily influenced by the money supply. The logarithmic form of money pressure, the nominal wage index, and wholesale prices strongly link the real sectors and price system.[13] Both money and capital markets (the investment function represents the capital market in this study) decide the real interest rate. The labor market decides the real wage.

The interflow and linkage of the Taiwan model is depicted in Figure 2.1.

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[13] The strong linkage between the real sectors and the price sector can be detected by the following equations:
(a) LOGMON = LOG((P*MS)/Y) = LOGP+LOGMS-LOGY,
(b) LOGNW = LOG(P*W) = LOGP*LOGW.

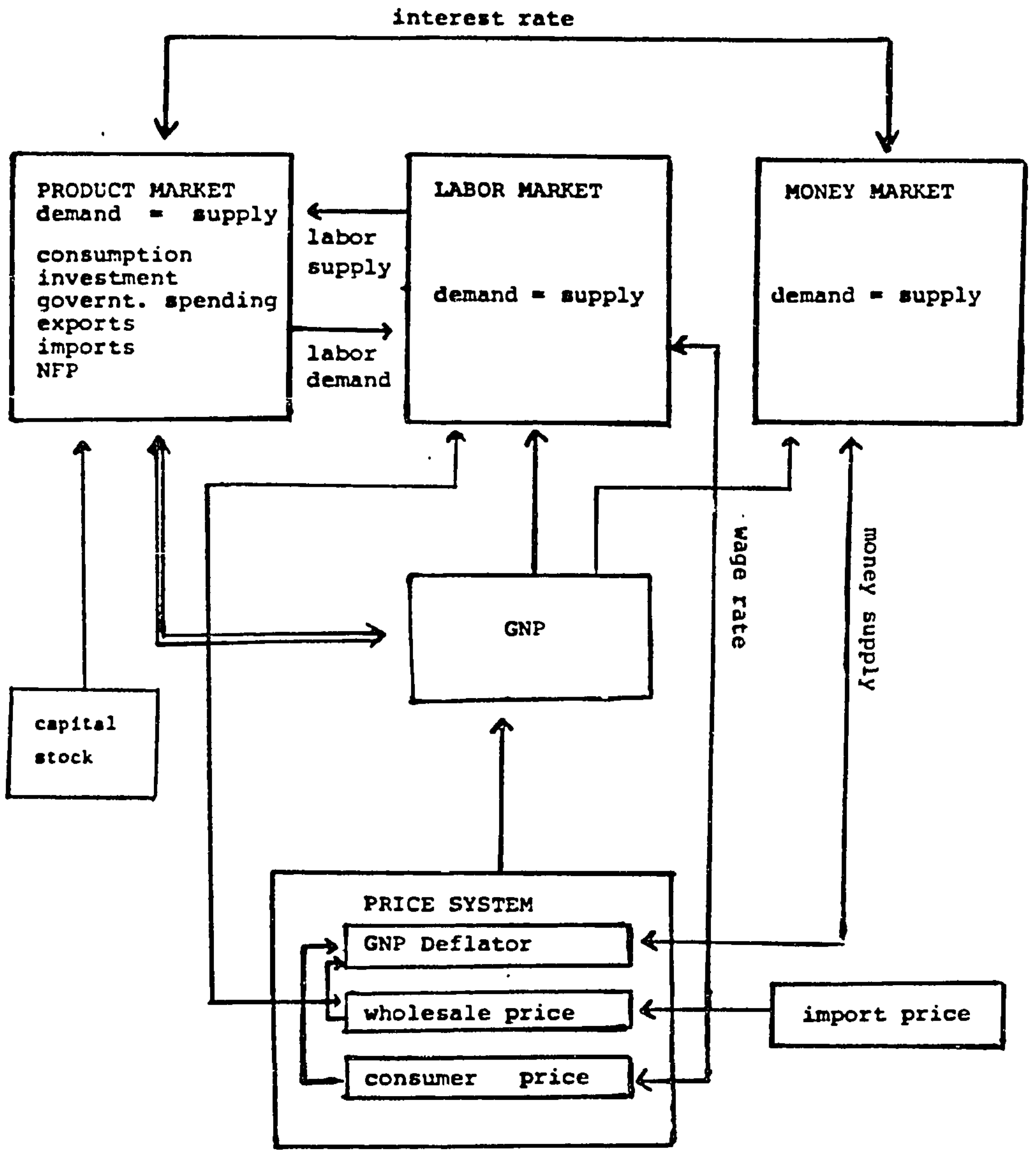

Figure 2.1 Flow Chart of Taiwan Equilibrium Model

2.6 NONLINEAR SYSTEM WITH LINEAR APPROXIMATION

In the Taiwan Equilibrium Model, the functions of money demand, consumer price, and the GNP deflator are transformed into logarithms. Though they are logarithmically linear forms in an algebraic sense, their original forms actually are non-linear. In applying the SAS package to run the model, the original variable and the log-transformed variable are treated as two individual variables. For example, Y and LOGY are treated as two different variables. This arrangement is appropriate for estimating parameters; however, it becomes inappropriate and illegitimate when doing multiplier analysis, forecasting, simulation, and policy experiments. There are two reasons for this:

1. Mathematically Y is known whenever LOGY is known, and vice versa, no matter which position of exogeneity or endogeneity exists.
2. Linkage within the model is greatly reduced if the original variables and the corresponding log-transformed variables are treated as individual and independent.

The log-transformed variables can be converted back to their original variable status by applying Taylor's Theorem.[14] Taylor's Theorem states that the non-linear function

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[14] For the details about Taylor's Theorem, see Chapter 13, Calculus, 3rd edition, by Salas and Hille (New York: John Wiley & Sons, 1978).

$y = f(x)$ can be linearly approximated as:

$$y = f0 + (\partial f/\partial x)\ (x - x0)$$

where $\partial f/\partial x$ = Jacobian gradient,

x0 = mean value of the corresponding variable,

$f0 = \bar{y} - f(x0)$ = residual = 0, and

$\bar{y}$ = mean value of Y.

For the purpose of demonstration, the log-transformed consumer price equation LOGCPI = h0+h1*LOGWPI+h2*LOGNW can be approximated through the following steps:

(1) LOGCPI=h0+h1*LOGWPI+h2*log(P*W).

(2) LOGCPI=h0+h1*LOGWPI+h2*LOGP+h2*LOGW.

(3)

$$(\partial f/\partial x)\ (x - x0) = \left(\frac{1}{\overline{CPI}};\ 0\ ,\ \frac{h1}{\overline{WPI}}\ ,\ \frac{h2}{\overline{P}}\ ,\frac{h2}{\overline{W}} \right) \begin{pmatrix} CPI-\overline{CPI} \\ 1-1 \\ WPI-\overline{WPI} \\ P - \overline{P} \\ W - \overline{W} \end{pmatrix} = 0$$

(4) $CPI/\overline{CPI} = (1-h1-h2-h2) + (h1/\overline{WPI})\, WPI + (h2/\overline{P})\, P + (h2/\overline{W})\, W.$

(5) $CPI = (1-h1-2*h2)\,\overline{CPI} + (h1/\overline{WPI})\,\overline{CPI}*WPI + (h2/\overline{P})\, P*\overline{CPI}$

$+ (h2/\overline{W})\, W*\overline{CPI}.$

Equation in 5 is finally the linear approximation for the original logarithmic CPI function.

2.7 DYNAMIC MULTIPLIER ANALYSIS

A dynamic model can be written into a matrix form as:

$$W\ Y = A^*\ Y_{-1} + B^*\ X + C^*\ X_{-1} + e \quad \text{------------------------------} (2.7.1)$$

The matrix form can be further simplified into a reduced form as:

$$Y = A\ Y_{-1} + B\ X + C\ X_{-1} + v \quad \text{------------------------------} (2.7.2)$$

where Y = the matrix of endogenous variables,

X = the matrix of exogenous variables,

W = the matrix of the coefficients for Y,

A* = the matrix of the coefficients for Y ,

B* =the matrix of the coefficients for X,

C* =the matrix of the coefficients for X ,

e = residuals,

$A = W^{-1}\ A^*$,

$B = W^{-1}\ B^*$,

$C = W^{-1}\ C^*$,

$v = W^{-1}\ e$,

Y_{-1}= the matrix of endogenous variables with one-period-lag,

X_{-1}= the matrix of exogenous variables with one-period-lag.

The reduced form of 2.7.2 can be further expanded to:

$$Y = BX + (AB+C)X_{-1} + (A^2\ B+C)X_{-2} + \text{----} (A^K\ B+C)X_{-K} \text{----} \quad (2.7.3)$$ [15]

[15] If there is no lagged exogenous variables, then matrix C equals zero. Equation 2.7.3 can be simplified as $Y = BX + AB\ X_{-1} + A^2\ B\ X_{-2} -- + A^K\ BX_{-K}$. The Taiwan equilibrium model is the simplified case, since the C matrix is zero.

The impact multipliers are mathematically defined as $\partial y/\partial x = B$, which indicate the effects of a one-dollar change in exogenous variables in the current period upon the change in the endogenous variables in the current period. The interim multipliers are mathematically defined as $\partial y/\partial x = \sum_{t=1}^{k} (A^{t} B+C)$, which indicate the effects of a one-dollar change in exogenous variables in prior k periods upon the change in endogenous variables in the current period. Thus, the total multiplier can be defined as the sum of both the impact and the interim multipliers, i.e., $B+\sum_{t=1}^{k}(A^{t} B+C)$.

The stability of the dynamic multipliers can be detected by the eigen values of the matrix of A, denoted as z. Eigen values are defined as the values which can make the following equation hold:

$|A-zI| = 0,$

where A = a k by k matrix,

I = a k by k unitary matrix,

z = eigen values.

Because A is a k by k matrix, there are at most k eigen values. Let the absolute value of the largest eigen value be equal to z^*, then

A) If A is a symmetric matrix, all z are real numbers, and the following rules apply:

1. If $z^* < 1$, the model is uniformly converged.
2. If $z^* > 1$, the model is uniformly diverged.

3. If $z^* = 1$, the model is a uniform case.

B) If A is a non-symmetric matrix, some eigen values are imaginary, and the following rules apply:

1. If $z^* < 1$, the model is oscillatingly converged.
2. If $z^* > 1$, the model is oscillatingly diverged.
3. If $z^* = 1$, the model is uniformly oscillated.

Because of the built-in business cycles, the multipliers may be positive in some years and negative in others. A proper dynamic model should detect the necessary length of the business cycle.

Chapter III

DATA SOURCES FROM TAIWAN, JAPAN AND THE U.S.

3.1 DATA OF TAIWAN

The time series annual data covering the period of 1961-82 are applied in this model. The data for most of the variables in this study are available in the "Taiwan Statistical Data Book, 1983" published by the Council for Economic Planning and Development, Taipei, R.O.C. Data for the Import Price Index (PM), 1962-79, were obtained from A Model for a Four-Year Plan for Economic Development of Taiwan published by the Council for Economic Planning and Development (CEPD), 1981. PM Data for the periods of 1961 and 1980-82 were supplied directly by CEPD through the mail.

Data for the wage rate are calculated by using the following formula: the wage rate is equal to the national income distributed as a wage bill divided by the labor employed. Due to the difficulty of obtaining reliable data, this proxy wage rate is used.

The data of Taiwan have some limitations. Yu and Lee (1978, p90), in their article entitled "The Experience of Econometric Modeling in Taiwan" address these limitations as follows:

> We have no suitable data for wage rates for the whole economy and no reliable data for capital stock. The data for employment are very rough.

It is also widely recognized by economists that the data for the money supply, and therefore money demand, are not reliable due to the existence of an active black market for money and many mutual savings-and-loan associations[16] throughout the whole island. The official statistical data only take the transactions from the formally recognized organizations into account. Accordingly the author believes that the official data is biased and underestimated.

3.2 DATA OF THE U.S. AND JAPAN

The data for the U.S. GNP for the period 1961-81 came from the *Statistics Abstract of the U.S.* published by the U.S. Department of Commerce, and the data for the year 1982 came from the *Survey of Current Business*, April 1983 issue, also published by the U.S. Department of Commerce.

The data for the Japanese GNP 1961-81 came from the *Japan Statistics Year Book* published by the Japanese Bureau of Statistics, Office of the Prime Minister, and the *Europa Year Book*, issued by Europa Publications, London. The data

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[16] In Taiwan, mutual savings-and-loan associations can be initiated and organized by anyone. At the present time there is no particular law or regulation to regulate this kind of association, other than Civil Law. Only those who register as a bank and/or a trust company or a financial company are regulated by Banking Law or other particular financial business codes.

for the year 1982 came from the Feb/March 1983 issue of the *Japan Report*, published by the Japan Information Center, Consulate General of Japan, New York.

Chapter IV

RESULTS AND INTERPRETATIONS OF THE TAIWAN MODEL

4.1 RESULTS OF THE ESTIMATION

To take care of simultaneous bias, a correlation between endogenous variables and residuals, either 2SLS or 3SLS must be applied to a simultaneous model. When 2SLS is applied, two steps must be performed. The first step is to regress the explanatory endogenous variables on the predetermined variables of the model. The second step is to treat the fitted endogenous variables as instrumental variables and regress the stochastic equations. Once the 2SLS parameters have been calculated, the residuals of each equation are used to estimate the cross-equation variables and covariances—just the same as in Zellner's (1962) estimation process. In 3SLS estimation an additional third step is needed in which the generalized least squares method is used to take care of the cross equation correlation and obtain the parameter estimates. The 3SLS yields more efficient estimates than the 2SLS because the 3SLS takes into account cross-equation correlation.[17]

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[17] For details about the 2SLS and 3SLS and their examples, see Pindyck and Rubinfeld (1981), Econometric Models & Economic Forecasts, Chapter 11, New York: McGraw Hill, and Liew (1984), Econometrics, a forthcoming book, Univ-

Estimates for the parameters of the 8 stochastic equations were determined using SAS. The results of the application of the 2SLS and 3SLS methods are reported respectively as follows (the figure in the parenthesis under the coefficient is the t value for that particular coefficient):

4.1.1 Results of 2SLS

Product Market:

Y= CON + I + G + X - M + NFP --------------------(4.A.1)

DCON = CON - LAGCON ------------------------------(4.A.2)

CON=27.109+0.21164Y+0.5455LAGCON+e1--------------(4.A.3)

(4.93) (4.03) (4.41) R^2 =0.9986

I =35.5181+1.2994 DCON - 1.1924 R+0.0054 K

(0.72) (1.94) (-0.84) (0.14)

+ 0.7846 LAGI+e2-------------------------------(4.A.4)

(2.53) R^2 =0.973

M =-51.5128+0.3836 Y+0.1022 X+0.1776 LAGM+e3-----(4.A.5)

(-1.37) (1.95) (0.39) (0.93) R^2 =0.9914

Labor Market:

L =3.2085+.00299Y-1.868 W+0.1335 T+.1357WPI+e4 --(4.A.6)

(44.57) (5.96) (-5.00) (10.16) (0.96) R^2 =0.9977

Money Market:

LOGMS=-4.6171-.0934LOGR+1.5798LOGY

(2.59) (-.62) (4.19)

-0.0796LGLNMS+e5 --------------------------(4.A.7)

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ersity of Oklahoma.

(-.37) R^2 =0.9922

Price System:

WPI=0.1586+0.7796 PM +0.227 LAGWPI+e6 ------------(4.A.8)

(9.19) (15.28) (0.32) R^2 =0.9961

LOGCPI=0.0035+.7795 LOGWPI+.1893 LOGNW+e7 --------(4.A.9)

(0.32) (8.78) (4.64) R^2 =0.9936

LOGP=.2557+.1802LOGMON+.1792LOGWPI

(5.36) (5.67) (1.67)

+0.5373LOGCPI+e8 --------------------------(4.A.10)

(4.87) R^2 =0.9980

4.1.2 Results of 3SLS

Product Market:

Y = CON + I + G + X - M + NFP -------------------(4.B.1)

DCON = CON - LAGCON -----------------------------(4.B.2)

CON=25.0802+0.1926 Y + 0.5912 LAGCON+e9 ---------(4.B.3)

(5.80) (5.27) (6.84)

I =55.045+1.3266 DCON-2.0659 R+0.0432 K

(2.38) (4.10) (-3.09) (2.37)

+ 0.4431 LAGI+e10 ----------------------------(4.B.4)

(2.89)

M =-21.0785+0.2307 Y+0.3788 X+0.1260 LAGM+e11 ---(4.B.5)

(-1.10) (2.40) (2.88) (1.07)

Labor Market:

L =3.2630+0.0035 Y-2.1116W+.1252T+0.0903WPI+e12 (4.B.6)

(51.16) (8.09) (-6.66) (10.81) (0.73)

Money Market:

LOGMS=-3.7064-.1455 LOGR+1.3868LOGY

(-4.7) (-2.23) (8.44)

+0.019LGLNMS+e13 -------------------------- (4.B.7)

(0.21)

Price System:

WPI=0.1504+0.7455 PM+0.070 LAGWPI+e14 ---------- (4.B.8)

(10.32) (20.11) (1.40)

LOGCPI=0.0040+.8362 LOGWPI+.1652 LOGNW+e15 ------ (4.B.9)

(0.37) (13.37) (5.68)

LOGP=.2911+.205LOGMON+.0815LOGWPI

(11.43) (12.69) (1.64)

+0.5757LOGCPI+e16 ------------------------- (4.B.10)

(12.19)

4.1.3 The Findings from the Estimation

All correct signs for the estimated coefficients can be determined by either the 2SLS or 3SLS method. Because 3SLS is more efficient than 2SLS, the t values reported in 3SLS are greater than those in 2SLS, implying that the coefficients are more significantly different from zero when 3SLS is applied. The coefficient of determination (R^2) for the investment function is 97% and for the other functions is higher than 99%, showing that every equation in the model has a very good fit.

In the import function, both exports and GNP are found to be significant at 1% level, indicating that imports are enhanced by the expansion in GNP and exports. The significant positive relationship between exports and imports reflects well the highly trade-oriented economy of Taiwan.

Though the consumption function in this model is very simple, the GNP of the current year is a sufficient explanatory variable for consumption. The marginal propensity to consume is 0.1926 and is significant at 0.01%. Although interest rates have long been under the control of the Government on Taiwan,[18] evidence still shows that they have a significant impact on the activities of investment and money demand.

In the labor market it is found that GNP is related strongly and positively to labor demand, while wage rates are only negatively related. In the price system, the wholesale prices are significantly explained by import prices, indicating that the stability of domestic prices is vulnerable to the price fluctuations of trade partner countries. The wholesale prices and nominal wages in turn influence the consumer prices. Finally, the wholesale prices,

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[18] Recently the Government on Taiwan established a preliminary money market. More agents and instruments were introduced into the market. The interest rate was no longer officially approved by the Central Bank of China as it had been for the past 20 years. But the adjustment of interest rates must still be approved by the Banking Industry Membership Association.

consumer prices, and money pressure in turn affect the stability of the GNP deflator.

4.2 STATIC IS-LM

The Keynesian version of the IS-LM model treats the nominal wage and the price level as exogenous variables and uses these to solve for the equilibrium values of real GNP and the interest rate (Note that in Keynesian IS-LM[19] curves GNP is usually placed on the horizontal axis and interest rate on the vertical axis). The classical version treats the equilibrium values of employment and real GNP as predetermined variables. They are used to solve for the equilibrium values of the price level and the interest rate (Note that in the classical IS-LM, the price level is placed on the horizontal axis and the interest rate is placed on the vertical axis). In this section, the static Keynesian IS-LM curves for the economy of Taiwan will be derived from 3SLS estimation results.

The IS curve is the locus of points of the combined values of interest rate (R) and GNP (Y) which correspond to equilibrium in the output market for given values of the exogenous variables, which in turn influence the demand for

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[19] The curves are named for the key variables in the two equilibrium conditions: IS refers to investment (I) and savings (S) equilibrium in output market and LM refers to money demand (L) and money supply (M) equilibrium in money market.

output (such as government spending (G), exports (X), and net foreign payment (NFP) in this study). Since the output market consists of 5 equations, the identity of DCON (4.B.2) first needs to be substituted into the equation of investment (4.B.4), then the equations of consumption (4.B.3), investment (4.B.4), and imports (4.B.5) must be substituted into the product demand identity (4.B.1). The third step is to replace all variables in the right-hand side of the product demand identity with their mean values except for the variable, interest rate[20] (R).

The following IS curve is derived according the above procedures:

$$Y=599.111-2.6398\ R \quad \text{------------------------} (4.2.1)$$

To rearrange equation 4.2.1 and divide it by 2.6398, equation 4.2.1 can be restated as:

$$R=226.954-0.37882\ Y \quad \text{------------------------} (4.2.2)$$

The LM curve is the locus of points of the combined values of interest rate (R) and GNP, consistent with equilibrium in money market. Because the money equilibrium equation 2.3.7 is in a logarithmic form, the LM is a curve rather than a straight line like the IS curve derived above.

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[20] A more straightforward method to derive the IS curve is (1) to replace the variables in the right-hand side of the equations of consumption, investment, and imports with their mean value except interest rate and GNP, (2) to substitute the generalized equations by (1) into the product demand identity and then do further generalization.

For the purpose of deriving an LM curve, the status of the money supply is first changed to be exogenously determined and then the MS and LAGMS in equation 4.B.7 are replaced by their mean values. By completing the processes described above, equation 4.B.7 can be expressed as

LOG(123.62)=-3.7064-.1455 LOGR+1.3868 LOGY
+0.019 LOG(114.62) ------------------(4.2.3)

Equation 4.2.3 is calculated and rearranged, and is rewritten as follows:

LOGR=-57.961+9.5313 LOGY -------------------------(4.2.4)

The equations 4.2.2 and 4.2.4 are the static IS-LM curves for the Taiwan economy and are shown in Figure 4.1. As can be seen in this figure, the equilibrium point occurs at A where R=11.75%, and Y= 568 NT$ billions. A comparative static analysis of this Keynesian IS-LM model can be made by allowing one or more of the exogenous variables to vary. These changes will cause either or both the IS and LM curves to shift.

4.3 DYNAMIC IS-LM

A Koyck-type lag is employed in the consumption, investment, import, and money supply functions. This scheme provides the Taiwan Model with a dynamic nature that is capable of showing its path of movement to an equilibrium point.

To derive a dynamic IS curve, it is first necessary to substitute the identity of DCON (4.B.2) into the equation of investment (4.B.4). Second, it is necessary to substitute the functions of consumption (4.B.3), investment (4.B.4), and imports (4.B.5) into the output demand identity (4.B.1), and also replace the variables of G, X, and NFP with their mean values. By completing the processes described above, the identity equation can be shown as:

1.2174 Y = 416.3037+0.0489 LAGCON+0.4431 LAGI

-0.126 LAGM-2.0659 R -------------------- (4.3.1)

Rearranging the terms and dividing both sides by 2.0659, we rewrite equation 4.3.1 as:

R = 201.512+0.0237 LAGCON+0.2145 LAGI

-0.061 LAGM-0.3788 Y -------------------------- (4.3.2)

Equation 4.3.2 is the dynamic IS curve for the economy of Taiwan. If the values for LAGCON, LAGI, and LAGM are supplied, the dynamic IS curve for each year can be obtained. For example, to calculate the dynamic IS curve for 1971, 1970's data are supplied for CON, I, and M. The dynamic IS curves for the period of 1966-72 are listed as follows:

R=212.869-0.3788 Y -------------------------------- (4.3.3)

R=213.525-0.3788 Y -------------------------------- (4.3.4)

R=216.495-0.3788 Y -------------------------------- (4.3.5)

R=218.032-0.3788 Y -------------------------------- (4.3.6)

R=218.082-0.3788 Y -------------------------------- (4.3.7)

R=221.543-0.3788 Y -------------------------------- (4.3.8)

R=224.164-0.3788 Y -------------------------------- (4.3.9)

The dynamic LM curve can be derived by supplying the mean value of the money supply (MS) for the money equation 4.B.7. Employing this scheme and rearranging the equation, 4.B.7 can be shown as:

0.1455 LOGR=-8.523+1.3868 LOGY+.019 LGLNMS ------(4.3.10)

Dividing both sides by 0.1455, 4.3.10 can be written as:

LOGR=-58.5773+9.5313 LOGY+0.1306 LGLNMS ---------(4.3.11)

Equation 4.3.11 is the dynamic LM curve for the Taiwan Model. The dynamic LM curve for each year can be obtained by providing the value of the money supply for the previous year. The dynamic LM curves for the period of 1966-72 are listed as follows:

LOGR=-58.107+9.5313 LOGY -------------------------(4.3.12)

LOGR=-58.069+9.5313 LOGY -------------------------(4.3.13)

LOGR=-58.067+9.5313 LOGY -------------------------(4.3.14)

LOGR=-58.061+9.5313 LOGY -------------------------(4.3.15)

LOGR=-58.051+9.5313 LOGY -------------------------(4.3.16)

LOGR=-58.037+9.5313 LOGY -------------------------(4.3.17)

LOGR=-58.006+9.5313 LOGY -------------------------(4.3.18)

The dynamic IS-LM curves for the period of 1966-72 are shown in Figure 4.2, which shows the IS curve moving right-upward and LM curve moving left-upward through the time, indicating that Taiwan experienced GNP growth accompanied by higher interest rates. But the magnitude of the shifts in the IS curve is greater than that of the LM, showing that fiscal policy was a stronger determinant of economic growth than monetary policy during this period. This can be clearly seen in Figure 4.2 in which a upward-moving path is described by points A, B, C, D, E, F and G.[21]

4.4 LONG-RUN EQUILIBRIUM IN IS-LM

In the long run, an equilibrium will eventually be reached so long as the dynamic model is convergent. If convergence is the case, once the equilibrium is reached, it will stay until there is new momentum to cause it to shift away. Therefore, in the long-run equilibrium, the value of a variable in a certain year equals its value in the previous year. The dynamic simultaneous model of Taiwan in this study is a converged case. The condition of the stability of a model will be discussed in greater detail in the next chapter. To obtain a long-run IS curve for the Taiwan Model, several steps need to be followed:

1. Let CON=LAGCON, I=LAGI, M=LAGM, and therefore obtain a long-run investment and import function respectively from equations 4.B.3 and 4.B.4.
2. Substitute the function of consumption (4.B.3), and the long-run investment and import functions which are obtained from 1 into the output demand identity

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[21] There is some mathematical restriction on these dynamic IS-LM curves. If Y is a large number then a negative R is generated by the IS curve, but this negative R is not compatible with the logarithmic LM curve.

(4.B.1).

3. G, X, and NFP are replaced with their mean values and therefore the identity will be reduced to contain only two variables, ie, R and Y, and a constant.

By following the above steps, the long-run IS curve is obtained as:

R=133.609-0.21373 Y -------------------------------- (4.4.1)

Using the same scheme and letting LOGMS = LGLNMS and replacing MS with its mean value, the long-run LM curve can be obtained as:

LOGR=-57.951+9.5313 LOGY --------------------------- (4.4.2)

The long-run IS-LM curves are plotted in Figure 4.3, in which the long-run equilibrium point occurs at Z where R=12.25%, and Y=568 NT$ billions. Compared with Figure 4.2, Z is greater than A, B,... and E, but the gaps are decreasing, reconfirming a dynamic path moving to higher R and GNP.

4.5 AS-AD

In previous sections the IS-LM analysis assumed that the price level was exogenous. It is generally agreed that the assumption of the exogeneity of the price level and the short-run phase are two important shortcomings of static IS-LM analysis. In this section a model with fewer restrictions is developed in order to explain the overwhelming phenomenon of stagflation which Taiwan experienced in the early 1970s.

By using an approach different from that of other economists,[22] Gordon (1978,p178), made several assumptions and derived the so-called aggregated supply (AS) curve which depicts the relationship between real output and price level. His assumptions are listed as follows:

1. Firms are interested in the current price of their output, because they can sell the worker's daily output immediately; therefore, they can promptly visualize the change in the price level and adjust their optimal level of labor employment.
2. Workers are interested in the future expected price level, because they are paid for two weeks or a month of work. They do not immediately realize the change in actual price. Labor supply (shift of the whole curve) increases when actual price level rises above expectations.

The Gordon's type AS curve is derived as shown in Figure 4.4. As can be seen in Graph (a) of Figure 4.4, VMP(p0)[23] and L(p0) represent labor demand and labor supply curves re-

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[22] Meyer (1980), among others, derives the AS curve by starting with the equation of profit-maximizing demand for labor: W=P*FN, where W = nominal wage rate, P = price level, FN= marginal physical product of labor. Since FN is a declining function of output, the AS curve can therefore be written as P= W/FN = W*S(x), where W = a given constant wage rate, S(x) = FN in terms of the declining function of output.

[23] In which VMP represents the value of the marginal physical product of labor and VMP(p0) the value of the marginal physical product of labor at the price level of p0, i.e., VMP(p0) = MPP(L) * p0.

spectively at the price level of p0. The labor equilibrium point falls at E0 and labor is hired at L0 when the price level is at p0. When the price level increases from p0 to p1, the firms will promptly adjust their demand curve from VMP(p0) to VMP(p1) because they can promptly recognize the change in prices. Unlike the firms, the workers suffer from a money illusion and do not realize the change in prices immediately. If the workers are totally fooled, the labor supply curve will remain at L(p0), even though the actual price level is at p1. If this is the case the labor equilibrium point occurs at E1, and labor is employed at L1.

Graph (b) in Figure 4.4 represents the graph of a production function. Tracing L0 and L1 from (a) to (b), Y0 and Y1 are found the GNP at the price level of p0 and p1 respectively. Now the combinations of p0 and Y0, and p1 and Y1 are obtained from Graphs (a) and (b). These combinations are graphed in Graph (c), and an AS curve is derived and indicated by AS(0).

It is notable that if the workers are not completely fooled, they will gradually realize the change in prices, and thus, the labor supply curve L(p0) will shift left and upward. If the workers realize the change in prices immediately and demand higher nominal wages, in the classical sense, expected prices will be equal to actual prices, and L(p0) will thus shift up to L(p1). As can be seen in Graph (a), a new equilibrium point will fall at EE, and the labor employed will remain at L0. Accordingly, a classic vertical AS curve will appear as shown as AS(1) in Graph (c).

Having discussed the theoretical framework of the AS curve, the derivation of an AS curve for the Taiwanese economy is described. The following steps are necessary:

1. A linear production function[24] is obtained as:

   Y = -442.702+147.0242 L+0.2245 LAGK+0.095 T ---(4.5.1)

2. Replacing LAGWPI by its mean value, the wholesale price equation 4.B.8 can be generalized as:

   WPI = 0.2056+0.7455 PM -----------------------(4.5.2)

3. Using Taylor's Theory, the GNP deflator equation 4.B.10 is linearly approximated as:

   P = 0.1101+0.9161 MON+0.0791 WPI+0.5688 CPI ---(4.5.3)

4. Substituting the generalized WPI, i.e., 4.5.2, and the CPI function 4.B.9 into 4.5.3, and making the necessary calculations and rearrangements, we express WPI as:

   WPI = -0.2358+1.93769 P-1.96167 MON-0.20214 W

---

[24] A linear production function instead of a Cobb-Douglas production function is used because it is more convenient to derive AS-AD curves by using linear forms. All logarithmic forms are linearly approximated by using Taylor's Theory during the process of deriving the AS-AD curves. However, a Cobb-Douglas type production function for the Taiwanese economy can be expressed as: LOGY=1.74515 +1.35501 LOGL +0.25783 LGLNK +0.21511 LOGT,

where LOGY = GNP in logarithmic form,
LOGL = labor employed in logarithmic form,
LGLNK = lagged capital in logarithmic form,
LOGT = Time in logarithmic form.

-0.12634 PM ------------------------------(4.5.4)

5. Substituting 4.5.4 into the labor equilibrium equation 4.B.6, and making the proper calculations and rearrangements, we can express the labor equation as:

L = 3.2417+0.0035 Y-2.12985 W +0.1252 T +0.17497 P

-0.17714 MON-0.0114 PM --------------------(4.5.5)

6. The real wage rate (W) in 4.5.5 being expressed as NW/P, where NW = nominal wage rate, and P=price level, 4.5.5 can be rewritten as:

L = 3.2417+0.0035 Y-2.12985 (NW/P) +0.1252 T

+0.17497 P-0.17714 MON-0.0114 PM ---------(4.5.6)

7. The equation 4.5.6 is linearly approximated as:

L = 0.1348+3.507 P +0.0035 Y-2.12958 NW+0.1252 T

-0.17714 MON-0.0114 PM --------------------(4.5.7)

8. Substituting 4.5.7 into the production function 4.5.1 and replacing T, and LAGK by their mean values, we can simplify 4.5.1 as:

Y = 57.594+515.613 P+0.51458 Y-313.139 NW-26.0438 MON

-1.6761 PM ------------------------------(4.5.8)

9. Rearranging 4.5.8 and dividing both sides by 515.613, we can rewrite 4.5.8 as:

P = -0.1117+0.00094 Y+0.6073 NW+0.505 MON

+0.00325 PM ------------------------------(4.5.9)

10. Replacing NW, MON, and PM by their mean values, we can generalize 4.5.9 as:

P = 0.37371+0.00094 Y ---------------------(4.5.10)

Equation 4.5.10 is the generalized AS curve.

The aggregate demand curve (AD) is the locus of combinations of points of the price level and real output in which both the output market and the money market are at equilibrium. The AD curve for the economy of Taiwan can be obtained by the following three steps:

1. Substituting the static IS curve 4.2.2 into the money market equilibrium equation 4.B.7, and replacing MS by NMS/P, where NMS = nominal money supply, and P = GNP deflator, we obtain the following equation:

   LOG(NMS/P)=-3.7064-0.1445 LOG(226.954-0.37882 Y)
   +1.38677 LOGY+0.019 LGLNMS-------(4.5.11)

2. Replacing NMS and lagged MS by their mean values and rearranging the equation, then an AD curve for the Taiwanese economy is obtained as:

   LOGP=8.5316+0.1445 LOG(226.954-0.37882 Y)
   -1.38677 LOGY --------------------------(4.5.12)

3. Using Taylor's Theory, we approximate equation equation as:

   P = 3.364-0.00404 Y -------------------------(4.5.13)

The AS-AD curves (i.e., equations 4.5.10 and 4.5.13 respectively) for the economy of Taiwan are plotted in Figure 4.5, in which the equilibrium point occurs at point Q, where P=0.9125, and Y=573 NT$ billions. The equilibrium GNP value derived from the AS-AD analysis should be theoretically identical to that from the IS-LM analysis. When Figure 4.5 is compared with Figure 4.1, it is found that the former has an equilibrium GNP value equal to 573 and the latter a value of 568. The difference results from the generalization processes applied to IS-LM and AS-AD analyses. This discrepancy does not necessarily imply inconsistency between the results of the IS-LM and AS-AD analyses.

It is important to notice that equation 4.5.9 is an AS curve in which the GNP deflator is expressed as a function of GNP, nominal wage, money velocity, and import price. A sharp increase in any or a combination of NW, MON, and MP will shift AS curve left-upward, and thus generate a stagflation. In the period of 1973-74, Taiwan experienced a stagflation shocked by the sharp increase in import prices, particularly by the petroleum price increase due to the OPEC oil embargo. In this period, real GNP increased only 1.12%, but the price level jumped as high as 37.43%.

In this chapter the results of 2SLS and 3SLS of the Taiwan equilibrium model, and textbook type IS-LM and AS-AD analyses have been presented, showing that the empirical results of the Taiwan model are compatible to current economic theories. In next chapter, forecast and simulation of this model will be performed to further support the validation of this model.

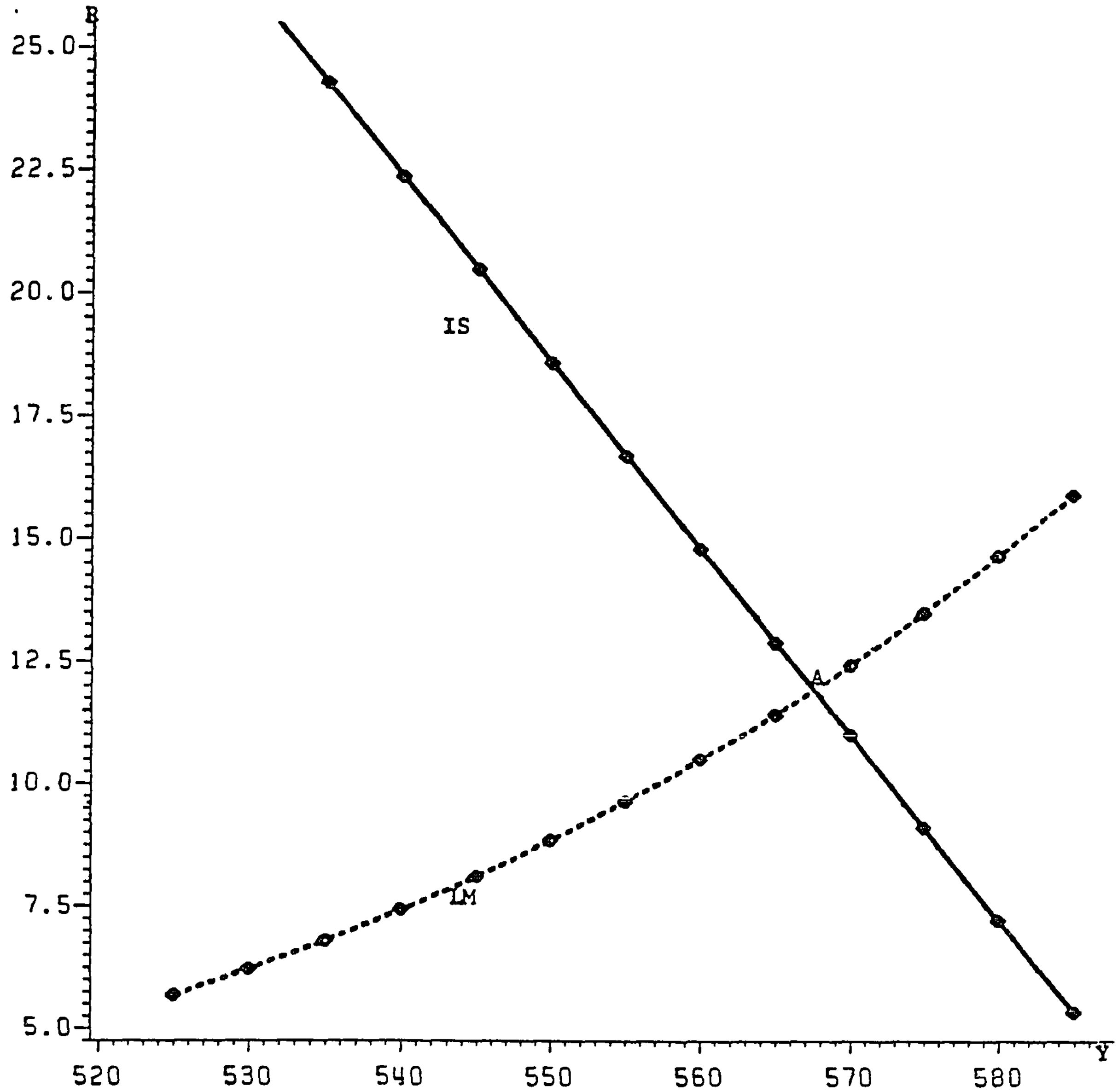

Figure 4.1 Static IS-LM Curves

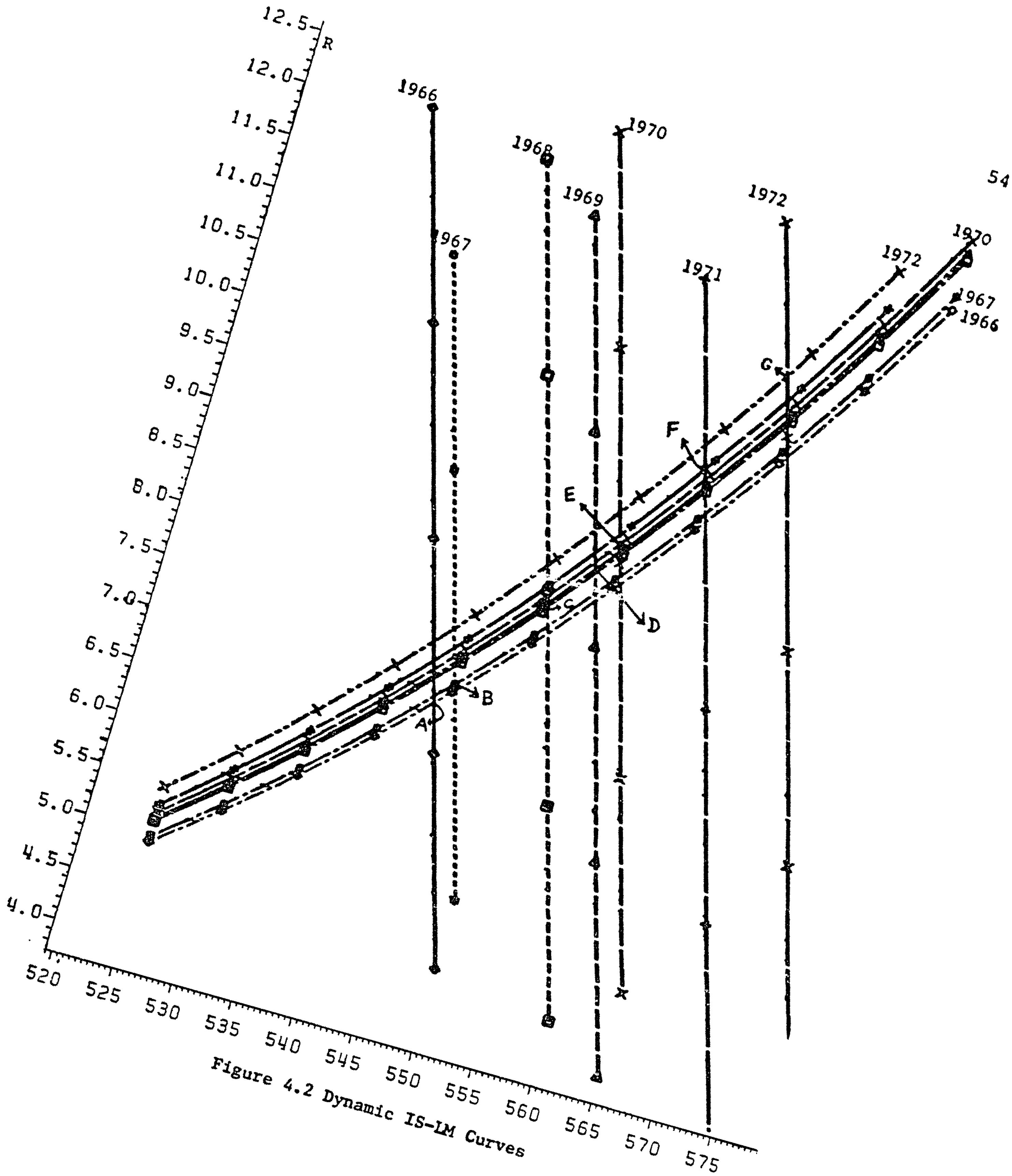

Figure 4.2 Dynamic IS-LM Curves

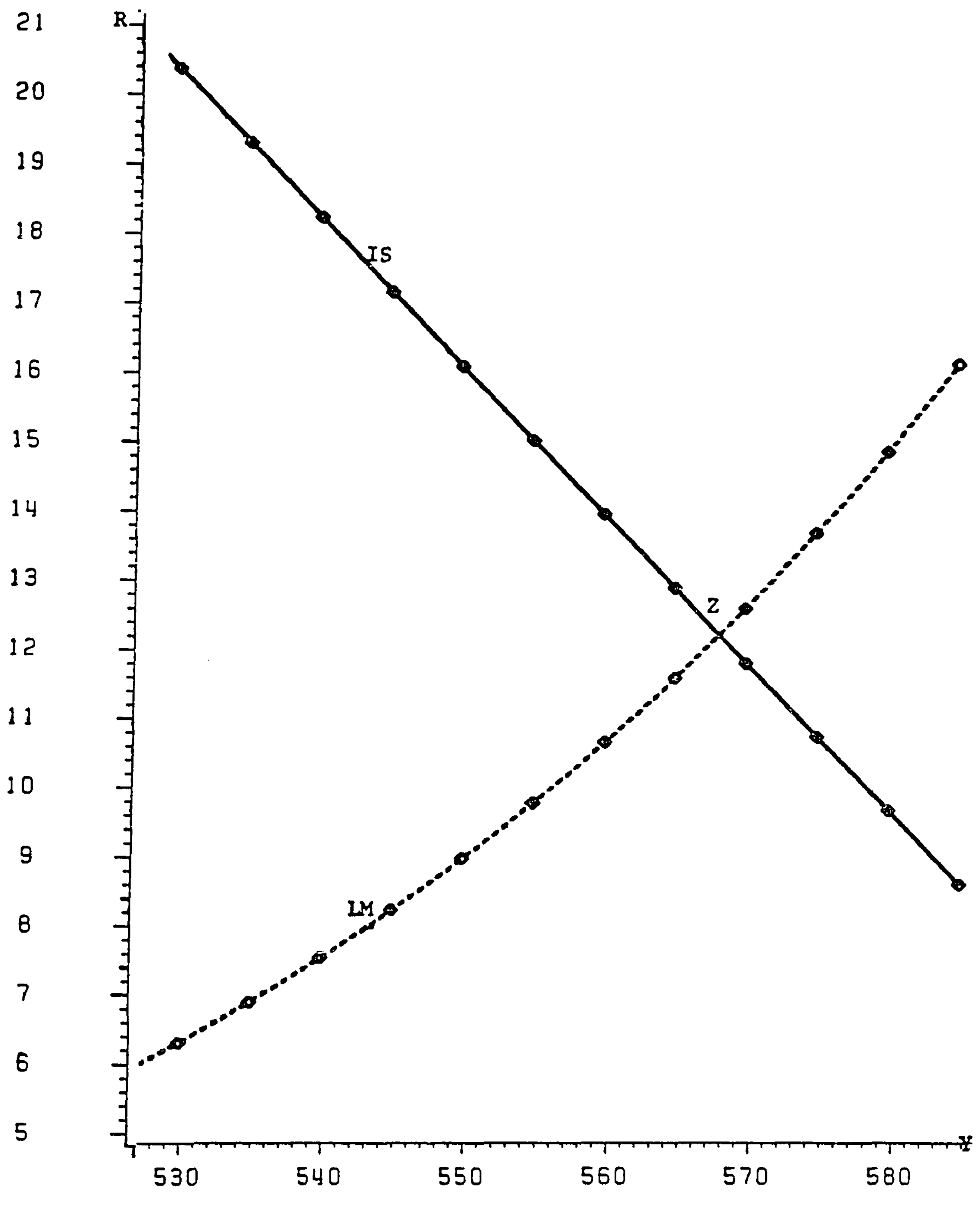

Figure 4.3 Long-Run Equilibrium in IS-LM

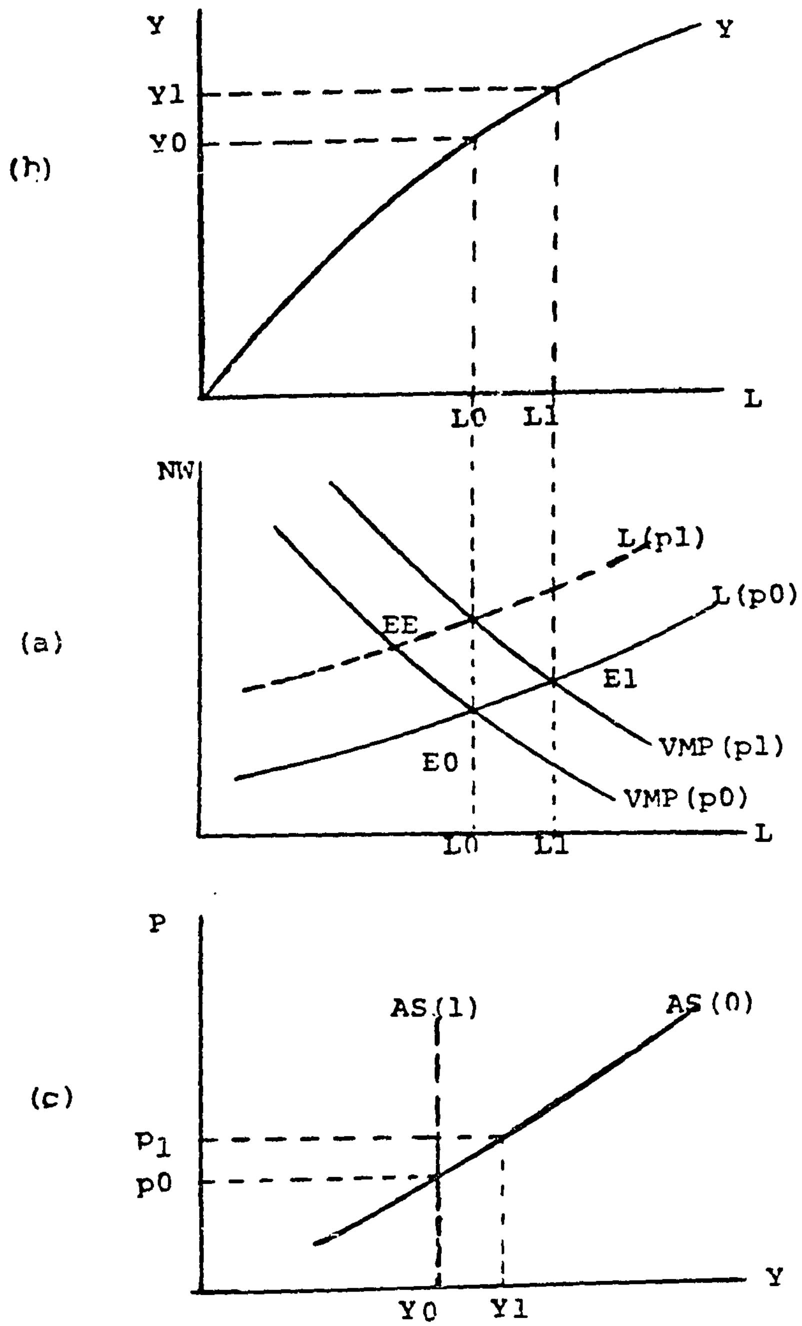

Figure 4.4 AS Curve

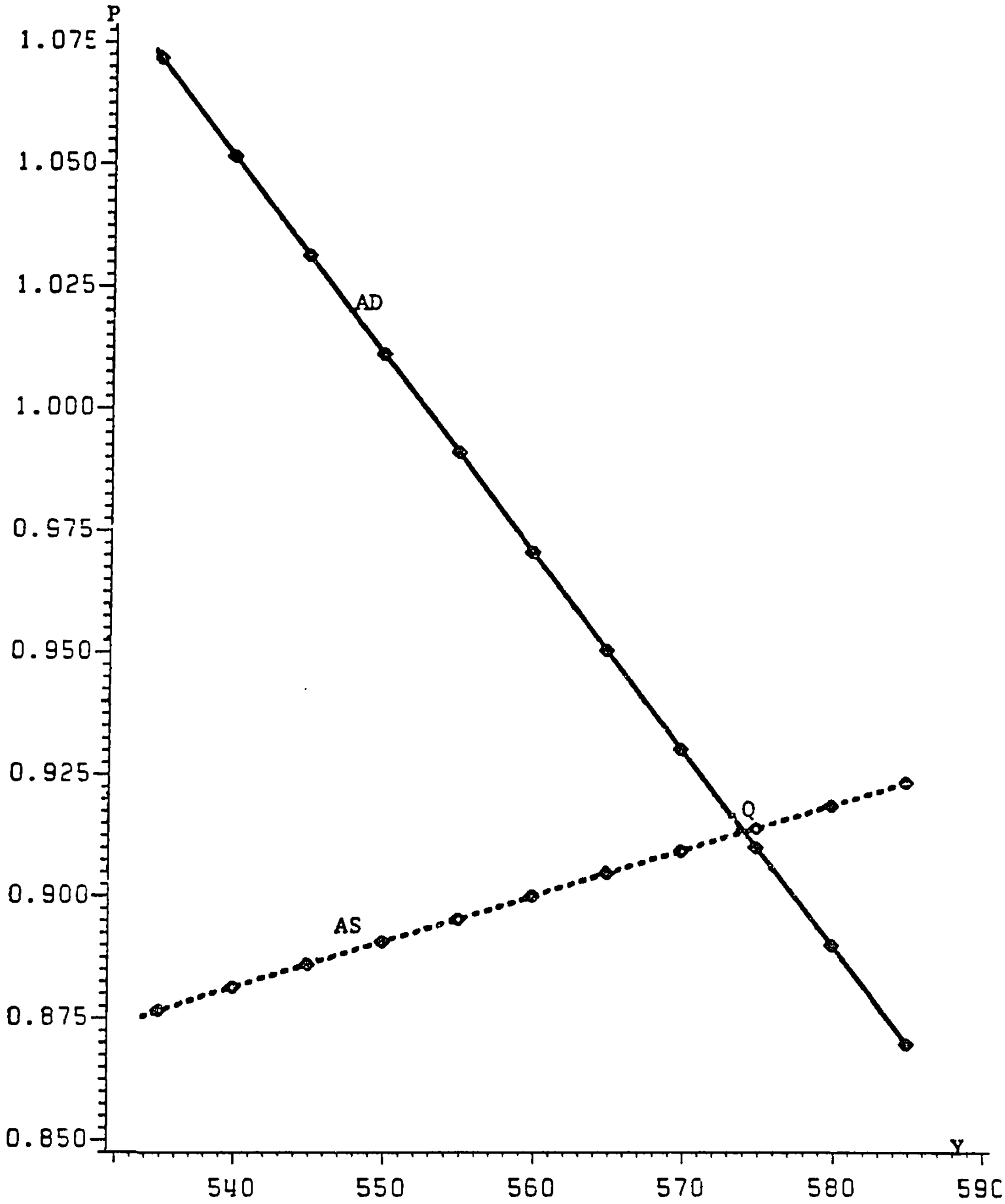

Figure 4.5 AS-AD Curves

Chapter V

FORECAST AND SIMULATION

5.1 INTRODUCTION

For a single-equation regression model the R^2, F, and t statistics can be used to evaluate the goodness of fit of the equation, and the Durbin-Watson statistic to test the degree of autocorrelation. For a simultaneous model, this same set of statistics can still be applied for testing the goodness of fit of each single equation in the model. However, the goodness of fit of each individual equation does not guarantee that the model as a whole is of a good fit. To check the validation of a simultaneous model either a forecast or a simulation, or both, should be performed. The compact Taiwan model is a dynamic model. Traditionally it is called a "forecast" if the actual values of the lagged endogenous variables are used in doing the simulation, and a "simulation" if the forecasted values are used.

The results of 3SLS method are used for forecasting and simulation because the 3SLS is more efficient than the 2SLS as discussed in Chapter IV. In section 2.3, Chapter II, the Taiwan equilibrium model was specified with 8 stochastic equations and 2 identities. The increment in consumption identity 2.3.3 can be directly introduced into the 3SLS estimated investment equation 4.A.2, and therefore the whole model system is reduced to contain only 8 stochastic equations and 1 identity. However, as discussed in section 2.6, Chapter II, the logarithmically transformed equations must be converted into linear approximations by Taylor's linear approximation approach in order to achieve better interactions for forecasting and simulation.

Using these linear approximation procedures the CPI, P, and money market equations listed in subsection 4.1.2, Chapter IV can be approximated as:

CPI = -0.1348+0.8211 WPI+0.1672 P+0.1659 W --------(5.1.1)

P = 0.1358+0.00167 MS-0.00038 Y+0.0995 WPI

+0.7154 CPI ------------------------------(5.1.2)

MS = -32.178-0.8508 R+0.31703 Y+0.0205 LAGMS ------(5.1.3)

Rewriting the product demand identity and the non-logarithmic linear equations listed in section 4.1.2, chapter IV, we obtain:

Y = CON+I+G+X-M+NFP -------------------------------(5.1.4)

CON = 25.086+0.1926 LAGY+0.5912 LAGCON-------------(5.1.5)

I = 55.045+1.3266 (CON-LAGCON) - 2.0659 R

+0.0432 K+0.4431 LAGI--------------------------(5.1.6)

M = -21.0785+0.2307 Y+0.3785 X+0.126 LAGM ---------(5.1.7)

L = 3.263+0.0035 Y-2.1116 W+0.1252 T+0.0903 WPI ---(5.1.8)

WPI = 0.1504+0.7455 PM+0.07 LAGWPI ----------------(5.1.9)

The above 9 equations are equivalent to the original 10-equation model and can be written into the same matrix form which appeared in chapter II:

$$W\ Y = (A^*)Y_{-1} + (B^*)X + (C^*)X_{-1} + e \text{ ----------------- } (2.7.1)$$

In this matrix form Y, CON, I, M, L, MS, P, WPI, and CPI are treated as 9 endogenous variables, and the intercept, G, X, W, T, R, NFP, PM, and K as 9 exogenous variables. The matrices A, B, and C for the reduced form $Y=AY_{-1}+BX+CX_{-1}+v$ can be obtained by using either Liew's (1973) Dymult Program or TSP package by supplying the matrices W, A*, B* , and C* . Once the matrices of A, B, and C are obtained, then the forecasted (or simulated) values for the endogenous variables can be derived by supplying the historical (or simulated) data of the lagged endogenous and the current exogenous variables. This procedure is called a dynamic forecasting (or simulation) in terms of exogenous variables.[25] In this study the process of this ex-post forecasting was executed using the TSP (Time Series Processor) program, whereas the ex-post simulation was performed using a Pascal program.

One method to test the performance of a model is to compare the forecasted (or simulated)[26] endogenous values with

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[25] For more details about the dynamic solution and forecast, see Econometrics, a forthcoming book, by C.K. Liew, The University of Oklahoma.

[26] We do not distinguish forecast and simulation in the coming general discussion of how to evaluate the performance of a simultaneous model.

their actual values. The smaller the difference between the forecasted and actual values, the better the goodness of fit of the model. The measure most often used is called the RMS (root-mean-square) simulation error, which is defined as:

$$RMS = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^f - Y_t^a)^2} \quad \text{-----} (5.1.1)$$

where Y^f = forecasted value of Y,

Y^a = actual value of Y,

T = number of periods in the forecast.

The magnitude of this error can be evaluated only by comparing it with the average size of the variable in question.

Another measure of the deviation of the forecasted variable from its time path is the RMS percent error, which is defined as:

$$\text{RMS \% error} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y^f - Y^a}{Y_t^a}\right)^2} \quad \text{-----} (5.1.2)$$

Other measures are the mean simulation error, defined as:

$$\text{mean error} = \frac{1}{T}\sum_{t=1}^{T}(Y_t^f - Y_t^a) \quad \text{-----} (5.1.3)$$

and the mean percent error, defined as:

$$\text{mean \% error} = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y_t^f - Y_t^a}{Y_t^a}\right) \quad \text{-----} (5.1.4)$$

The measures of mean error and mean percent error share the same shortcomings as they may be close to zero, but in fact, large positive errors cancel out large negative errors. Therefore, the methods of mean absolute error and mean absolute percent error are designed to avoid the problem of mutually offsetting errors. It is generally agreed that RMS is a better method to measure the goodness-of-fit of a model. Low RMS error is however only one desirable measure of the degree of fit for a model. Another criterion is how well the model can forecast the turning points in a historical path. A simple regression line may produce low RMS errors, but fail to predict the turning points; therefore, this simple regression line would not be an accurate model.[27]

Because the measures of RMS error and mean error all have their own weakness, Theil (1961, 1966) introduced a more effective and convenient statistic, called Theil's inequality coefficient, to measure the magnitude of the RMS error. Theil's inequality is defined as:

$$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^f - Y_t^a)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^f)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^a)^2}} \qquad \text{-------------(5.1.5)}$$

---

[27] More details about the measures of simulation errors and their comparison, see Pindyck and Rubinfeld (1981, pp. 360-367).

Note that the numerator of U is nothing but the RMS error, and because of the design of the denominator, U will always fall between 0 and 1. If $Y^f = Y^a$, then U=0, implying there is a perfect fit. On the other hand, if U is close to 1, there is only a little fit or no fit at all.

5.2 THE RESULTS OF FORECAST AND SIMULATION

By using the process discussed in the previous section, the results of the forecasting and simulation demonstrate that the compact equilibrium model has a high degree of good fit. The actual, forecasted, and simulated values for the endogenous variables Y , CON, I, M, MS, L, WPI, CPI, and P are listed in Table 5.1. The historical data are denoted as Y, CON,..., the forecasted values as YHAT1, CONHAT1,..., and the simulated values as YHAT2, CONHAT2,....

The correlation coefficients between the actual and forecasted values, and the actual and simulated values, as well as the root mean squares (RMS), mean absolute error, mean error, and Theil's inequality coefficient, are reported in Table 5.2. Every statistic for both the forecasted and simulated shows that the Taiwan equilibrium model as a whole displays a good fit. The correlation coefficients of the actual and forecasted values for investment (I) and money supply (MS) are 0.9799 and 0.9873, respectively, and the coefficient of the actual and simulated values for investment is around 0.9835. These values are the lowest among the correlation coefficients, but still present strong evidence for a high goodness of fit for this model. Their corresponding Theil's coefficients are 0.0533, 0.0502, and 0.0487 respectively, and are satisfactorily low. The RMS for the GNP(Y) simulation is 36.69. Although it looks large, it is still reasonably low when compared with its mean value of 540.76. The Theil's coefficient for the GNP simulation is 0.0283, showing the high satisfaction of this GNP simulation. The actual, forecasted, and simulated values for each endogenous variable are shown by the graphs in Figures 5.1 to 5.9. Generally, simulation produces a larger deviation from the historical path than does the forecast. This is because the former uses simulated values for the lagged endogenous variables and the latter uses actual values. The deviations are obviously accumulated in simulation, but not in the forecast. Accordingly, it is no surprise that the RMS values in the simulation are higher than those in the forecast, and that the Theil's coefficients in the simulation are also larger than those in the forecast. The only exception to this is that investment (I) and money supply (or demand) (MS) both perform better in the simulation than in the forecast.

Generally, both the forecasting and simulation of the Taiwan model successfully reflect the turning points for each endogenous variable. Once again, however, the forecast and the simulation for I and MS remain the two exceptions. As can be seen in Figure 5.3 and 5.6, the historical paths of I and MS are zigzag in their appearance, but the forecasted and simulated I and MS curves are smoother and do not reflect the historical turning points so well. It is also worthwhile to note here that the forecasted and simulated values for prices generate very close results; correspondingly, their statistics are similar, and their graphical representations are almost congruent through the entire period.

In this chapter the forecasting and the simulation of the Taiwan equilibrium model have been examined, showing that the model as a whole has a high degree of good fit and is capable of predicting turning points. In next chapter the multipliers and business cycle will be analyzed to find out the impacts of exogenous variables on endogenous variables and the length of Taiwan's business cycle.

TABLE 5.1 RESULTS OF FORECAST AND SIMULATION

YEAR	Y	YHAT1	YHAT2	CON	CONHAT1	CONHAT2
1962	185.470	192.813	192.831	121.784	129.000	129.000
1963	202.850	216.435	225.025	129.208	139.119	145.036
1964	227.820	233.854	248.398	146.157	146.874	159.029
1965	252.910	246.226	263.244	159.520	159.292	170.176
1966	275.690	267.612	279.541	169.350	171.331	179.925
1967	304.800	292.338	303.897	184.026	181.930	190.405
1968	332.440	326.680	336.240	199.716	197.252	202.862
1969	362.370	361.385	374.761	214.337	213.247	217.679
1970	403.210	399.344	419.722	230.559	229.240	235.137
1971	455.230	450.998	474.899	249.213	248.826	256.133
1972	515.820	515.600	544.699	273.575	272.351	282.044
1973	581.930	569.405	609.705	305.247	297.179	309.944
1974	588.460	567.973	610.014	318.516	315.702	326.573
1975	613.410	618.753	639.053	340.651	333.420	342.089
1976	696.100	699.230	737.430	364.061	362.094	370.299
1977	764.710	769.281	820.257	388.948	389.514	403.016
1978	870.620	858.532	926.333	422.803	421.515	442.887
1979	940.970	910.055	987.174	465.947	451.569	478.293
1980	1003.07	992.675	1054.406	490.706	493.130	512.316
1981	1053.63	1050.25	1115.881	508.098	518.996	544.408
1982	1093.20	1097.19	1177.287	529.058	538.451	575.341

Table 5.1 RESULTS OF FORECAST AND SIMULATION (continued)

YEAR	L	LHAT1	LHAT2	MS	MSHAT1	MSHAT2	P	PHAT1	PHAT2
62	3.541	3.476	3.476	19.58	-2.734	-2.734	.413	.407	0.407
63	3.592	3.629	3.636	24.19	9.503	9.911	.428	.432	0.432
64	3.658	3.720	3.742	31.34	16.268	18.266	.446	.437	0.437
65	3.763	3.799	3.824	36.64	20.119	22.467	.442	.456	0.456
66	3.856	3.916	3.920	39.93	27.813	28.176	.445	.473	0.474
67	4.050	4.054	4.052	49.76	38.156	38.041	.475	.494	0.495
68	4.225	4.226	4.212	51.99	50.802	49.577	.507	.520	0.520
69	4.390	4.427	4.418	56.43	63.273	62.721	.540	.530	0.530
70	4.576	4.576	4.582	62.69	77.271	78.245	.559	.557	0.558
71	4.733	4.686	4.692	79.44	95.305	96.478	.576	.598	0.600
72	4.948	4.943	4.951	100.75	118.228	119.567	.609	.633	0.635
73	5.327	5.235	5.260	131.81	135.436	138.398	.700	.712	0.715
74	5.486	5.377	5.385	105.95	138.802	140.157	.962	.931	0.931
75	5.521	5.471	5.404	138.57	155.663	150.889	.947	.941	0.936
76	5.669	5.706	5.698	164.10	183.686	183.739	1.000	.979	0.978
77	5.980	5.980	5.983	206.39	208.160	209.558	1.062	1.046	1.045
78	6.228	6.230	6.271	269.93	237.870	242.196	1.112	1.137	1.139
79	6.424	6.384	6.425	261.24	253.960	257.620	1.238	1.271	1.274
80	6.547	6.634	6.603	276.37	280.574	278.400	1.436	1.466	1.467
81	6.672	6.712	6.673	280.82	300.895	298.285	1.608	1.590	1.588
82	6.881	6.769	6.762	312.70	318.675	319.220	1.669	1.623	1.624

Table 5.1 RESULTS OF FORECAST AND SIMULATION (continued)

YEAR	I	IHAT1	IHAT2	M	MHAT1	MHAT2
1962	29.802	34.669	34.669	33.329	36.296	36.296
1963	35.038	48.049	48.482	36.806	44.345	45.347
1964	39.260	54.333	55.418	43.776	51.595	54.335
1965	50.667	50.664	55.186	53.958	58.504	61.735
1966	53.122	57.245	56.511	55.657	67.767	69.200
1967	69.854	66.953	65.668	71.518	76.776	78.571
1968	81.023	81.076	78.200	91.676	92.652	92.822
1969	87.873	92.162	92.618	108.470	110.097	109.875
1970	105.608	104.100	109.592	132.553	130.831	131.624
1971	123.641	123.288	128.673	160.249	160.723	161.228
1972	137.340	146.460	152.367	194.103	198.909	199.753
1973	163.697	156.557	168.912	240.849	234.528	237.112
1974	216.438	163.477	173.977	272.170	232.841	233.259
1975	188.939	201.997	183.996	253.980	249.941	241.065
1976	216.231	208.828	215.613	316.254	298.772	297.004
1977	222.804	236.278	245.641	335.240	339.248	337.552
1978	251.046	256.464	276.273	382.378	392.627	396.018
1979	308.217	267.895	287.880	450.042	419.671	424.463
1980	325.743	301.970	302.031	482.515	464.215	459.472
1981	320.586	324.621	319.159	488.302	498.542	593.714
1982	293.728	340.728	340.864	472.662	516.299	517.115

Table 5.1 RESULTS OF FORECAST AND SIMULATION (continued)

YEAR	WPI	WPIHAT1	WPIHAT2	CPI	CPIHAT1	CPIHAT2
1962	.498000	.511484	0.512	.435000	.413243	0.413
1963	.530000	.522971	0.524	.445000	.431323	0.432
1964	.543000	.514774	0.514	.444000	.432829	0.433
1965	.518000	.529848	0.528	.443000	.455665	0.454
1966	.525000	.537790	0.539	.452000	.471604	0.472
1967	.538000	.547226	0.548	.468000	.488780	0.490
1968	.554000	.562300	0.563	.504000	.511384	0.512
1969	.553000	.559693	0.560	.630000	.514413	0.515
1970	.568000	.573042	0.574	.549000	.538700	0.539
1971	.568000	.594220	0.595	.564000	.578588	0.579
1972	.594000	.610621	0.613	.581000	.605831	0.607
1973	.729000	.698174	0.700	.629000	.692975	0.695
1974	1.02500	.970039	0.968	.927000	.953248	0.951
1975	.973000	.952739	0.949	.976000	.957027	0.953
1976	1.00000	.964009	0.962	1.00000	.986379	0.985
1977	1.02800	1.02032	1.018	1.07000	1.05188	1.050
1978	1.06400	1.09907	1.098	1.13200	1.14724	1.147
1979	1.21100	1.24621	1.249	1.24300	1.30347	1.306
1980	1.47200	1.46301	1.466	1.47900	1.52886	1.531
1981	1.58400	1.58266	1.582	1.72000	1.66839	1.668
1982	1.57400	1.58901	1.589	1.78900	1.69758	1.698

5.2 STATISTICS FOR FORECAST AND SIMULATION

		Forecast	Simulation
Y :	1. correlation coefficient	0.9995	0.9996
	2. RMS	10.8640	36.6900
	3. mean absolute error	8.3840	29.4200
	4. mean error	4.1940	-29.3400
	5. Theil's coefficient	0.0087	0.0283
CON:	1. correlation coefficient	0.9990	0.9981
	2. RMS	5.8590	16.4800
	3. mean absolute error	4.1740	12.4300
	4. mean error	0.0689	-12.4300
	5. Theil's coefficient	0.0091	0.0250
I :	1. correlation coefficient	0.9799	0.9835
	2. RMS	19.8300	18.2900
	3. mean absolute error	12.8500	12.9600
	4. mean error	0.1358	- 3.3800
	5. Theil's coefficient	0.0533	0.0487
M :	1. correlation coefficient	0.9946	0.9944
	2. RMS	16.4000	16.8600
	3. mean absolute error	11.1300	11.9000
	4. mean error	0.0622	-0.0510
	5. Theil's coefficient	0.0300	0.0309
L :	1. correlation coefficient	0.9989	0.9988
	2. RMS	0.0515	0.0538
	3. mean absolute error	0.0409	0.0421
	4. mean error	0.0024	0.0016

	5. Theil's coefficient	0.0050	0.0052
MS :	1. correlation coefficient	0.9873	0.9884
	2. RMS	16.3700	15.7100
	3. mean absolute error	13.9500	13.3700
	4. mean error	-1.2880	-1.8290
	5. Theil's coefficient	0.0502	0.0482
P :	1. correlation coefficient	0.9987	0.9986
	2. RMS	0.0216	0.0224
	3. mean absolute error	0.0186	0.0195
	4. mean error	-0.0029	-0.0032
	5. Theil's coefficient	0.0119	0.0123
WPI:	1. correlation coefficient	0.9980	0.9979
	2. RMS	0.0229	0.0236
	3. mean absolute error	0.0186	0.0192
	4. mean error	-0.0000	0.0000
	5. Theil's coefficient	0.0125	0.0129
CPI:	1. correlation coefficient	0.9968	0.9967
	2. RMS	0.0352	0.0360
	3. mean absolute error	0.0277	0.0284
	4. mean error	-0.0023	-0.0023
	5. Theil's coefficient	0.0189	0.0193

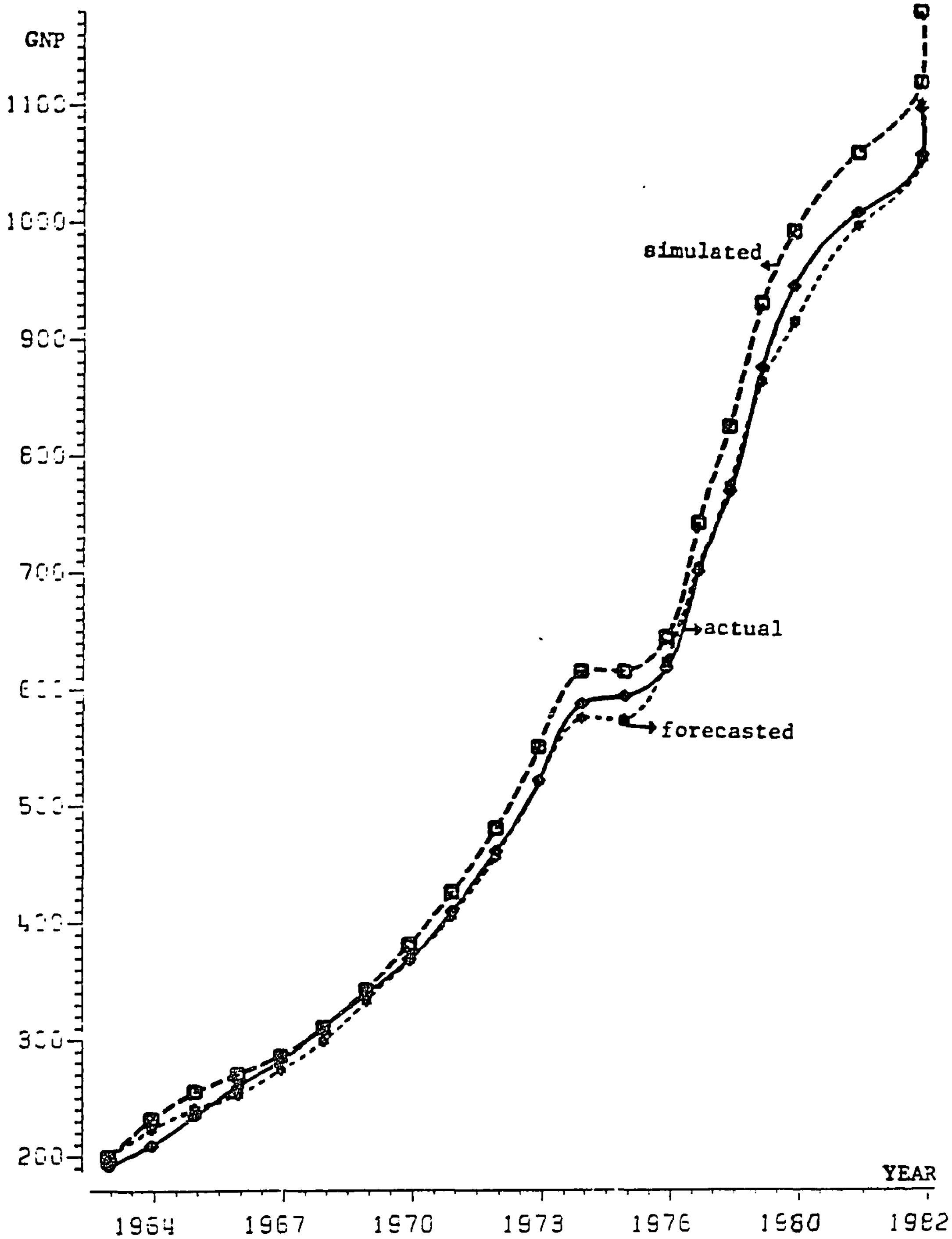

Figure 5.1 Actual-Forecasted-Simulated GNP

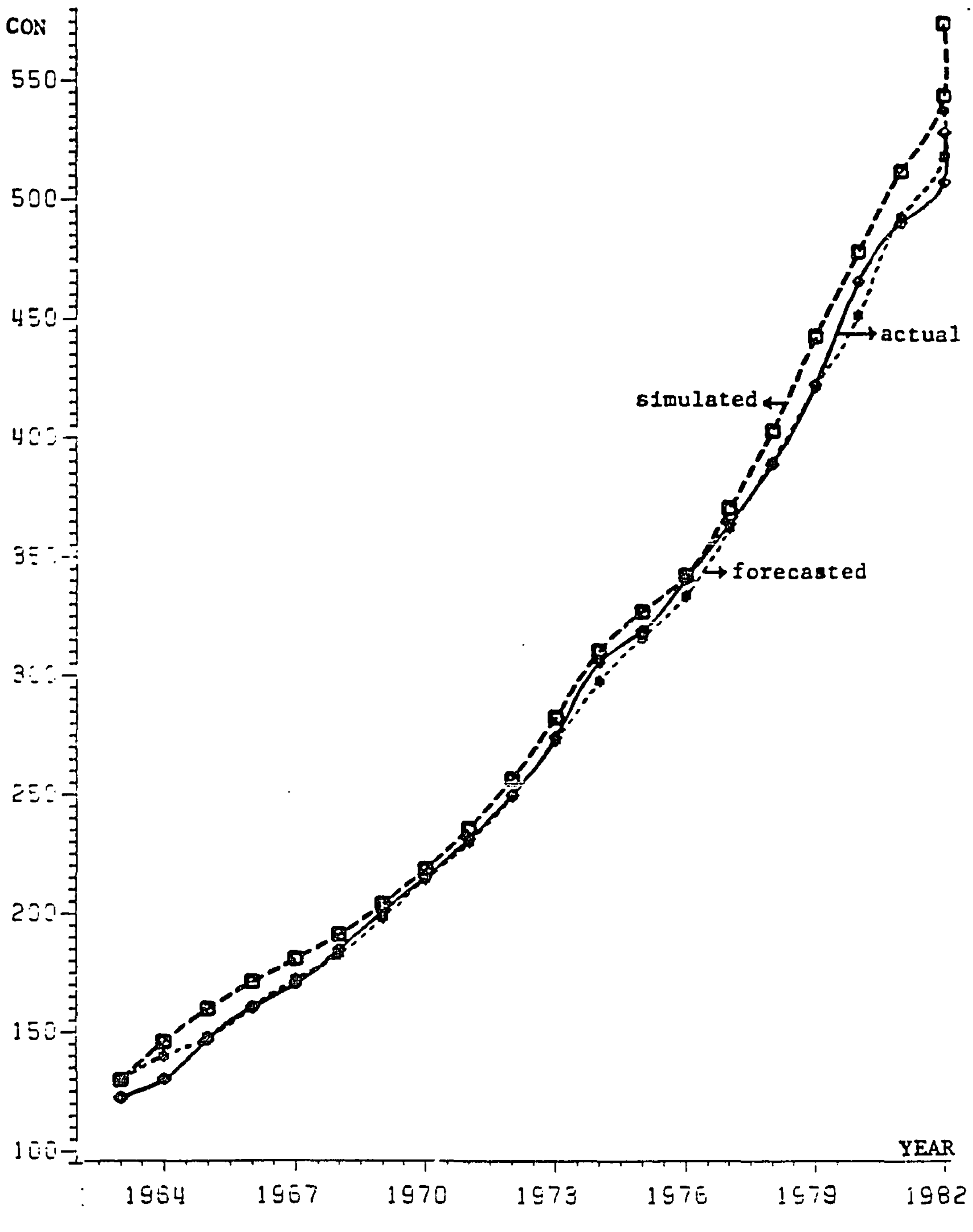

Figure5.2 Actual-Forecasted-Simulated CON

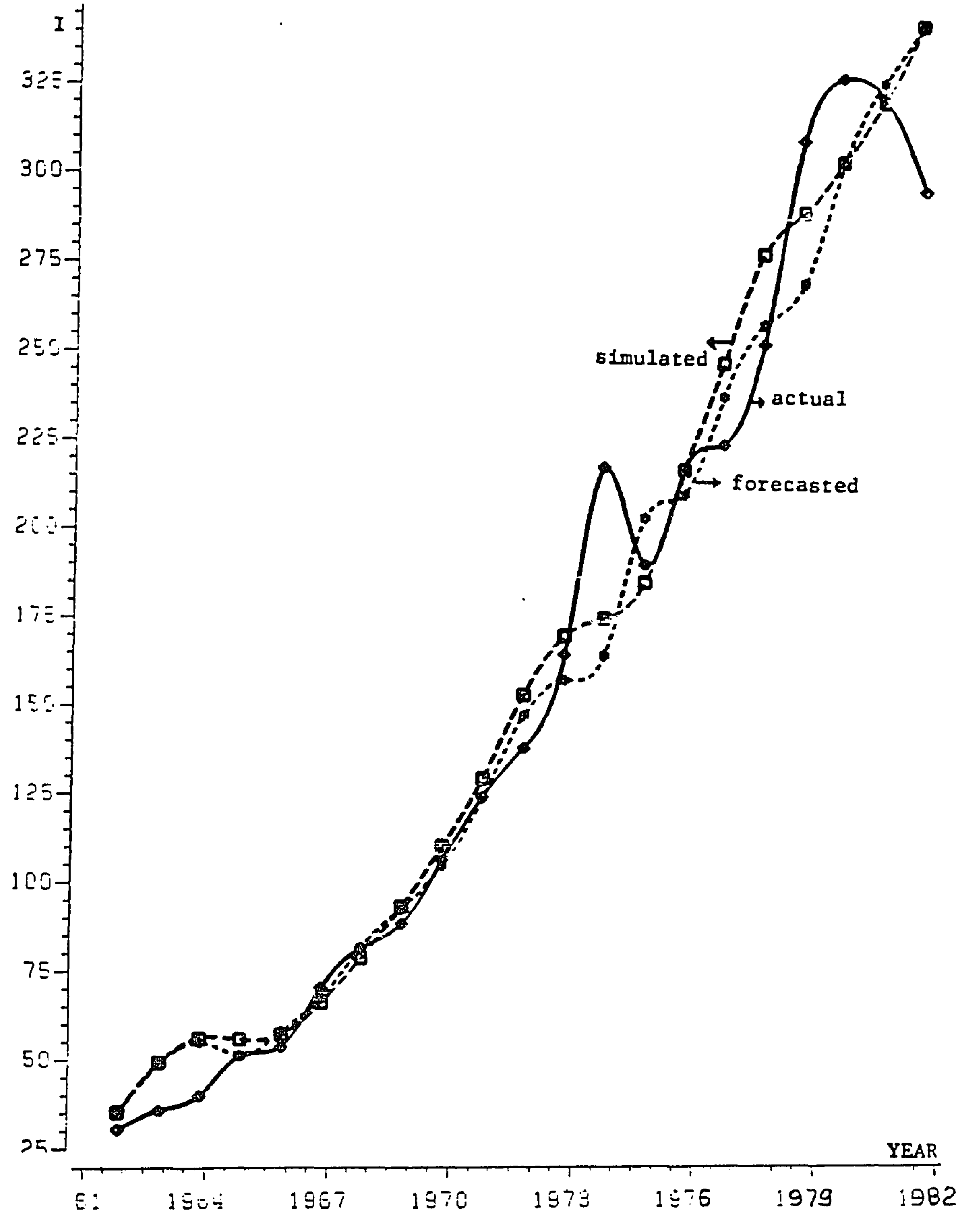

Figure 5.3 Actual-Forecasted-Simulated I

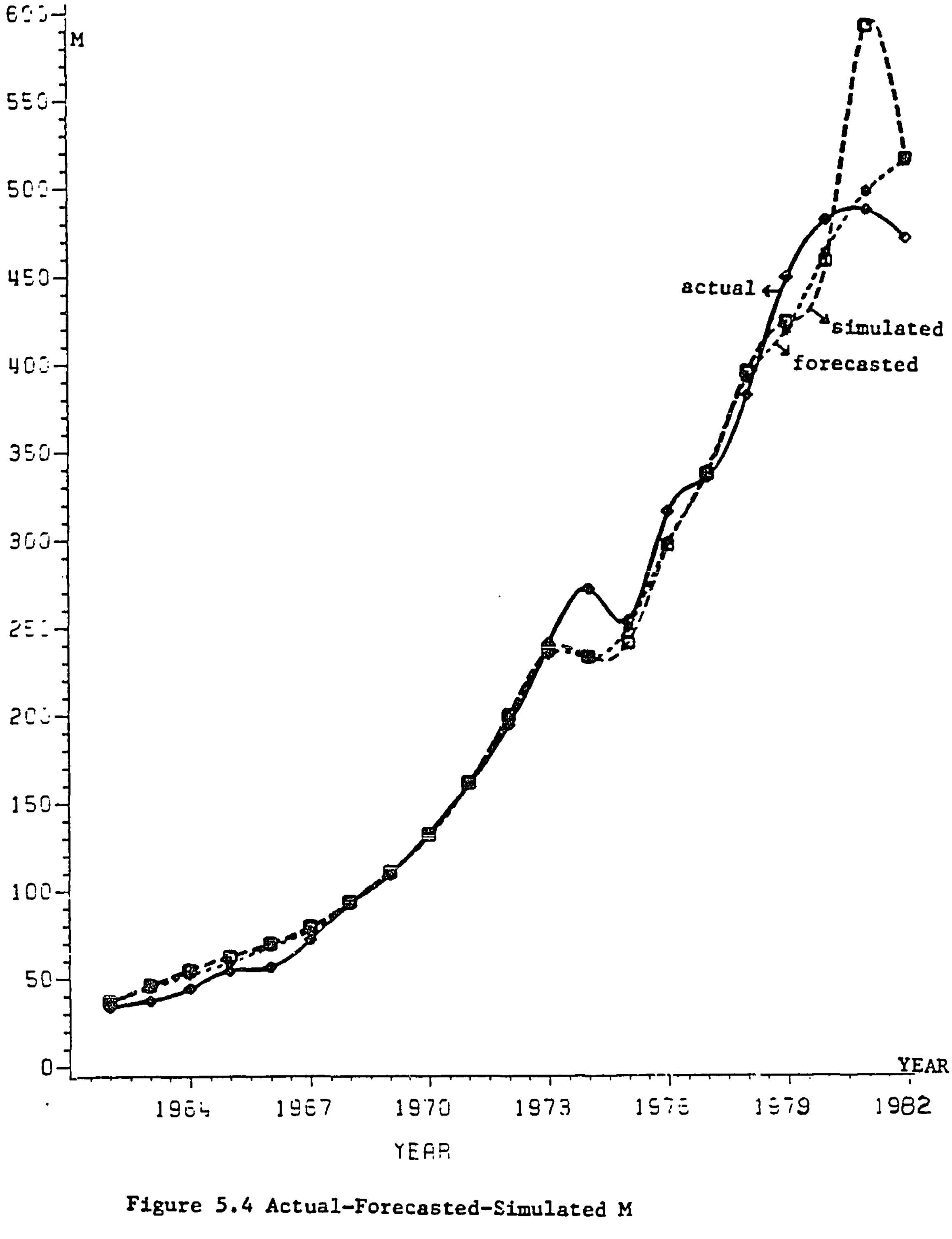

Figure 5.4 Actual-Forecasted-Simulated M

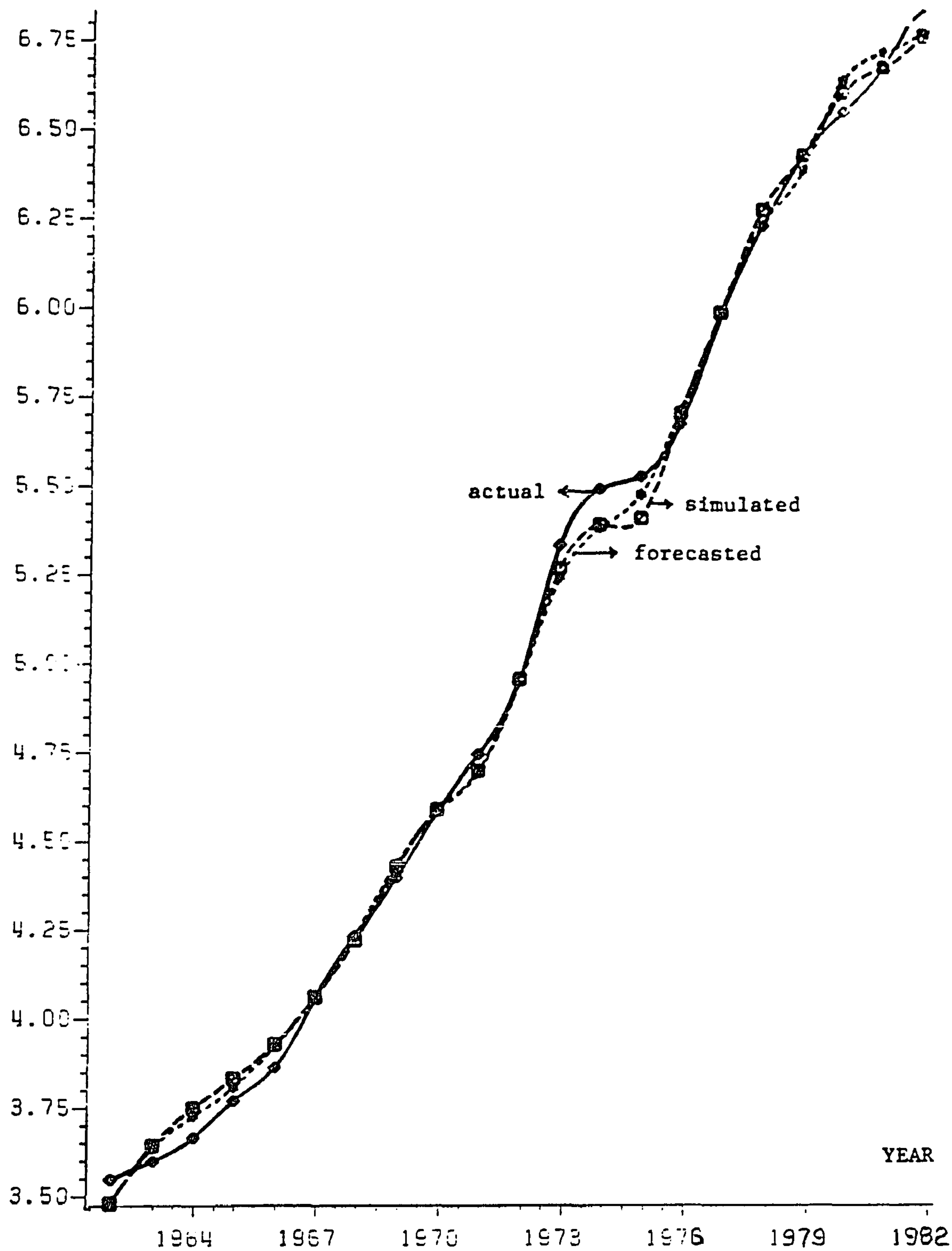

Figure 5.5 Actual-Forecasted-Simulated L

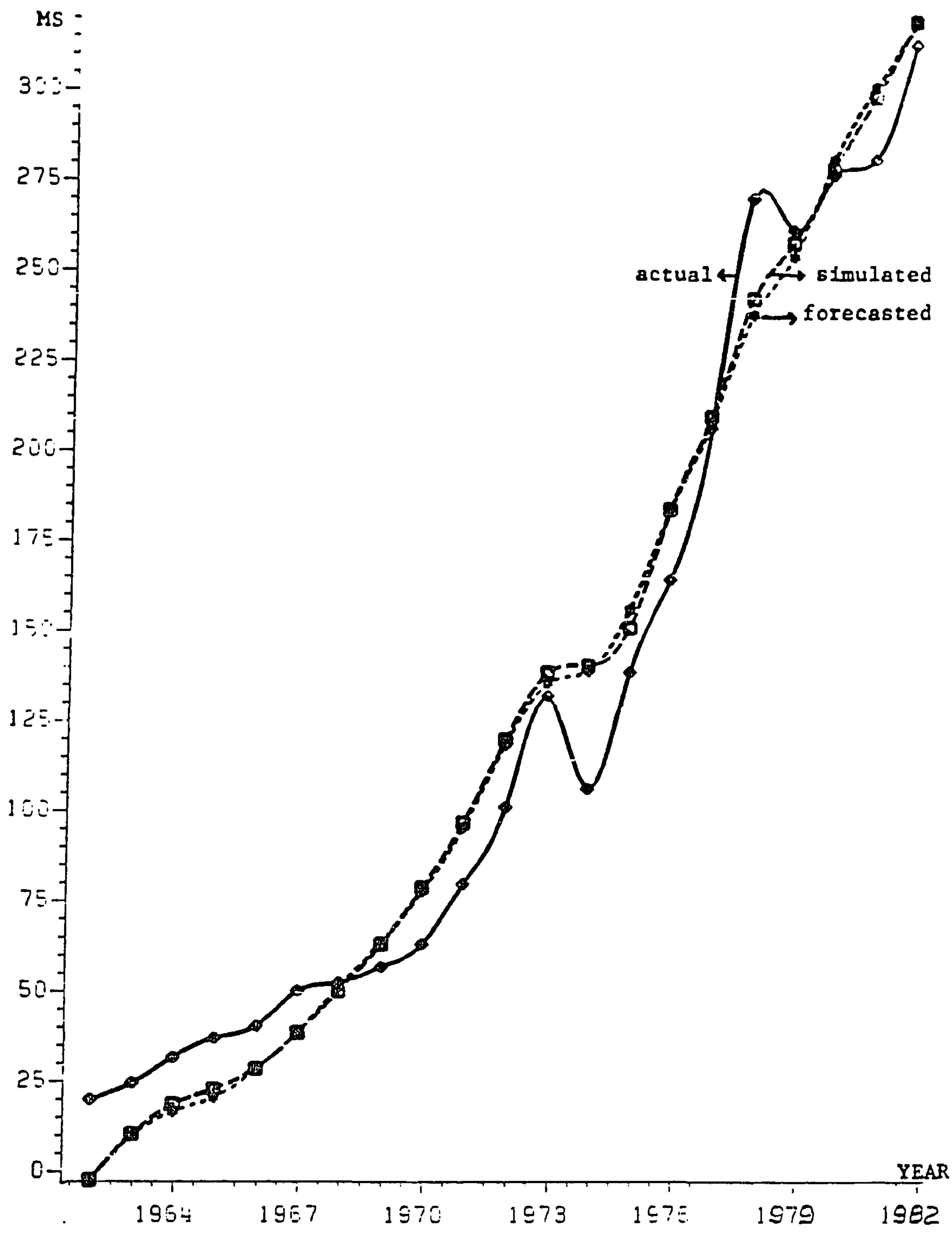

Figure 5.6 Actual-Forecasted-Simulated MS

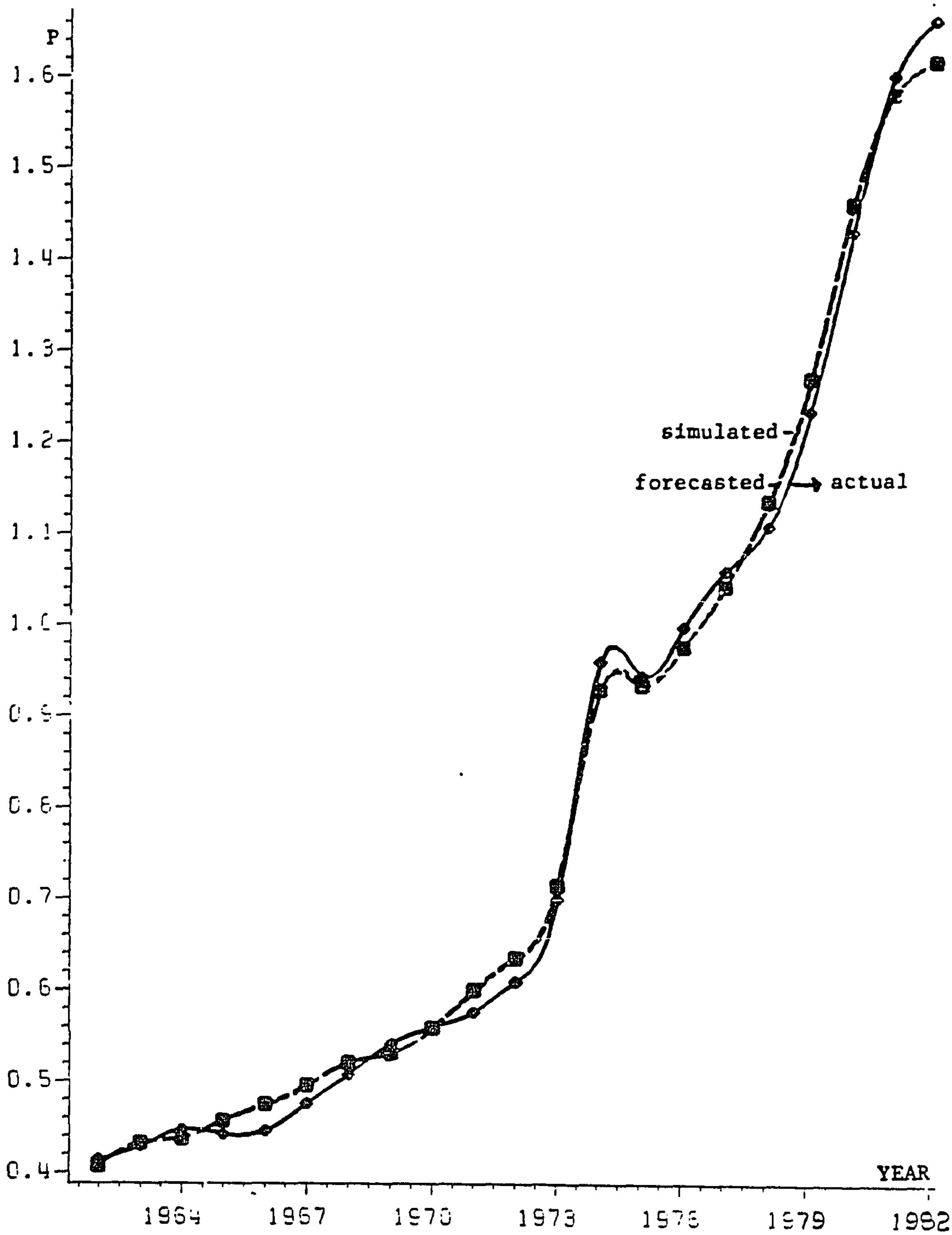

Figure 5.7 Actual-Forecasted-Simulated P

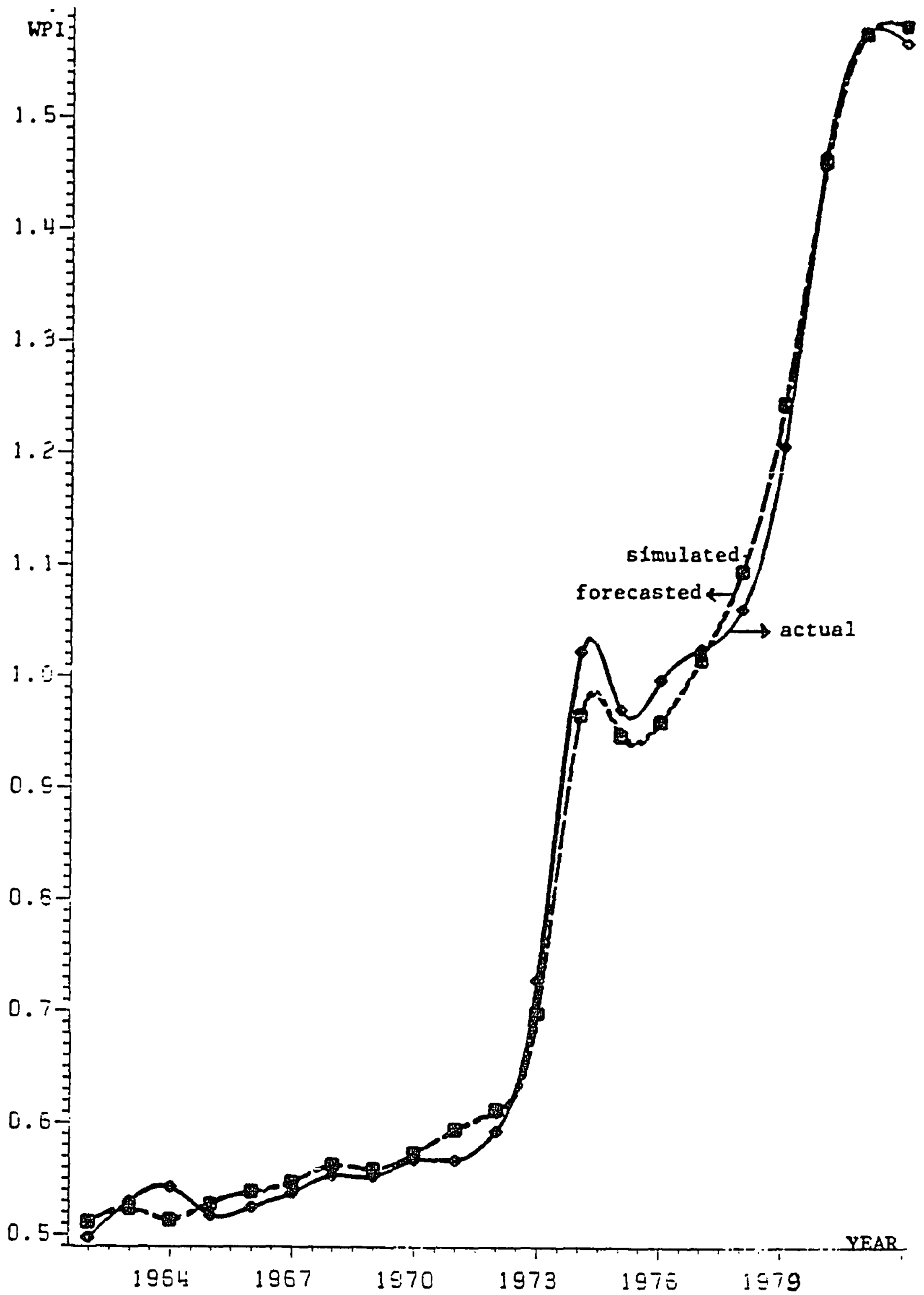

Figure 5.8 Actual-Forecasted-Simulated WPI

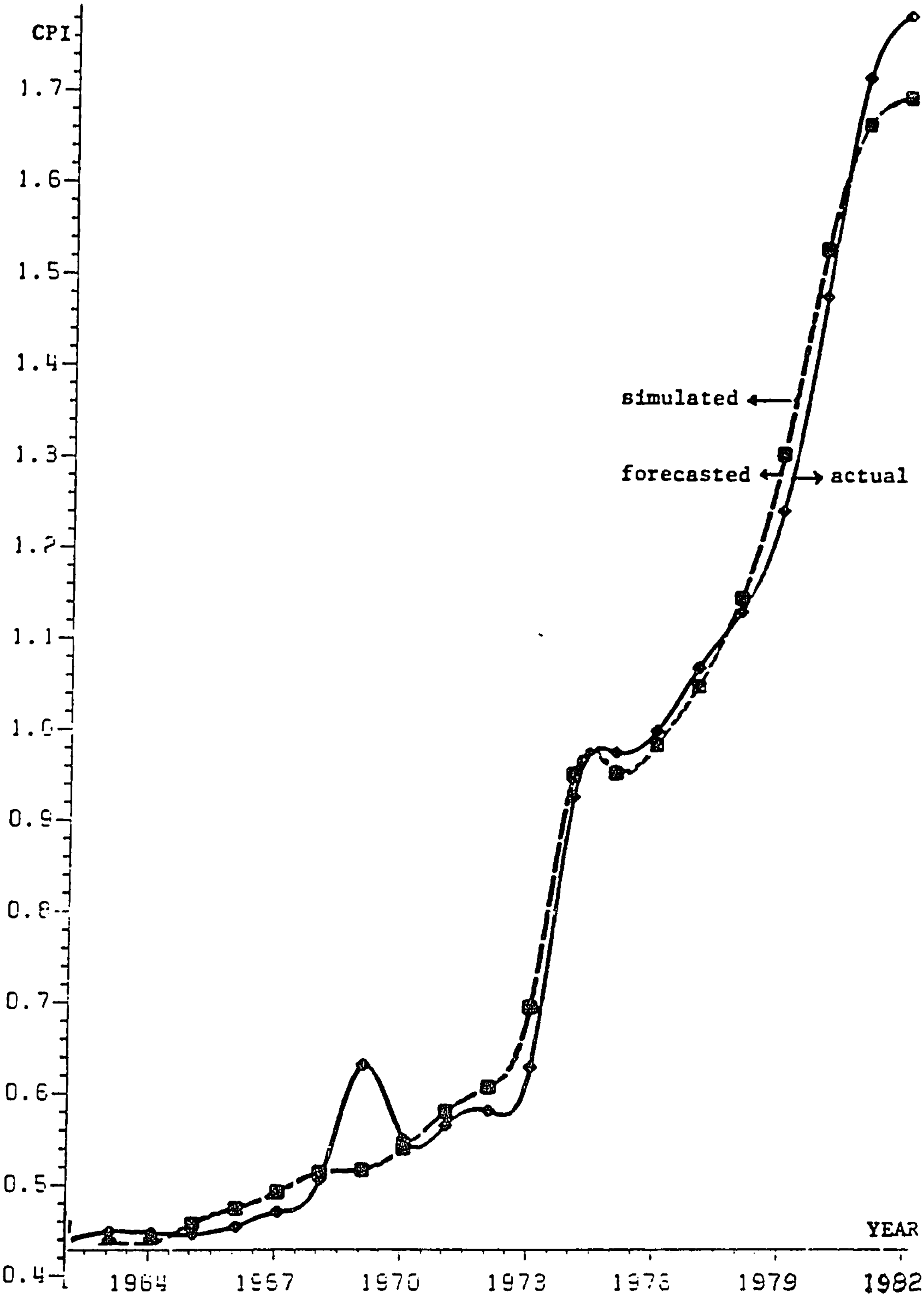

Figure 5.9 Actual-Forecasted-Simulated CPI

Chapter VI

THE MULTIPLIER ANALYSIS AND BUSINESS CYCLE

Based on the theoretical framework discussed in section 2.7 the dynamic multipliers and their characteristics relating to the business cycle are analyzed in this chapter. Liew's (1973) Dymult Program produces the matrices A, B, and C, for the reduced form 2.7.3. Because A is not a symmetrical matrix, the Taiwan model cannot be a uniform case. The stability condition discussed in Chapter II is verified by the Dymult Program. This Program does not run the multipliers for models with divergence.

6.1 BUSINESS CYCLE

The total and interim multipliers for each exogenous variable which are generated by the Dymult Program show that the Taiwan model is a case of converged oscillation. The interim multipliers of government consumption (G), exports (X), interest rate (R), and import price index (PM) are shown in Tables 6.1 through 6.4. The total multipliers of G, X, W (wage rate), T (time trend), R, PM, and K are shown in Table 6.5. Not all of the interim and total multipliers are shown, because these omitted multipliers are not as relevant to policy implications and do not need to be discussed in detail. The interim multipliers of the intercept, NFP, and K follow the same pattern as those of G and X. They are positive in the first several periods, negative in the following 8 or 9 periods, then positive again for another 8 or 9 periods, and negative for the next 8 or 9 periods. Only the multipliers of the interest rate appear negative initially. After about the first five periods they become positive and remain positive for the following 8 periods, and then they turn into negative for the next 8 periods. However, all the multipliers demonstrate that the Taiwanese economy has a business cycle of about 16 years.

The interim multipliers of G and X are shown in Figures 6.1 and 6.2, in which it is easy to find out that the business cycle covers about 16 years. One interesting point to be noted here is that the expansion of G has initially a significant impact on the GNP after which the effect is spread to the other variables. Referring to Figure 6.1, it is shown the curve of the multipliers of G on Y leads first, followed by the curves of G on M, MS, I, CON, L, and P.

6.2 MULTIPLIER ANALYSIS

One of the purposes of dynamic multiplier analysis is to determine the presence of a business cycle. This has been discussed in the previous section. This section will discuss another equally important purpose of multiplier analysis. This is to find out the impact of an exogenous variable on the endogenous variables.

As mentioned in the previous section the interim multipliers of G and X follow a cyclical pattern of positive impacts for the first several years, followed by negative impacts for the subsequent years. The absolute values of the multipliers decline continuously throughout the pattern and finally disappear. Because of the cyclical nature of the interim multipliers of this model, the total multipliers become more important for detecting the overall impacts of the exogenous variables.

As can be seen from Table 6.5, the total multiplier of G on Y is 1.261, implying that fiscal expansion is a feasible policy for economic growth in Taiwan. The total multiplier of G on MS is 0.4082, showing that the expansion in G causes both money demand and money supply to increase. The total multipliers of G and X on consumption are 0.5943 and 0.3369 respectively, showing that both the government spending and exports have significant positive impacts on consumption.

The impacts of exports on economic growth have long been the subject of intense research and heated debates. The total multiplier of X on GNP is 1.1512, indicating that exports are an important contributor to the economic growth of Taiwan. This finding confirms the results by Haberler (1959), Michaely (1977), Balassa (1977), and Tyler (1981), among others, though their studies are based on data from a large number of LDCs.[28] The total multiplier of X on labor employed is 0.0025, an impressively small number. We must not be fooled by this small number and form the conclusion that exports do not help labor employment very much in Taiwan. We must remember that X is measured in billions of New Taiwan dollars and L is measured in millions of laborers. This small multiplier is distorted downward by this large difference in units. Indeed, it should be concluded that exports raise the level of labor employment. This conclusion is consistent with a later finding in Chapter VIII, in which exports will be directly related to the unemployment rate. The finding of the favorable impacts of exports on both GNP and employment confirms the results by Kuo, Ranis, and Fei (1981), although they applied the approach of market expansion analysis[29] on the Taiwanese economy. This finding also confirms the results by Mohammad (1981), although his study was based on data from a great number of LDCs and Taiwan was not included.

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[28] Remember, as indicated in footnote 6 that the studies by Michaely, Balassa, and Tyler did include Taiwan.

[29] This approach asserts that employment expansion is dependent on the market expansion which can be divided into domestic expansion, export expansion, import substitution, and the change in input-output coefficients. The basic concept can be expressed mathematically as:

$$L = z\,Y,$$

$$\Delta L = z\,(\Delta Y) + (\Delta z)\,Y,$$

where L = labor, Y = GNP, z = L/Y = labor coefficient.

The total multiplier of X on imports (M) is 0.6218, indicating that exports pull imports up. This result reflects the highly trade-oriented Taiwanese economy. Taiwan exports cause the money supply to expand eventually. This is evidenced by the fact that the total multiplier of X on MS is 0.2315. This finding features the effects of Taiwan's foreign-exchange control system in which the proceeds from exports must be sold to the Central Bank of China, and must not be used or transmitted to the other countries without permission from the government.

The total multipliers of G and X[30] on the GNP deflator (P) are 0.00023 and 0.00013 respectively, indicating that the expansion in G and X causes a demand-pull inflation.

The total multipliers of K on Y, CON, I, M, and MS are 0.0978, 0.0461, 0.0776, 0.0258, and 0.0317 respectively, suggesting that the increases in capital stock have expansionary effects on GNP, consumption, investment, imports, and money supply (demand). The total multiplier of K on labor demand is 0.0003,[31] indicating that capital stock and labor are observed complementary goods rather than substitution goods through the study period.

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[30] Both multipliers are biased downward due to the big deviation between their units in measure.

[31] It is distorted downward due to the unit of K in terms of billion while L in terms of million.

Monetary policy is another one of the most important policy instruments in Taiwan. In the Taiwan model an equilibrium equation for the money market is specified. Moreover, the money supply(or demand) is treated as an endogenous variable and the interest rate (R) as an exogenous variable. This arrangement corresponds particularly well to the features of the Taiwanese economy in the period of 1961-82. During this time the money supply was influenced by exports, and the interest rate was controlled by the Central Bank of China. As can be seen from Table 6.5, the total multipliers[32] of R on Y, CON, I, M,L, MS, P, and CPI are all negative, indicating that the increases in interest rate curb the expansion of GNP, consumption, investment, imports, labor employment, and money demand. In contrast, however, the increases in the interest rate help to control inflation.

The total multipliers of import price (PM) on the GNP deflator, WPI, and CPI are 0.625, 0.802, and 0.763, respectively, indicating that the prices in Taiwan are significantly influenced by the price changes in the trade partner countries.

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[32] Note that both interim and total multipliers of R are biased upward in absolute value because R is relatively smaller than other variables.

Table 6.1 MULTIPLIERS OF G

N	Y	CON	I	M	L	MS	P
0	127.78	24.61	32.65	29.48	.4472	40.51	.02169
1	15.276	17.49	5.02	7.24	.0535	5.67	.00417
2	2.711	10.87	-6.55	1.55	.0097	.9949	.00069
3	-3.280	5.80	-9.64	-0.56	-.0114	-1.020	-.00052
4	-5.005	2.46	-8.69	-1.225	-.0175	-1.608	-.00089
5	-4.571	0.58	-6.36	-1.209	-.0160	-1.482	-.00084
6	-3.368	-0.308	-3.99	-0.929	-.0118	-1.098	-.00063
7	-2.128	-0.592	-2.14	-0.608	-.0074	-0.697	-.00040
8	-1.153	-0.572	-0.924	-0.343	-.0040	-0.380	-.00022
9	-0.504	-0.435	-0.228	-0.159	-.0018	-.1674	-.00010
10	-.1304	-0.282	.1018	-.0502	-.0005	-.0448	-.00003
11	.0481	-0.158	.2106	.0048	.0002	.0143	.00000
12	.1086	-0.072	.2065	.0257	.0004	.0347	.00000
13	.1083	-0.022	.1584	.0282	.0004	.0351	.00000
14	.0838	.0032	.1034	.0229	.0003	.0273	.00000
15	.0551	.0125	.0582	.0156	.0002	.0180	.00000
16	.0312	.0134	.0270	.0092	.0001	.0103	.00000
17	.0146	.0107	.0084	.0045	.0001	.0049	.00000
18	.0047	.0072	-.0009	.0017	.0000	.0016	.00000
19	-.0003	.0042	-.0044	.0001	-.0000	-.0001	.00000
20	-.0023	.0021	-.0048	-.0005	-.0000	-.0007	-.00000
21	-.0025	.0007	-.0039	-.0006	-.0000	-.0008	-.00000
22	-.0021	.0000	-.0027	-.0006	-.0000	-.0007	-.00000

Note: The above multipliers have been multiplied by 100.

Table 6.2 Multipliers of Exports

N	Y	CON	I	M	L	MS	P
0	79.42	15.30	20.29	56.17	.2780	25.18	.01348
1	3.40	9.70	1.56	7.86	.0119	1.59	.00156
2	0.23	5.78	-4.508	1.04	.0008	.1043	.00010
3	-2.359	2.96	-5.733	-.4129	-.0083	-.7459	-.00040
4	-2.995	1.17	-4.911	-.7429	-.0105	-.9647	-.00054
5	-2.588	0.195	-3.473	-.6906	-.0091	-.8402	-.00048
6	-1.843	-0.239	-2.116	-.5123	-.0065	-.6016	-.00035
7	-1.131	-0.359	-1.097	-.3254	-.0040	-.3708	-.00022
8	-0.591	-0.326	-0.442	-.1773	-.0021	-.1950	-.00016
9	-0.242	-0.240	-0.081	-.0720	-.0008	-.0808	-.00005
10	-.0481	-.1509	.0818	-.0210	-.0002	-.0169	-.00001
11	.0403	-.0814	.1284	.0066	.0001	.0124	.00001
12	.0665	-.0353	.1180	.0162	.0003	.0213	.00001
13	.0620	-.0089	.0873	.0163	.0002	.0201	.00001
14	.0462	.0036	.0554	.0173	.0002	.0151	.00001
15	.0295	.0078	.0301	.0084	.0001	.0097	.00001
16	.0162	.0077	.0132	.0048	.0001	.0053	.00000
17	.0072	.0060	.0035	.0023	.0000	.0024	.00000
18	.0020	.0039	-.0012	.0007	.0000	.0007	.00000
19	-.0005	.0022	-.0028	-.0000	-.0000	-.0002	-.00000
20	-.0014	.0010	-.0029	-.0003	-.0000	-.0005	-.00000
21	-.0015	.0003	-.0022	-.0004	-.0000	-.0005	-.00000
22	-.0011	-.0000	-.0014	-.0003	-.0000	-.0004	-.00000
23	-.0008	-.0002	-.0008	-.0002	-.0000	-.0003	-.00000

Note: The above multipliers have been multiplied by 100.

Table 6.3 Multipliers of Interest Rate

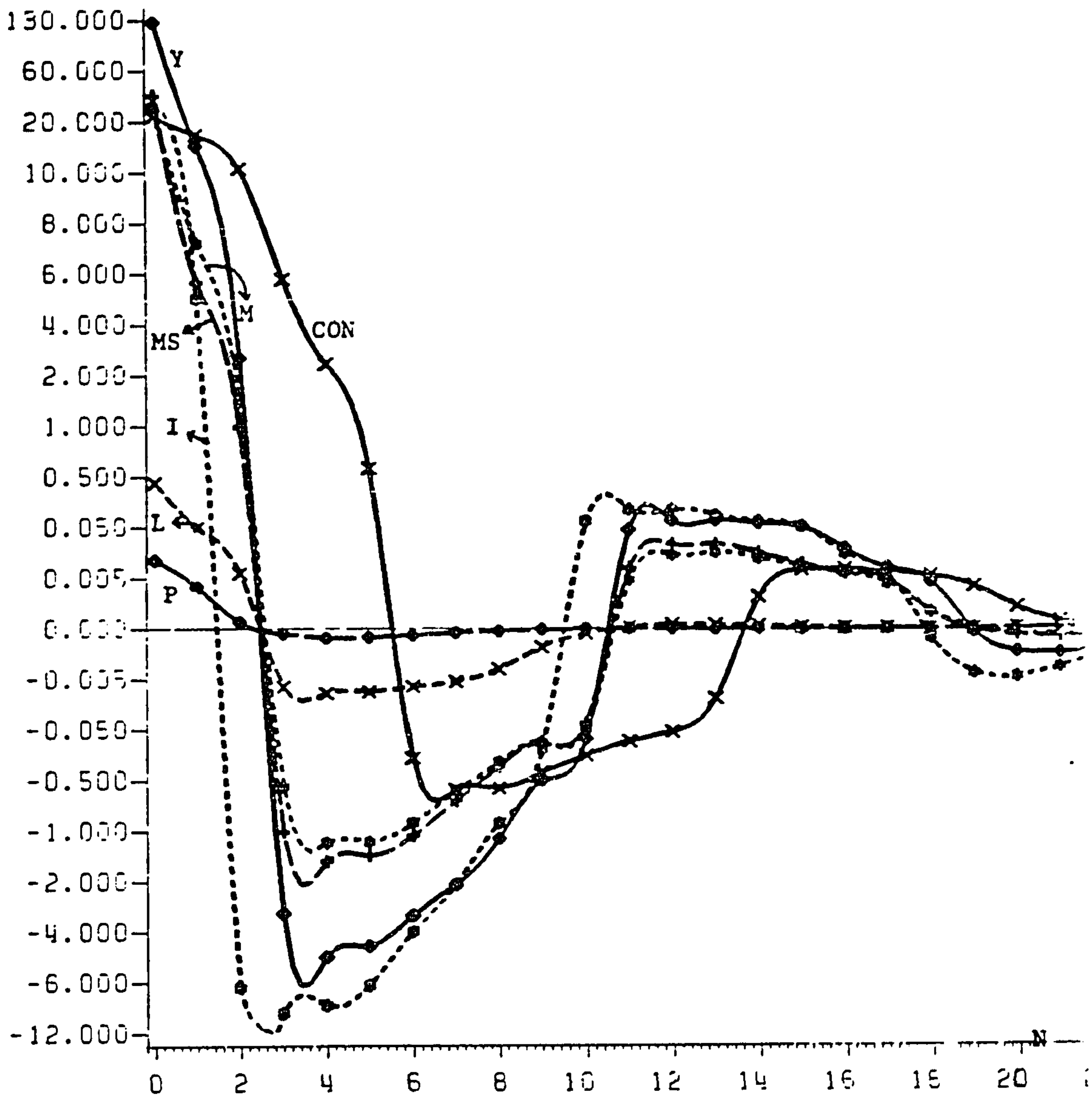
N	Y	CON	I	M	L	MS	P
0	-2.6398	-.50842	-2.7404	-.6090	-.00924	-1.6877	-.00206
1	-1.4853	-.58665	-1.3180	-.4194	-.00520	-.50548	-.00032
2	-0.7154	-.48461	-0.4487	-.2179	-.00250	-.23716	-.00014
3	-0.2492	-.33450	.00033	-.0849	-.00087	-.08387	-.00005
4	-0.0070	-.19911	.17976	-.0123	-.00002	-.00395	-.00000
5	.09132	-.10012	.21096	.0195	.00032	.02887	.00002
6	.11005	-.03800	.17589	.0278	.00039	.03548	.00002
7	.09273	-.00460	.12224	.0249	.00032	.03013	.00002
8	.06491	.00978	.03246	.0181	.00023	.02120	.00001
9	.03917	.01333	.03716	.0113	.00014	.01285	.00001
10	.02005	.01174	.01436	.0061	.00007	.00662	.00000
11	.00789	.00846	.00201	.0026	.00003	.00264	.00000
12	.00125	.00524	-.00338	.0006	.00000	.00045	.00000
13	-.00168	.00278	-.00477	-.0003	-.00004	-.00052	-.00000
14	-.00248	.00116	-.00425	-.0006	-.00003	-.00080	-.00000
15	-.00224	.00026	-.00309	-.0006	-.00001	-.00073	-.00000
16	-.00164	-.00016	-.00192	-.0005	-.00000	-.00053	-.00000
17	-.00103	-.00029	-.00103	-.0003	-.00000	-.00034	-.00000
18	-.00055	-.00028	-.00044	-.0002	-.00000	-.00018	-.00000
19	-.00024	-.00021	-.00010	-.0001	-.00000	-.00008	-.00000
20	-.00006	-.00014	.00005	-.0000	-.00000	-.00002	-.00000
21	.00003	-.00008	.00010	.0001	.00000	.00001	.00000
22	.00005	-.00003	.00010	.0001	.00000	.00017	.00000
23	.00005	-.00001	.00008	.0001	.00000	.00017	.00000
24	.00004	.00000	.00005	.0000	.00000	.00013	.00000

Table 6.4 Multipliers of PM

N	P	WPI	CPI
0	0.58167160	0.74550003	0.70938545
1	0.04071701	0.05218500	0.04965694
2	0.00285019	0.00365295	0.00347599
3	0.00019951	0.00025571	0.00024332
4	0.00001397	0.00001790	0.00001703
5	0.00000098	0.00000125	0.00000119
6	0.00000007	0.00000009	0.00000008
7	0.00000000	0.00000001	0.00000001
8	0.00000000	0.00000000	0.00000000
9	0.00000000	0.00000000	0.00000000
10	0.00000000	0.00000000	0.00000000

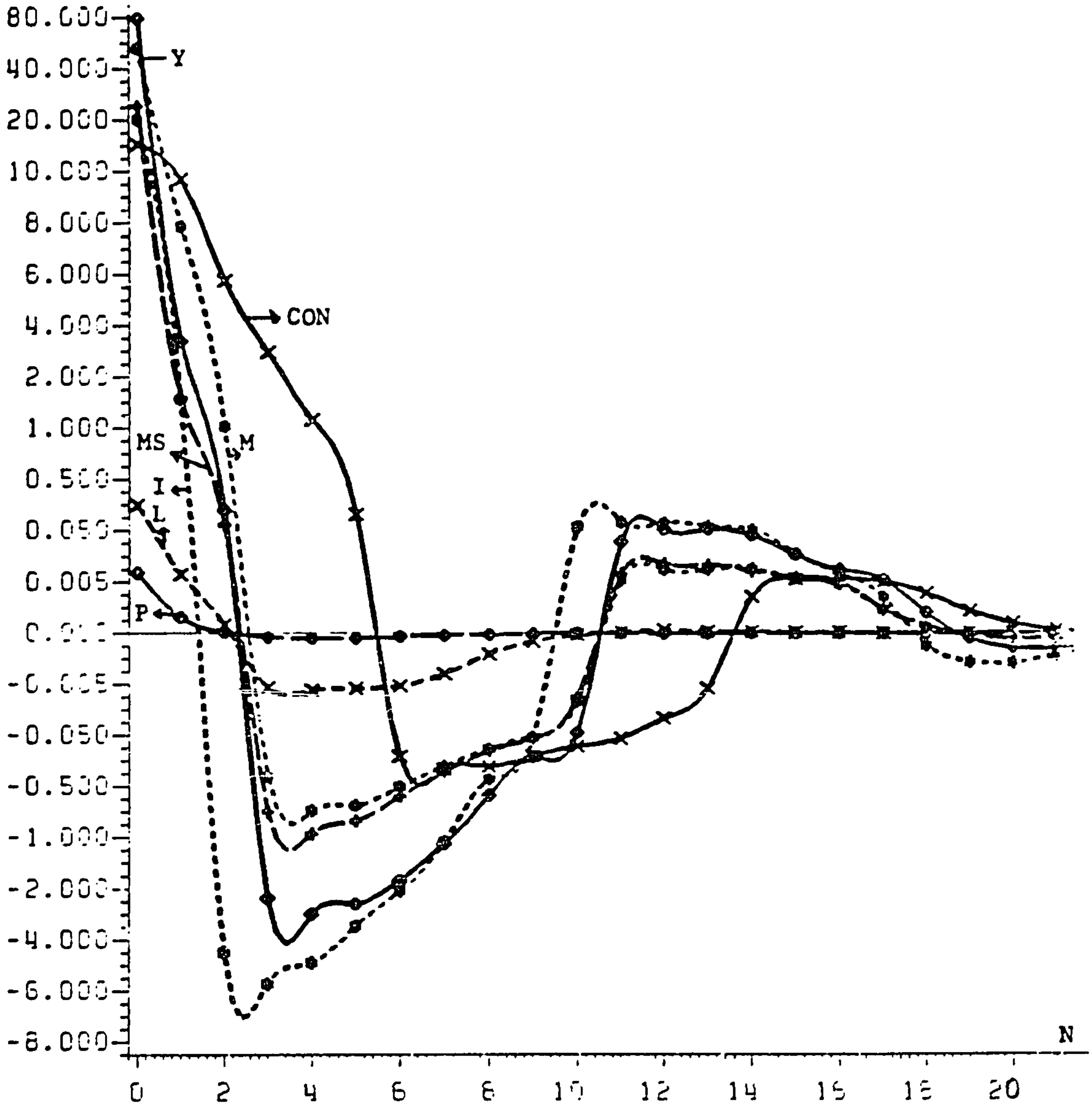
Table 6.5 Total Multipliers

	Inter	G	X	W	T	R	NFP	PM	K
Y	232.488	1.261	1.1512	0.0	0.0	-4.679	1.2613	0.0	0.0978
CON	170.895	0.5943	0.3369	0.0	0.0	-2.205	0.5943	0.0	0.0461
I	98.842	0.0	0.0	0.0	0.0	-3.710	0.0	0.0	0.0776
M	37.250	0.3329	0.6218	0.0	0.0	-1.235	0.3329	0.0	0.0258
L	4.091	0.0044	0.0025	-2.11	0.125	-0.016	0.0044	0.072	0.0003
MS	42.397	0.4082	0.2315	0.0	0.0	-2.383	0.4082	0.0	0.0317
P	0.154	0.0002	0.0001	0.135	0.0	-0.0025	0.0002	0.625	0.00002
WPI	0.161	0.0	0.0	0.0	0.0	0.0	0.0	0.802	0.0
CPI	0.024	0.00004	0.00002	0.188	0.0	-0.0004	0.00004	0.773	0.0



Note: True multipliers = vertical scale / 100.

Figure 6.1 Multipliers of Government Consumption



Note: True multipliers = vertical scale / 100.

Figure 6.2 Multipliers of Exports

Chapter VII

POLICY EXPERIMENTS OF THE TAIWAN EQUILIBRIUM MODEL

7.1 INTRODUCTION

Policy experiments enable policy makers to discover which policy , or which policy mixture, is optimal for solving economic problems. In the Taiwan model, the variables are aggregated into 9 endogenous variables, i.e., Y, CON, I, M, L, MS, P, WPI, CPI and 9 exogenous variables, i.e., intercept, G, X, R, W, T, NFP, PM, and K. For a government, fiscal and monetary policies are the two most important policy instruments. In this study, G represents the fiscal policy, and R, the monetary policy. However, it is not necessary to restrict that the movement of R is totally influenced by the change in money supply, because the Government of Taiwan has brought interest rates under control in the past several decades. R could be changed instantly by an order from the government. R could also be changed slowly through market mechanism by allowing the money supply to change.

In this chapter some policy experiments will be performed, based on the following cases. The time horizon for these experiments has been set up for an 8 year period, from 1983 to 1990.

1. All exogenous variables, except NFP, grow as a trend.[33]
2. The same as in 1, but assume further that exports drop 20% in both 1985 and 1986. This would be due to the fact that there is a world-wide recession in 1985 and 1986, and there is no policy exercised to rescue the country from recession. From 1987 on, the exports are hypothesized to grow at 5%, roughly the same as the trend growth rate.
3. The same as in 2, but the government exercises fiscal policy as a remedial measure by increasing government spending 20%, starting in 1984 and extending through 1987. After 1988 government spending is assumed to be maintained at a growth rate of 5%.
4. The same as in 2, but the government uses only monetary policy by decreasing interest rates 20%, during the period 1984-1987. After 1988 interest rates are hypothesized to be maintained constant.
5. The same as in 2, but the government uses both the monetary and the fiscal policies described in 3 and 4.

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[33] The historical data of NFP do not show that a trend appeared, rather they show a relatively small figure for most years when compared with the other components of the GNP. Their mean value is therefore used for these experiments. The equations of the time trend for other exogenous variables, the corresponding R^2 , and their forecasted trend values are listed in Appendix B.

6. The same as in 5, but assume the government exercises both fiscal and monetary policies in 1986 which is one year after the world-wide recession has begun. This delay is due to the so-called "recognition" and "legislation lags".

The Pascal program which was used for the simulation in Chapter V was revised and used for these policy experiments. All endogenous variables were simulated, but only the simulated GNP, MS, L, and GNP Deflator (P) are discussed in this chapter, because they represent respectively the key variable for each market and for price system.

7.2 RESULTS

The results of simulated GNP, MS, L, and GNP Deflator are shown from Table 7.1 to 7.4 respectively, in which corresponding indices are used to match the order of the cases. For example, Y1 and P1 represent the simulated GNP and GNP Deflator for the first case. The simulated GNP, MS, L, and P are also drawn from Figure 7.1 to Figure 7.4, in which the attached numbers, e.g., 1, 2, 3,..., represent each corresponding case number.

As can be seen from Tables 7.1 to 7.3 and Figures 7.1 to 7.3, the pattern of simulated MS and L for each case is similar to that of Y. The policy results of Y and P for each case are reported together in detail below. Some important impacts of policy experiments on MS and L are also discussed, but not case by case.

Case one is simulated under the hypothesis that the exogenous variables, except NFP, grow as a trend. As can be seen from the columns denoted Y1 and P1 in Tables 7.1 and 7.4, respectively, it is found that Y1 and P1 are higher throughout the entire period except for 1984, when earlier policy actions are taken to counter the coming recession in 1985. The GNP grows at an average rate of about 8% per year but with a declining trend.

Case two is simulated under the assumption that exports grow as a trend in the first 2 years, but drop 20% in both 1985 and 1986 due to a world-wide recession. It is found that the GNP (Y2) starts to decline in 1985, the beginning year of the recession, if no policy is exercised to counter the effects. That Y2 maintains the lowest among these six experiments indicates that the government should do something eventually if a higher GNP is desired. However, P2 remains the lowest of the six experiments, indicating that higher prices are generated by policy actions. Higher outputs, and hence higher employed levels, are accompanied by higher prices. This finding suggests that the principles of the Okun's law (1962, 1972) and the Phillip's curve (1958) hold in the economy of Taiwan. This assertion will be further proven by the following experiments and the results found in the next chapter.

In case three, it is assumed that the government anticipates a world-wide recession coming in 1985, and therefore starts to take the action by increasing government spending by 20% in 1984. It is found that this measure is very effective as can be shown in Figure 7.1, where fiscal action raises the GNP from Y2 to Y3.

When Y3 and Y4 in Figure 7.1 are compared (Y4 represents the GNP path when monetary policy is applied), fiscal policy is found to be more effective than monetary policy. However, fiscal policy causes higher inflation than monetary policy as can be seen in Figure 7.4 where P3 is higher than P4.

If the government takes both monetary and fiscal policies to counter the recession (a combination of cases 3 and 4), the resulting effect is also a combination of both. This combination is shown by Y5 in Figure 7.1. As can be seen from Figure 7.1, the height of Y5 is the height of Y3 plus the distance between Y2 and Y4. The same conclusion is applied to P, as shown in Figure 7.4 where the height of P5 is the height of P3 plus the distance between P2 and P4.

When Y5 (both fiscal and monetary policies are applied in 1984) and Y6 (both fiscal and monetary policies are applied in 1986) in Figure 7.1 are compared, Y5 is found to be higher than Y6 before 1989. This implies that an early action is preferable to a late action. Y6 exceeds Y5 after 1989, because government spending is assumed to be maintained on its trend before 1986. Therefore G is increased on a bigger base in 1986 but on a smaller base in 1984. This bigger base generates a bigger economic momentum and eventually causes Y6 to exceed Y5.[34] The result that Y6 exceeds Y5 after 1989 does not have any conflict with the previous conclusion that an early action is better than a late one.

As can be seen in Figure 7.2, the money supply (or demand) decreases while exports decline, confirming that MS is highly influenced by exports under the foreign-exchange control system. It is also found that policy actions generate higher MS as can be shown by MS3, MS4, MS5, and MS6 which are all higher than MS2 for which no action is taken.

As can been seen in Figure 7.3, during the recession period labor demand decreases. This implies exports are an important factor in the determination of employment levels. This finding confirms the results in Chapter VI and Chapter VIII.

Also interesting to note is that the GNP deflator (P) does not decrease as the GNP, MS, and L do in the recession period. However, the increasing rate of P is declining during the recession. The reason that P continues to increase in 1984 and 1985 is that the effect of import price (PM) on

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[34] The interest rates (R) are decreased on a smaller base in 1986 than that in 1984. But as mentioned previously, the effect of R is minor on Y and other endogenous variable, and the effect of R can thus be ignored here.

P dominates that of X and Y, as can be evidenced in Table 6.5 in which the total multiplier of PM on P is much bigger than the multipliers of the other variables on P.[35]

7.3 CONCLUSION

The share of exports in GNP was 45% and 54% in 1960 and 1982 respectively. The figures of the export-share show their importance to the economy of Taiwan. Furthermore, these experiments show that a 20% decrease in exports in both 1985 and 1986 could have been a disaster to the Taiwanese economy if proper policies had not been applied. A matching 20% adjustment in both monetary and fiscal policies executed one year earlier would not have been effective enough to bring the growth of GNP back on a sound track, implying either that policies should have been taken much earlier or that matching percentages should have been higher.

It was further found that policy actions generate higher prices and that a more effective policy also generates higher inflation. Given a certain GNP growth rate and/or infla-

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[35] The reason can also be investigated by studying the P equation in reduced form (from Liew's (1973) Dymult Program applied to the forecast and multiplier analysis in Chapter V and VI, respectively) which is stated as follows: P= 0.00001 LAGCON + 0.001 LAGI - 0.00003 LAGM + 0.00004 LAGMS + 0.055 LAGWPI + 0.1333+ 0.00022 G + 0.000135 X + 0.1348 W - 0.00206 R + 0.00022 NFP +0.58167 PM +0.00001 K. Note that G, W ,PM, and K are assumed to continue growing as a trend in the recession period and the coefficient for PM is larger than those for the other variables.

tion rate, an optimal policy or policy mixture can be found if more experiments are performed.[36] In next chapter, a disequilibrium model of Taiwan will be expanded from the previous equilibrium model for obtaining additional information about the Taiwanese economy for the purpose of comparison.

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[36] More efficient approaches to solve the optimal control problem were developed by Klein and Su (1980) and Chow (1975).

Table 7.1 Simulated GNP by POLICY EXPERIMENTS

YEAR	Y1	Y2	Y3	Y4	Y5	Y6
82	1093.20	1093.20	1093.20	1093.20	1093.20	1093.20
83	1187.87	1187.87	1187.87	1187.87	1187.87	1187.87
84	1365.48	1365.48	1394.89	1367.93	1397.33	1365.48
85	1474.71	1310.58	1381.84	1316.27	1387.53	1310.58
86	1571.40	1243.31	1368.28	1252.05	1377.00	1278.85
87	1661.19	1284.88	1476.27	1296.01	1487.40	1370.78
88	1747.59	1350.36	1554.58	1361.49	1565.70	1499.91
89	1832.44	1430.56	1637.73	1440.34	1647.51	1657.70
90	1916.40	1519.77	1725.91	1527.60	1733.75	1761.49

Table 7.2 Simulated MS by Policy Experiments

Year	MS1	MS2	MS3	MS4	MS5	MS6
83	347.18	347.18	347.18	347.18	347.18	347.18
84	375.41	375.41	384.73	376.34	386.29	375.41
85	408.53	356.50	378.93	359.66	382.10	356.50
86	437.93	338.77	377.98	343.30	382.51	350.72
87	465.27	355.68	415.61	361.22	421.15	383.90
88	491.65	376.79	440.37	381.97	445.55	425.24
89	517.65	402.00	466.36	406.41	470.77	474.88
90	543.51	429.89	493.89	433.38	497.38	506.61

Table 7.3 Simulated L by Policy Experiments

Year	L1	L2	L3	L4	L5	L6
83	7.0086	7.0086	7.0086	7.0086	7.0086	7.0089
84	7.1798	7.1798	7.2827	7.1849	7.2913	7.1798
85	7.3993	6.8248	7.0704	6.8444	7.0900	6.8248
86	7.5582	6.4753	6.9032	6.5051	6.9330	6.5997
87	7.6751	6.4877	7.1405	6.5254	7.1782	6.7873
88	7.7607	6.5175	7.2059	6.5549	7.2433	7.0294
89	7.8195	6.5686	7.2649	6.6013	7.2975	7.3432
90	7.8518	6.6236	7.3157	6.6496	7.3417	7.4384

Table 7.4 Simulated P by Policy Experiments

Year	P1	P2	P3	P4	P5	P6
82	1.669	1.669	1.669	1.669	1.669	1.669
83	1.613	1.613	1.613	1.613	1.613	1.613
84	1.721	1.721	1.726	1.723	1.728	1.721
85	1.846	1.818	1.830	1.821	1.834	1.818
86	1.977	1.922	1.944	1.927	1.949	1.930
87	2.116	2.054	2.087	2.060	2.093	2.071
88	2.263	2.199	2.234	2.204	2.240	2.227
89	2.421	2.355	2.392	2.360	2.396	2.398
90	2.589	2.525	2.561	2.528	2.564	2.570

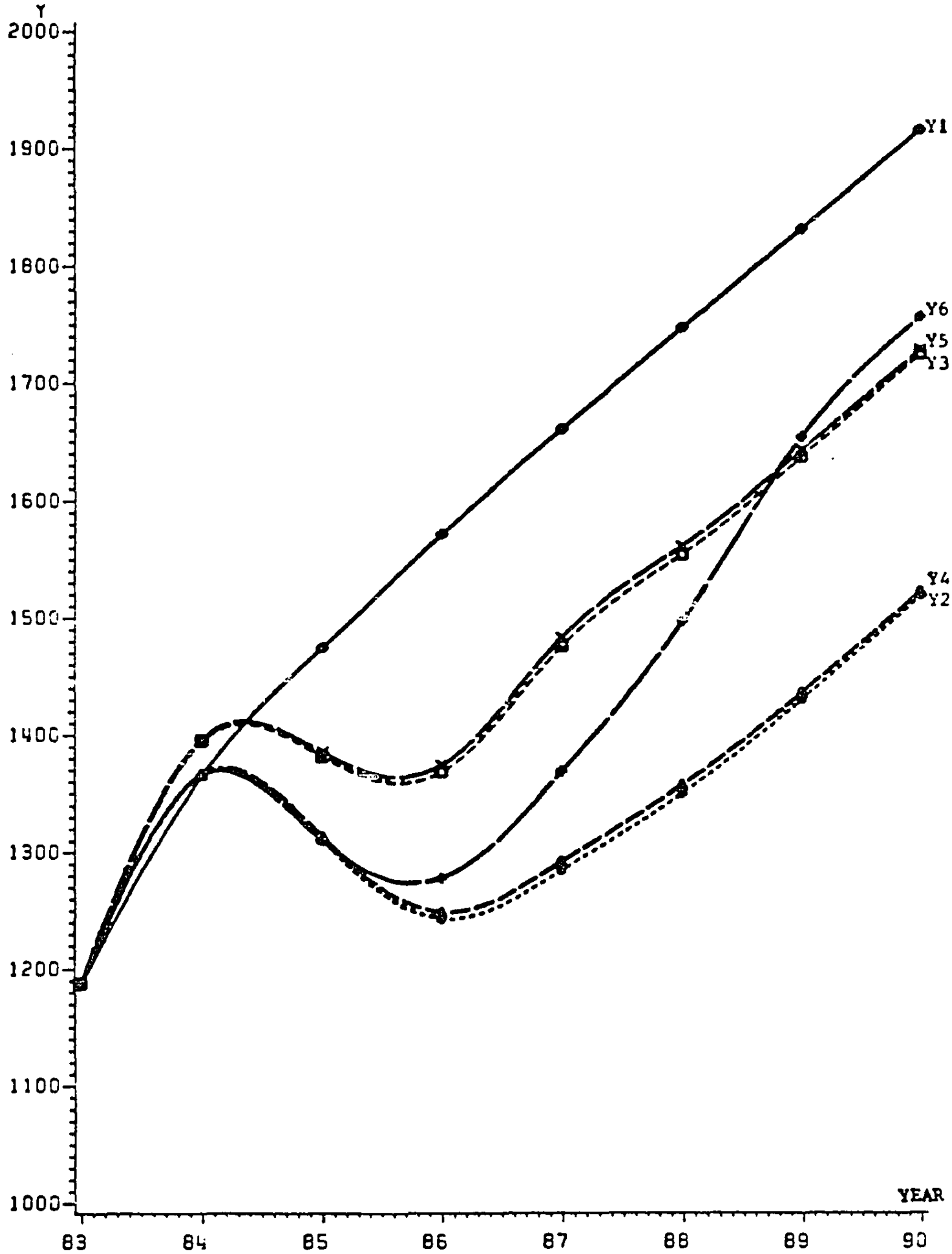

Figure 7.1 Policy Experiments on GNP

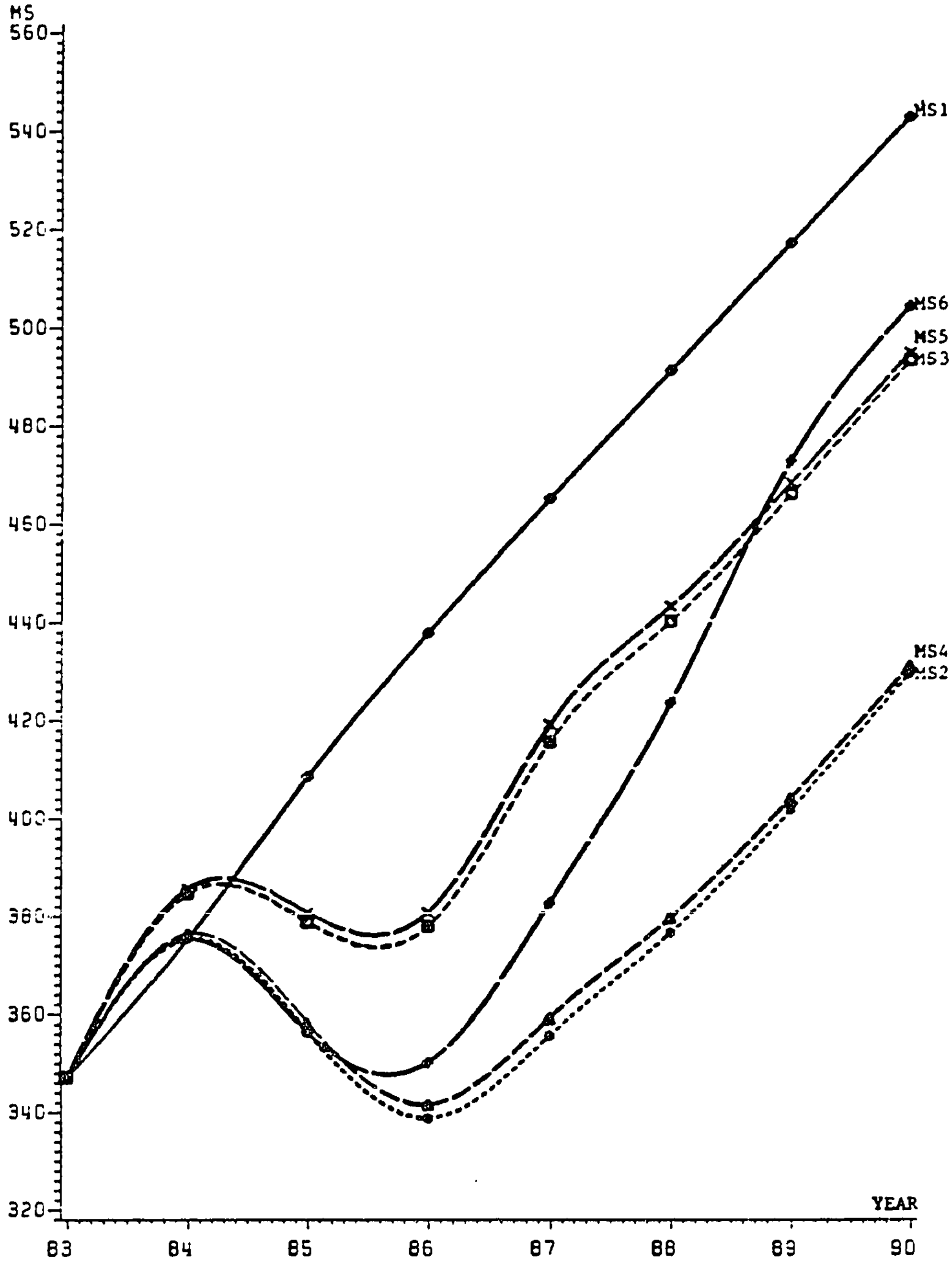

Figure 7.2 Policy Experiments on MS

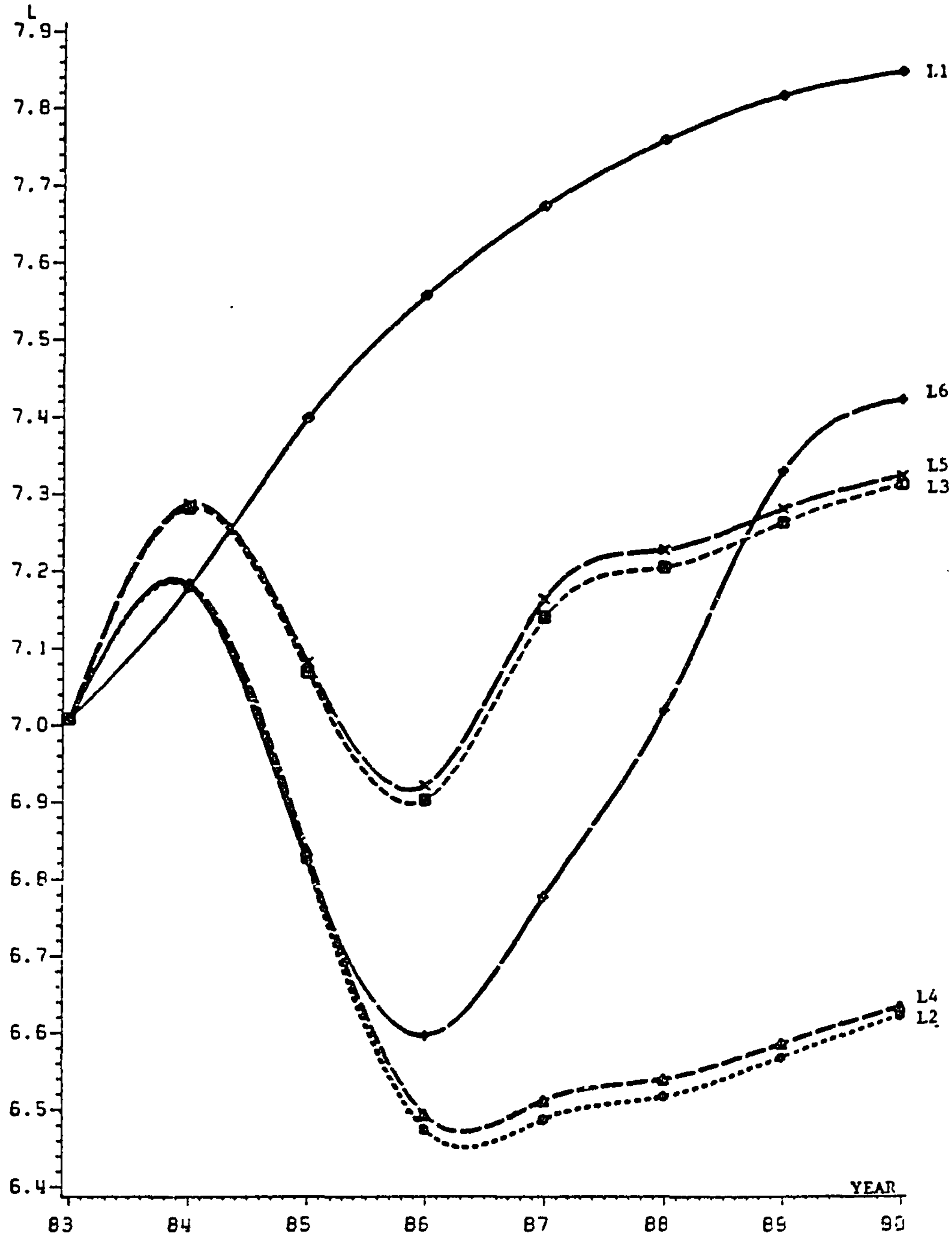

Figure 7.3 Policy Experiments on L

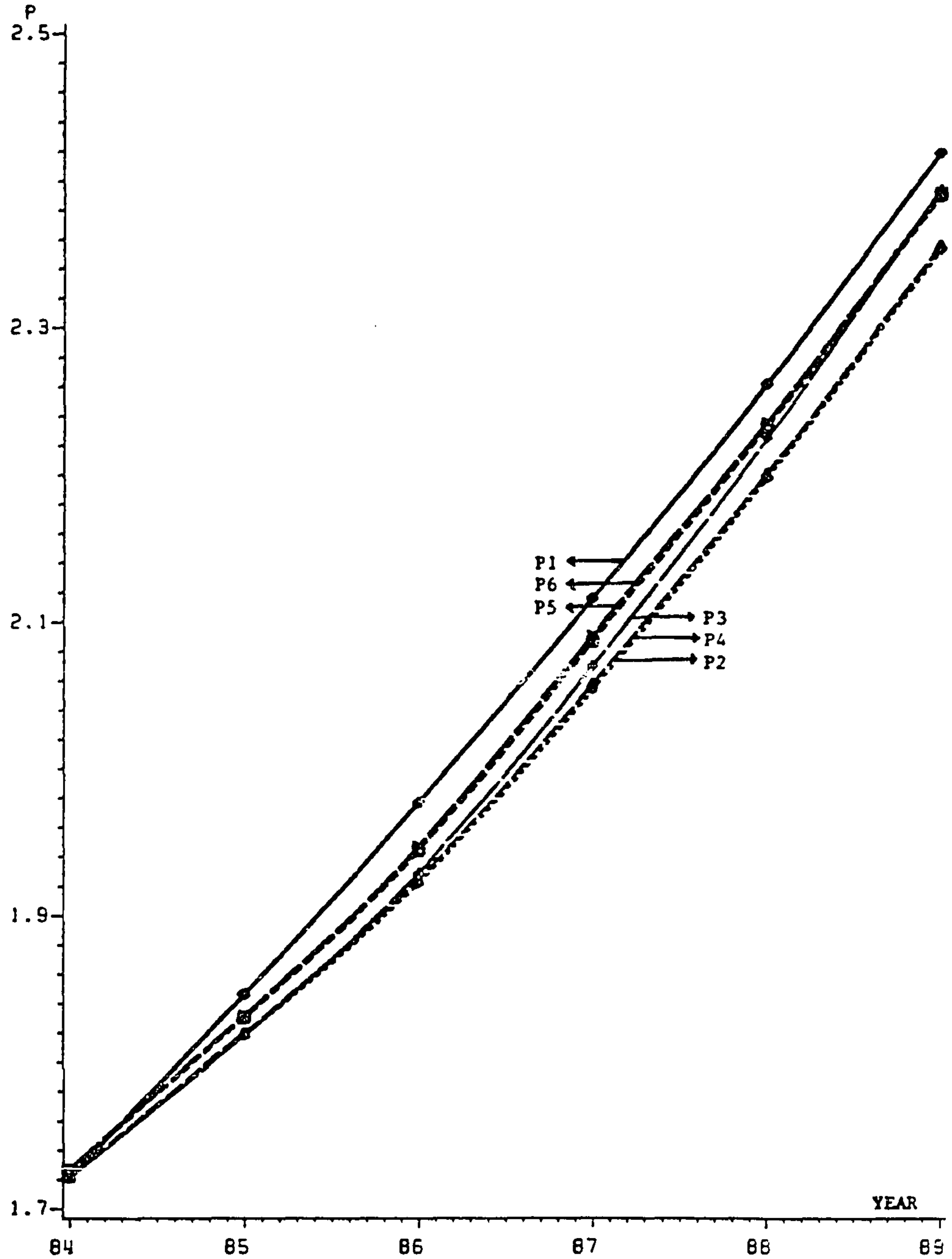

Figure 7.4 Policy Experiments on P

Chapter VIII

A DISEQUILIBRIUM TAIWAN MODEL

8.1 INTRODUCTION

The compact equilibrium model which was discussed in previous chapters can be expanded by changing the assumptions and introducing more equations and variables. As was asserted in section 1.1, Chapter I, one of the purposes of the compact model is to act as a trial model for economic planning. Usually the size of an economic planning model is much larger than that of a trial model. In a planning model, some key variables need to be disaggregated into more components for obtaining more detailed information. For example, in the model entitled "A Model for a Four-Year Plan for the Economic Development of Taiwan" built in 1981, consumption was disaggregated into food, semi-durable goods, and durable goods consumption. Import goods were disaggregated into consumption, capital, and material goods. The variables of investment, tax, and exports all were disaggregated into more components as well. In this chapter, the previous compact Taiwan model will be changed into a disequilibrium model, which is usually assumed in economic planning. It is still assumed that money supply and money demand are in equilibrium. The restriction that the product supplied equals the product demanded in the product market, and the labor supplied equals the labor demanded in the labor market has been eliminated. In addition to the ten equations in the compact equilibrium model, five more equations are introduced to complete the disequilibrium model. In the second section, the new equations are specified, and new variables explained. In the third section, the results and findings are reported.

8.2 MODEL SPECIFICATION AND EXPLANATION

The first ten equations of the disequilibrium model are identical to the ten equations in the equilibrium model, with the exception in equations 2.3.7 and 2.3.10. In equation 2.3.7 the variable LGLNMS has been deleted due to an inappropriate sign for the estimator. In equation 2.3.10 GAP has been added in order to capture the effects of demand pressure. The five additional equations are specified as follows (v is error term):

1. Product Supply

   The product supply equation is specified as

   LOGGNP=j0+j1 LGLNK+j2 LOGLF+j3 LOGT+v1 ----------(8.2.1)

   where LOGGNP = the time trend of GNP in log form,

   LOGLF = total labor force in log form, and

   LGLNK = lagged capital stock in log form.

   This equation represents the potential product of the Taiwanese economy, and can also be regarded as a supply-side constraint. This potential production, associated with actual production, will be related to the unemployment rate in equation 8.2.5.

2. Exports

In the disequilibrium model, exports are treated as an endogenous instead of an exogenous variable. The function of exports is specified as:

X=k0+k1 UY+k2 JY+k3 T+k4 LAGX+v2 ---------------(8.2.2)

where UY = GNP of the United States, in 1976 billions of dollars, and

JY = GNP of Japan, in 1976 trillions of yen.

3. Labor Supply

Labor supply is specified as the function of wage rate (W), and population (POP) and can be written as:

LF = l0+l1 W+l2 POP+v3 -------------------------(8.2.3)

The sign for both W and POP are expected to be positive.

4. GNP Gap

The gap between actual and potential GNP is specified as:

GAP = LOGY-LOGGNP ------------------------------(8.2.4)

where LOGGNP is the potential GNP in log form and identical to the product supply defined in equation 8.2.1. LOGY is the actual GNP in log form.

5. Unemployment

The unemployment function is specified as:

U = m0+m1 GAP+m2 LAGGAP+m3 LOGX+v4 -------------(8.2.5)

where U is the unemployment rate defined as (LF-L)/LF.

Okun's law (1962,1972) asserts that the ratio of the actual and potential GNP has a close negative connection with the unemployment rate. The unemployment equation is a revised version of Okun's law. As can be seen in equation 8.2.4, GAP is a logarithmic transformation of the ratio of actual and potential GNP. In addition to GAP, a Koyck-type lag of GAP and the logarithmic variable of exports are introduced. Because Taiwan is a highly trade -oriented country and exports have significant impacts on its employment level, the logarithmic variable of exports is brought into this equation. The sign of m1, m2, and m3 are expected to be negative.

8.3 THE RESULTS AND FINDINGS

The disequilibrium model with 15 equations is run with SAS. The results of the estimation by 2SLS and 3SLS are reported as follows (the figure in the parenthesis under the coefficient is the t value for that particular coefficient):

8.3.1 Results by 2SLS

Product Market:

Y = CON + I + G + X - M + NFP -------------------- (8.A.1)

DCON = CON - LAGCON ------------------------------ (8.A.2)

GAP = LOGY - LOGGNP ------------------------------ (8.A.3)

LOGGNP=.4297+.66005LGLNK+.36987LOGLF+.25153LOGT+v1 (8.A.4)

(3.61) (15.83) (2.96) (17.66) R^2 = 0.9996

CON= 27.2108+0.2128 Y+0.5428 LAGCON+v2 ------------(8.A.5)

(4.95) (4.05) (4.38) R^2 = 0.9986

I = 33.983+1.3364DCON-1.1585R+.00527K+.7866LAGI+v3 (8.A.6)

(0.686) (2.01) (-0.82) (0.14) (2.54) R^2 = 0.9730

X = -187.909+.1853UY-0.4994JY+3.8823T+.7466LAGX+v4 (8.A.7)

(-1.50) (1.40) (-0.72) (0.44) (5.13) R^2 = 0.9894

M = -52.756+0.39022 Y+0.0946 X+0.1744 LAGM+v5 -----(8.A.8)

(-1.41) (1.98) (0.36) (0.92) R^2 = 0.9914

Labor Market:

L = 3.212 +0.00303 Y-1.8752W+0.1329T+0.1243WPI+v6--(8.A.9)

(44.6) (6.04) (-5.02) (10.12) (.88) R^2 = 0.9977

LF = -0.4778+1.3037 W+0.3011 POP+v7 --------------(8.A.10)

(-0.72) (3.27) (4.63) R^2 = 0.9843

Money Market:

MS = -4.148+1.4501 LOGY-0.0993 LOGR+v8------------(8.A.11)

(-3.42) (11.16) (-0.68) R^2 = 0.9921

Price System:

LOGP=0.0940+0.0695 LOGMON+0.1194 LOGWPI+0.7698 LOGCPI

(1.35) (1.47) (1.29) (6.20)

+0.5478 GAP+v9 -------------------------------(8.A.12)

(2.86) R^2 = 0.9987

WPI = 0.1586+0.77964 PM+0.0227 LAGWPI+v10 --------(8.A.13)

(9.19) (15.28) (0.32) R^2 = 0.9961

LOGCPI= 0.00348+0.77952 LOGWPI+0.1893 LOGNW+v11 --(8.A.14)

(0.32) (8.78) (4.64) R^2 = 0.9936

Unemployment:

U = 0.0578-0.0588 GAP-.0436LAGGAP-.00707LOGX+v12 (8.A.15)

(10.15) (-1.66) (-0.97) (-6.27) $R^2 = 0.7957$

8.3.2 Results by 3SLS

Product Market:

Y = CON + I + G + X - M + NFP -------------------- (8.B.1)

DCON = CON - LAGCON ------------------------------ (8.B.2)

GAP = LOGY - LOGGNP ------------------------------ (8.B.3)

LOGGNP=0.474+0.6438LGLNK+0.4173LOGLF+.248LOGT+v13 (8.B.4)

(6.66) (29.05) (6.89) (38.26)

CON = 27.984+0.2236 Y+0.51815 LAGCON+v14 ---------- (8.B.5)

(7.32) (7.45) (7.30)

I = 42.939+1.2196DCON-1.4717R+.0206K+.6528LAGI+v15 (8.B.6)

(2.42) (5.31) (-2.98) (1.55) (6.16)

X = -183.969+.1619UY-.1559JY+2.7555T+.7426LAGX+v16 (8.B.7)

(-2.25) (1.96) (-0.38) (0.47) (7.91)

M = -36.1566+0.3093 Y+0.1895 X+0.2049 LAGM+v17 ---- (8.B.8)

(-2.72) (5.18) (2.27) (2.92)

Labor Market:

L = 3.2026+0.00287 Y-1.747 W+0.1367T+0.0588WPI+v18 (8.B.9)

(68.29) (11.45) (-8.61) (15.32) (0.81)

LF = -0.2965+1.4171 W+0.2829 POP+v19 ------------- (8.B.10)

(-.71) (5.81) (7.12)

Money Market:

LOGMS= -4.3525+1.4725 LOGY-0.07655 LOGR+v20 ------ (8.B.11)

(-9.80) (28.36) (-1.55)

Price System:

LOGP = 0.1308+0.0946 LOGMON+0.0697 LOGWPI+0.7707 LOGCPI

(4.88) (5.34) (1.98) (19.00)

+0.4803 GAP+v21 ---------------------------- (8.B.12)

(5.91)

WPI = 0.1484+0.7373 PM+0.0814 LAGWPI+v22 --------- (8.B.13)

(11.38) (27.66) (2.33)

LOGCPI=0.0045+0.8175 LOGWPI+0.1743 LOGNW+v23 ----- (8.B.14)

(0.42) (15.38) (6.92)

Unemployment:

U = 0.0574-0.0654 GAP-0.0305 LAGGAP-0.007LOGX+v24 (8.B.15)

(10.67) (-3.21) (-1.26) (-6.64)

8.3.3 The Findings

As can be seen in the results by 2SLS, the R^2 for the function of unemployment 8.A.15 is the lowest, but still as high as 0.7957. R^2 for all the other equations is higher than 97%. Thess high R^2 values indicate that all equations represent a high goodness of fit. When the results by 2SLS are compared to those by 3SLS, all t-statistics in 3SLS have been improved. However, even in the results by 3SLS, the significance level for rejecting the null hypothesis of the coefficients being zero, for GY and T in equation 8.B.7 are as high as 70% and 65% respectively, for WPI in 8.B.9 43%, and for LAGGAP in 8.B.15 23%. These variables are still kept in the model because they provide some special information to the policy makers. The t statistics for all other estimated coefficients are significant at the level lower than (or equal to) 13%. For those equations which are specified identically or similarly to those in the previous compact equilibrium model, their results and findings are very similar. Therefore, it is not necessary to repeat the findings again.

In the compact equilibrium model, X was treated as an exogenous variable and was found to be a great contributor to the growth of the Taiwanese economy. Now X is treated as an endogenous variable in this disequilibrium model. Its own lag and the GNP of the United States (UY) were found the best explanatory variables to it. The significant positive coefficient for UY indicates that the increase in U.S. GNP increases the exports of Taiwan, therefore the GNP of Taiwan, consistent with the fact that Taiwan's trade surplus with the U.S. has increased in recent decades. The negative coefficient for Japanese GNP (JY), though significant only at 70% in 3SLS, indicates that the exports of Taiwan decrease while JY increases, consistent with the fact that Taiwan has had a trade deficit with Japan in the past three decades, and the unfavorable gap has become significantly greater in recent decades. The negative sign for the estimate of JY also suggests that the exportable goods of Taiwan to Japan have become less competitive and may have been shifted toward inferior goods while Japanese GNP has increased rapidly in the past several decades.[37]

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[37] Because the export function in this disequilibrium model

In the labor market, wage rates play an important role. On one hand the increase in wage rates will significantly reduce labor demand, but on the other hand, this increase in wage rates will stimulate labor supply. Population growth is also a significant source of labor supply.

With regard to the problem of unemployment, the gap between the actual and the potential GNP is significantly related to the unemployment rate which is consistent with Okun's law (1962,1972). In addition, exports are significantly negatively related to the unemployment rate, indicating that the increase in exports helps to reduce the unemployment rate. This finding confirms the result by Kuo, Ranis, and Fei (1981,pp.117-125), though they applied a different approach[38] to analyze the employment expansion in the economy of Taiwan.

In the previous Taiwan equilibrium model, demand pressure was not related to the GNP deflator or some other price index because it was assumed that the product market is almost cleared, and therefore no demand pressure exists. But demand pressure appears when the product demand is greater than the

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is highly aggregated, the reasons for the trade deficit (surplus) to Japan (U.S.) are not clear. More details can be obtained if individual export and import functions are established for Japan and the US, and the variables of the terms of trade and exchange rate should be incorporated into the model in addition to the GNP of the related countries.

[38] For their approach, see footnote 29.

product supply to a certain extent. In the disequilibrium model, GAP is identical to demand pressure. It is found that GAP has a significantly positive correlation to the GNP deflator. Combining equations 8.B.12 and 8.B.15 , and using Taylor's linear approximation, a Phillip's curve can be derived for the economy of Taiwan, confirming the finding in chapter VII that a Phillip's curve exists in the Taiwanese economy.

Finally, the multiplier analysis, forecast, simulation, and the Phillip's curve were not done for this disequilibrium model, but these represent an area for further research. However, in the study of this disequilibrium model, when compared with the previous equilibrium model, the magnitude of the coefficients does not change much, and the values of R^2 have remained high, thus convincing us that this disequilibrium model has a high degree of fit.

Chapter IX

CONCLUSIONS AND POLICY IMPLICATIONS

The main purpose of this study was to analyze the economy of Taiwan and thereby to find economic policy implications that will prove useful to policy makers.

In Chapter I, the problems of the economy of Taiwan and the objectives of this study were outlined. Further, a review of the literature contributing to this study was made. Shortcomings of earlier work by economists interested in the Taiwanese economy were also pointed out; another important purpose of this study was to try to eliminate such shortcomings of the previous models. For example, first, the data have been updated in an attempt to enlarge the degree of freedom. Second, 2SLS and 3SLS methods were applied for the estimation procedure instead of OLS. Third, a dynamic simultaneous model was introduced. The approaches of IS-LM, AS-AD, multiplier analysis, business cycle, and policy experiments were also utilized to enrich the findings.

Chapter II was devoted to the theoretical framework of this model, the introduction of the variables, and the specification of the equations. The characteristics of a dynamic model were also discussed.

Chapter III dealt with the sources and limitations of the data. The reliability of the data for the Taiwanese money supply, capital stock, and employment has been questioned by several economists. But there was no choice but to use these data because it was difficult to obtain other more accurate data for the substitution. A proxy wage rate was used, not only because there was difficulty in obtaining the actual data, but also because there are no suitable data for the wage rate for the entire economy of Taiwan.

In Chapter IV, the results of the 2SLS and 3SLS were reported, and the static IS-LM, dynamic IS-LM, long run IS-LM, AS-AD curves were derived. One interesting finding which deserves the attention of policy makers is that the magnitude of the shift of the dynamic IS curve was larger than that of the dynamic LM curve. This implied of course that Taiwan had experienced GNP growth accompanied by increasing interest rates, and that the effects of fiscal policy were stronger than those of monetary policy.

In Chapter V, the forecast and simulation for the Taiwan equilibrium model were performed, showing that the model is capable of predicting the turning points and has a high degree of fit.

In chapter VI, the multipliers and business cycle were analyzed. Both government consumption and exports were found to contribute to the growth of the economy of Taiwan;

however, interest rates were found to be a hindrance. It was also found that the Taiwanese economy has a business cycle of about 16 years.

Chapter VII was devoted to policy experiments. Three findings are worth repeating here: First, fiscal policy is more effective than monetary policy, consistent with the finding in Chapter IV. Second, exports are a major source of the economic growth of Taiwan. Third, earlier measures are better than later measures, suggesting that policy makers should foresee and respond to economic problems quickly.

In Chapter VIII, a disequilibrium model was developed from the previous equilibrium model. The assertion that exports are a major contributor to economic growth and to increased employment was reconfirmed. Recently Taiwan has encountered several obstacles which, if they are not overcome soon, will undermine its exports. Unskilled labor has been almost fully employed and wage rates have therefore been increasing in recent years. The high-technology-intensive industries of Taiwan are still in their preliminary stages of development, and the out-of-date labor-intensive industries have lost their competitiveness and marketability. Furthermore, protectionism is still growing all over the world, and the stability of Taiwan's domestic prices is very vulnerable to the fluctuation of import prices. Therefore, export promotion should be a major concern to the authorities of Taiwan, and more efforts should be made in overcoming the obstacles which will curb exports.

The above has demonstrated the contributions and findings of this study; however, this study is not without its own shortcomings. First, both the equilibrium and disequilibrium models leave out the variable of the terms of trade that characterizes the export and import functions.[39] Fortunately, this omission has had little effect on the R^2 for the export and import equations. Second, the data applied in this study covered a long period, from 1961 to 1982, but the economic structure has changed rapidly since 1971; therefore, the capacity of the ex ante forecast and simulation of these two models is expected to be weaker than that of ex post forecast and simulation. A quarterly model with the application of the latest data would probably have better ex ante forecast and simulation.

The present work suggests a few potential areas to be investigated with similar approaches. Terms of trade can be introduced into the models, if the required data can be ob-

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[39] This shortcoming was first pointed out by Professor Turner,The University of Oklahoma, when the proposal for this dissertation was presented. For a while, we defined the terms of trade as PM/P, but failed to obtain the correct signs for the coefficients. The definition of the terms of trade may need to be modified. For example, in addition to P and PM as we used in this study, the price index of major competitive countries, domestic price index for export goods, and the index of effective foreign exchange rate can be used for different modifications. Unfortunately, we failed to obtain the data for our attempts.

tained. The fluctuation of the terms of trade, and its effects on the economy of Taiwan, and also the Phillip's curve, multiplier analysis, forecast, and simulation for the disequilibrium model are all areas for further study. A repercussionary international model can be expanded from the disequilibrium model, provided that certain arrangements and modifications are made.

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Appendix A

TABLE OF THE VARIABLES

year	T	Y	CON	I	G	X	M
1961	1	171.97	112.382	29.358	41.219	21.570	32.436
1962	2	185.47	121.784	29.802	45.156	22.217	33.329
1963	3	202.85	129.208	35.083	46.855	28.752	36.806
1964	4	227.82	146.157	39.260	50.051	36.100	43.776
1965	5	252.91	159.520	50.667	52.518	44.450	53.958
1966	6	275.69	169.350	53.122	56.575	52.445	55.657
1967	7	304.80	184.026	69.854	62.385	60.531	71.518
1968	8	332.44	199.716	81.023	67.879	76.177	91.676
1969	9	362.37	214.337	87.873	74.688	94.309	108.470
1970	10	403.21	230.559	105.608	79.953	120.254	132.553
1971	11	455.23	249.213	123.641	83.206	159.596	160.249
1972	12	515.82	273.576	137.349	87.166	211.736	194.103
1973	13	581.93	305.247	163.697	92.390	261.606	240.849
1974	14	588.46	318.517	216.438	83.610	242.259	272.170
1975	15	613.41	340.651	188.939	95.465	245.794	253.980
1976	16	696.10	364.061	216.231	105.563	331.516	316.254
1977	17	764.71	388.949	222.804	118.412	374.795	335.240
1978	18	870.62	422.803	251.046	126.576	454.808	382.379
1979	19	940.97	465.947	308.217	137.655	478.830	450.042
1980	20	1003.07	490.706	325.743	147.443	523.237	482.516
1981	21	1053.63	508.098	320.587	151.740	567.610	488.302
1982	22	1093.20	529.058	293.728	159.399	583.572	472.662

year	L	LF	K	R	MS	W	NFP
1961	3.505	3.655	535.99	40.0000	19.010	0.33517	-0.123
1962	3.541	3.695	551.01	38.3535	19.579	0.36222	-0.163
1963	3.592	3.752	568.93	32.8037	24.194	0.38864	-0.168
1964	3.658	3.824	587.05	31.4798	31.343	0.43333	-0.024
1965	3.763	3.891	611.56	31.7647	36.638	0.47668	-0.228
1966	3.856	3.976	644.15	30.8571	39.934	0.51644	-0.144
1967	4.050	4.145	685.45	28.0421	49.762	0.55205	-0.479
1968	4.225	4.299	736.29	26.2722	51.992	0.58782	-0.680
1969	4.390	4.474	792.22	24.6667	56.430	0.60943	-0.367
1970	4.576	4.655	854.48	22.5403	62.687	0.66196	-0.611
1971	4.738	4.818	931.79	20.8333	79.437	0.75622	-0.181
1972	4.948	5.023	1020.75	18.4729	100.750	0.80191	-0.101
1973	5.327	5.395	1121.38	18.9286	131.811	0.81634	-0.163
1974	5.486	5.571	1243.09	15.3326	105.948	0.81865	-0.195
1975	5.521	5.657	1393.10	13.9916	138.571	0.91732	-3.455
1976	5.669	5.772	1537.20	12.0000	164.103	1.00000	-5.016
1977	5.980	6.087	1679.77	10.1224	206.392	1.04900	-5.014
1978	6.228	6.334	1839.40	9.6673	269.976	1.14182	-2.233
1979	6.424	6.507	2028.81	11.7124	261.242	1.22075	0.366
1980	6.547	6.629	2259.19	11.2813	276.366	1.30923	-1.546
1981	6.672	6.764	2483.83	9.4838	280.821	1.43357	-6.101
1982	6.811	6.960	2700.68	6.4410	312.703	1.54475	0.105

YEAR	PM	P	WPI	CPI	UY	JY
1961	0.449	0.405	0.483	0.425	1003.03	47.825
1962	0.439	0.413	0.498	0.435	1055.17	54.397
1963	0.453	0.428	0.530	0.445	1092.16	62.465
1964	0.439	0.446	0.543	0.444	1163.73	69.509
1965	0.458	0.442	0.518	0.443	1233.91	74.873
1966	0.471	0.455	0.525	0.452	1304.75	85.530
1967	0.483	0.475	0.538	0.468	1338.54	96.922
1968	0.502	0.507	0.554	0.504	1401.01	109.037
1969	0.497	0.540	0.553	0.530	1435.71	121.471
1970	0.515	0.559	0.568	0.549	1430.17	133.770
1971	0.542	0.576	0.568	0.564	1464.02	140.853
1972	0.564	0.609	0.594	0.581	1587.82	154.026
1973	0.679	0.700	0.729	0.629	1677.94	168.831
1974	1.031	0.962	1.025	0.927	1654.69	165.130
1975	0.980	0.947	0.973	0.976	1630.63	162.636
1976	1.000	1.000	1.000	1.000	1718.00	167.295
1977	1.073	1.062	1.028	1.070	1817.19	172.334
1978	1.176	1.112	1.064	1.132	1898.47	182.802
1979	1.370	1.238	1.211	1.243	1952.83	188.767
1980	1.647	1.436	1.472	1.479	1982.92	187.247
1981	1.783	1.608	1.584	1.720	2011.99	187.657
1982	1.781	1.669	1.574	1.789	1977.53	193.176

Appendix B

DATA FOR EXOGENOUS VARIABLES IN POLICY EXPERIMENTS

A. Equations Of Trend

(1) $\text{Log}(X) = 2.6293 + 0.2577\,T - 0.0038\,T^2$ $R^2 = 0.9919$

(2) $\text{Log}(K) = 6.0283 + 0.0815\,T$ $R^2 = 0.9802$

(3) $\text{Log}(W) = -1.1187 + 0.07012\,T$ $R^2 = 0.9949$

(4) $\text{Log}(G) = 3.6708 + 0.0643\,T$ $R^2 = 0.9875$

(5) $\text{Log}(R) = 3.8413 - 0.0794\,T$ $R^2 = 0.9600$

(6) $\text{Log}(PM) = -1.1691 + 0.0743\,T$ $R^2 = 0.8956$

B. Data For Exogenous Variables In Policy Experiments

Year	T	NFP	G	X	W	R	PM	K
1983	23	-1.196	172.26	696.63	1.639	7.496	1.7169	2705.84
1984	24	-1.196	183.70	753.97	1.758	6.924	1.8494	2935.65
1985	25	-1.196	195.89	809.85	1.886	6.395	1.9921	3184.98
1986	26	-1.196	208.89	863.29	2.023	5.907	2.1458	3455.48
1987	27	-1.196	222.76	913.29	2.170	5.456	2.3114	3748.95
1988	28	-1.196	237.55	958.86	2.327	5.039	2.4897	4067.35
1989	29	-1.196	253.31	999.10	2.496	4.654	2.6819	4412.80
1990	30	-1.196	270.13	1033.13	2.678	4.299	2.8888	4787.58

Note: Data for G, X, W, R, PM, and K are obtained by using the equations of trend listed in A.