An Analysis of the Annual Change in the Government Investment Multiplier in the Japanese Economy Using Several Model Types[1]

By

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ABSTRACT

Using several model types considering structural changes, this study analyzes the annual change in the government investment multiplier in Japan and the factors causing such a change. The results show the continuous downward trend of the multiplier. The increase in marginal propensity to import and the decline in production inducement coefficient are pointed out as the real side contributing factors. As the price and monetary side contributing factors, it is indicated that real interest rates become more sensitive to public investment and that the exchange rate becomes less sensitive to public investment, which are caused by the expanding supply–demand gap and deteriorating fiscal circumstances.

1. Introduction

Since the early 1990s, the Japanese economy has been struggling against a long and severe economic slump, which is often referred to as the Heisei recession. It is recognized that this downturn is due to the structural factors of the Japanese economy as well as the ordinary cyclical factors. In spite of the steady implementation of large–scale economic packages, it seems that the Japanese economy is yet to set out on the path to a true recovery. On the other hand, the fiscal circumstances are going from bad to worse because of such a fiscal policy management. Under these circumstances, there is a growing interest focused on the annual change in the government investment multiplier, i.e. whether or not the multiplier effect of public investment is declining. In order to properly make an empirical analysis of this issue, it is necessary to use the policy simulation model that considers not only the real side but also the price and monetary side of the economy because the multiplier is determined by the complicated inter-

actions among these factors. However, there have been only a few previous studies focusing on this controversial issue and conclusive information has not been obtained yet.

In such a context, using the multi-sector econometric (MSE) model, the macro econometric (ME) model, and the input-output (IO) model developed on the basis of the same samples, this study quantitatively discusses the annual change in the government investment multiplier in the Japanese economy and analyzes the factors causing such a change in detail through the following process: (1) a comparative analysis of the simulation results taking into consideration the structural differences among these models; (2) a comparative analysis of the simulation results derived from the cases where a certain influencing factor is treated as endogenous/exogenous; and (3) a causality analysis focusing on the correlation between a certain influencing factor and its determinant factor. The MSE and ME models used in this study have the advantages of being consistent with economic theory and the econometric method, and of the good fitting with the actual economy. The behavioral equations in these models are estimated taking into consideration structural robustness and the prevention of specification errors as well as traditional evaluation criteria. Furthermore, in order to consider the effect of the structural changes in households' and firms' behavior on the annual change in the government investment multiplier, attempts have been made to specify the time points and patterns of structural changes on the basis of the results of the Chow and CUSUM tests, and to reflect them in the models using dummy variables. In addition, the MSE model explicitly considers almost all of the short-term economic impact paths of fiscal policy, i.e. the factors causing the change in the government investment multiplier, including the price and monetary side factors as well as the real side factors. In spite of its large-scale property, this model is also characterized by easy operation. The models with these characteristics can be the analytical frameworks suitable for the purpose of this study.

This paper is organized as follows. The next section summarizes the short-term economic impact paths of fiscal policy and the previous studies that analyzed the annual change in the government investment multiplier in the Japanese economy. Section 3 briefly outlines the characteristics and structure of the MSE, ME, and IO models used in this study. Section 4 describes the flow and results of the analysis of structural changes. Section 5 describes the results of the quantitative discussion of the annual change in the government investment multiplier in the Japanese economy and the detailed analysis of the factors causing such a change. Finally, Section 6 provides concluding remarks.

2. Theoretical Backgrounds and Previous Studies

2.1. Short-Term Economic Impact Paths of Fiscal Policy

The short-term economic impact paths of fiscal policy are generally classified into seven categories: (1) Direct effect; (2) Indirect effect; (3) Induced effect; (4) Leakage-to-import effect; (5) Price adjustment effect; (6) Crowding-out effect; and (7) Mundell

−Fleming effect. They are usually explained as follows. An additional public investment raises the gross domestic product (GDP) directly through the GDP identity (Direct effect). It also creates an intermediate demand for the relevant industries through the process of intermediate inputs and induces an output throughout the economy (Indirect effect). The increase in income and output due to the direct and indirect effects induces final demand such as consumption expenditure and private investment (Induced effect). The induced effect creates another induced effect in the same manner and this ripple effect continues until the succeeding effect becomes negligible. On the other hand, part of the generated demand leaks to import (Leakage−to−import effect), and the increase in prices due to the high economic performance caused by the additional public investment reduces the generated demand (Price adjustment effect). In addition, the tight money balance and the increase in the fiscal deficit caused by the additional public investment raise interest rates, and this crowds out private investment (Crowding−out effect). There are two possible effects of the additional public investment on the exchange rate. One is that the exchange rate appreciates because of the capital inflow due to the increase in interest rates, and the current account becomes worse (Mundell−Fleming effect). The other is that the exchange rate depreciates because of the demand for foreign bonds induced by the increase in income. The relationships among the elasticities of money demand and foreign bond demand in response to the change in income and interest rates determine the direction in which the exchange rate moves. If international capital movements are active, the exchange rate appreciates.

2.2. Previous Studies on the Annual Change in the Government Investment Multiplier

There have been a few previous empirical studies that analyzed the annual change in the government investment multiplier in the Japanese economy using the ME model (Hori et al., 1998; Yoshino and Nakajima, 1999; EPA, 1998, 2000). However, the conclusions derived from these studies are quite inconsistent with each other and this issue seems to be in the middle of controversy. Thus, it is expected in this field that a further detailed analysis will be made to sort out the arguments. The results derived from these studies can be summarized as follows.

Hori et al. (1998) first theoretically analyzed the factors determining the government investment multiplier with the theoretical macroeconomic model in an open economy. They assumed the monetary policy of a fixed short−term interest rate, which is a realistic one for the Japanese economy, and a short time span where the price adjustment can be ignored. The results of this theoretical analysis showed that the government investment multiplier can be derived from the Keynesian cross (45−degree line) model where it is determined by the marginal propensities to consume, invest, and import without being affected by the price and monetary side factors of the economy. It was also suggested that the expectations of households and firms are likely to have a considerable impact on the government investment multiplier by affecting the marginal propensities to consume and invest. It becomes small if households and firms assume that the additional public investment will have a negative effect on the long−term growth path or will bring about a tax increase in the future. The past economic packages implemented in Japan were then reviewed with the vector autoregressive (VAR) model and it was pointed out that there was no empirical evidence that the crowding−

out or Mundell–Fleming effects had appeared. Next, the ME models of the same struc-
ture were applied to several time periods and it was found that there was little differ-
ence in the government investment multiplier between the 1980s and 1990s. They fi-
nally concluded that while it was true that the government investment multiplier
seemed to be declining due to the negative economic impact of the burst of the bubble
economy such as capital stock adjustment and asset price deflation, it had not declined
obviously in the 1990s.

Yoshino and Nakajima (1999) used the ME model that considers structural
changes in detail by dividing the sample period. They made both a short–term analysis
that considers the effect of creating demand alone and a long–term analysis that con-
siders not only the effect of creating demand but also the price adjustment and produc-
tivity effects. The results of these empirical analyses implied an upward trend of the
marginal propensity to consume, and a downward trend of the marginal propensity to
invest and the sensitivity of foreign bond demand to income. In addition, it was found
that the marginal propensity to import tended to be statistically insignificant due to the
change in the structure of trade after the Plaza Accord. It was also indicated that the
crowding–out and Mundell–Fleming effects tended to appear obviously because of the
increasing sensitivity of consumption expenditure, capital investment, and foreign bond
demand to interest rates due to the deregulation of finance and the mitigation of the
shortage of funds in the private sector. It was concluded in both analyses that the gov-
ernment investment multiplier declined remarkably in the 1990s.

EPA (1998, 2000) admitted the possibility of a downward trend of the marginal
propensity to consume and the output elasticity of labor demand, and the possibility of
an upward trend of the marginal propensity to import. However, it was shown that the
impact of the additional public investment on interest rates and the exchange rate was
becoming smaller. Moreover, it showed the possibility that consumption expenditure
and capital investment were restrained by households' concerns about the future and
the decline in firms' expected growth rate, indicating that the expectations of house-
holds and firms were becoming an increasingly important factor for the government in-
vestment multiplier. It also pointed out the possibility that the government investment
multiplier was becoming smaller because of the negative economic impact of the burst
of the bubble economy. In addition, it was found that the induced effect through capital
investment was becoming smaller in the 1990s as compared with the 1980s, although
there was little difference in the induced effect through consumption expenditure be-
tween the 1980s and 1990s. It concluded that while it was true that there were some
factors decreasing the government investment multiplier in the 1990s, it had not de-
clined obviously during the same period.

In this way, the results of these studies differ from each other with respect to not
only the annual change in the government investment multiplier in the Japanese econ-
omy but also the recent trend of the factors causing the change in it. It was similarly
pointed out that the expectations of households and firms and the negative economic
impact of the burst of the bubble economy were becoming increasingly important fac-
tors for the government investment multiplier. In contrast, the results are obviously in-
consistent with each other with respect to the annual change in the marginal propensi-
ties to consume, invest, and import, and the crowding–out and Mundell–Fleming ef-
fects.

3. Models

This section briefly describes the characteristics and structure of the MSE, ME, and IO models used in this study.

3.1. Multi–Sector Econometric (MSE) Model

The MSE model consists of econometrically estimated behavioral equations and definitional equations. It retains the sectoral disaggregation (i.e. interindustry linkages) of the IO model, and incorporates the disequilibrium dynamic structure, the marginal relationships, the data–oriented structure, and the Keynesian–type closure mechanism where income and output are fed back into final demand, into the model using an econometric framework. These characteristics can be considered as the general characteristics of the MSE model. Hence, the MSE model can accurately track the short–term dynamic adjustment path of the economy over time in response to external shocks where a supply–demand balance is achieved through the price mechanism. In short, the MSE model has the advantages of both the IO and ME models. Recent empirical studies have shown that such an integration improves the reliability of the economic impact analysis (West, 1994). Taking into account these general characteristics of the MSE model, this model is suitable for this study which attempts to make a quantitative and detailed analysis of the short–term economic impact of fiscal policy, as compared with other model types.

As the MSE model, the MS–JMACRO model (Takeshita, 2002)[2] is used in this study. This model is a short–term MSE model of disequilibrium dynamic type, developed for the Japanese economy. The basic structure of this model is shown in Figure 1. This model describes the commodity, labor, money, and foreign bond markets and comprises eight blocks: the final demand block; the output block; the labor block; the supply block; the price block; the value added block; the monetary block; and the income and assets block. All these blocks are interdependent, and are solved simultaneously and iteratively by the Gauss–Seidel method. This is a macroeconomic model and is disaggregated into 17 sectors as shown in Table 1, considering the availability of a consistent set of time series data. It thus describes the decision rules for economic variables by each sector such as investment functions, export/import functions, supply–demand balances, labor demand functions, wage functions, production functions, price functions, and value added functions. The institutional sectors in this model are classified into households, incorporated enterprises, foreign countries, and general government.

The MS–JMACRO model is developed using annual data on the basis of the System of National Accounts 1968 (SNA68) by 1990 price. The sample period of the behavioral equations is, in principle, from 1981 to 1998 because of the data limitations. The commodities and industries are classified separately in the model. In addition to

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[2] This literature is available on request to the author (E–mail: taka@yamaji.t.u–tokyo.ac.jp).

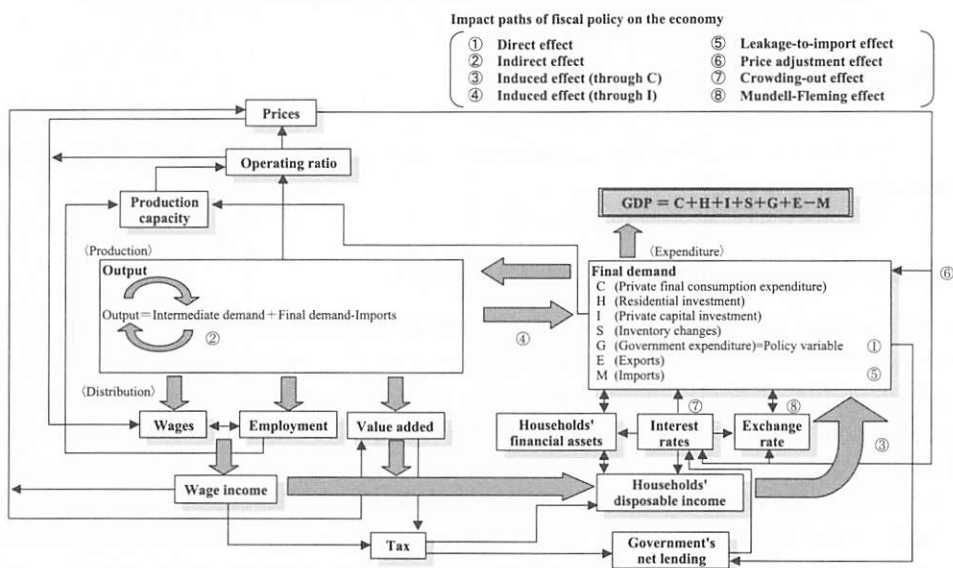## Figure 1: Basic structure of the MSE (MS-JMACRO) model

Table 1: Sectoral disaggregation in the MSE (MS-JMACRO) model

Sector no.	Sector name
(1)	Agriculture, forestry and fishery
(2)	Mining
(3)	Food and beverage
(4)	Textiles
(5)	Pulp, paper and paper products
(6)	Chemicals
(7)	Petroleum and coal products
(8)	Non-metallic mineral products
(9)	Basic metal
(10)	Fabricated metal products and machinery
(11)	Other manufacturing industries
(12)	Construction
(13)	Electricity, gas and water supply
(14)	Transportation and communication
(15)	Services and other tertiary industries
(16)	General government
(17)	Private non-profit institutions serving households

the general characteristics of the MSE model summarized above, the MS–JMACRO model is developed to encompass several characteristics in order to avoid the problems associated with traditional econometric model analysis as much as possible and to develop the analytical framework suitable for this study. These characteristics can be summarized as follows.

(1) *Explicit consideration of almost all of the short–term economic impact paths of fiscal policy*: This model explicitly considers almost all of the short–term economic impact paths of fiscal policy summarized in Section 2, i.e. the factors causing the change in the government investment multiplier, including the price and monetary side factors as well as the real side factors.

(2) *Consistency with economic theory*: The behavioral equations in this model are, in principle, derived from theoretical models to avoid the problem of an estimation that is not based on economic theory.

(3) *Consistency with the econometric method*: The behavioral equations in this model are estimated on the basis of traditional evaluation criteria such as the conditions for the parameters derived from economic theory, goodness of fit, lack of serial correlation, homoscedasticity, significance of the parameters, and model selection criteria. In addition, they are estimated taking into consideration the diagnostics such as the CUSUM test for structural robustness and the RESET test for specification errors in order to develop the model that is robust against the change in the external environment such as policy change. Furthermore, in order to consider the effect of the structural changes in households' and firms' behavior on the government investment multiplier, attempts have been made to specify the time points and patterns of structural changes on the basis of the results of the Chow and CUSUM tests, and to reflect them in the model using dummy variables.

(4) *Good fitting with the actual economy*: The MS–JMACRO model has the advantage of good fitting with the actual economy and can trace the historical trend of the observed time series data appropriately over the sample period. Furthermore, the explanatory variables are chosen carefully in developing this model with not only economic theory but also the Japanese economy's own characteristics (such as its employment practice) explicitly taken into consideration.

(5) *Transparency*: All the information about this model and the policy simulations using it is open (Takeshita, 2002) to facilitate their improvement.

(6) *Easy operation*: This model has the advantage of a very short computational time on a personal computer without simplifying the characteristics of the MSE model. Therefore, it becomes easy to test a model repeatedly to improve it to the required level. It also becomes easy to carry out policy simulations repeatedly to make a detailed empirical analysis.

The formulation of the MS–JMACRO model can be summarized as follows. The final demand block determines the real final demand components. The households' consumption function is derived from the life cycle/permanent income hypothesis based on microeconomic theory and the adaptive expectations formation hypothesis of Friedman regarding how consumers expect their permanent income. Capital investment by industry is determined by the investment function based on the acceleration princi-

ple taking into consideration the user cost of capital based on the neoclassical invest-
ment theory. Imports are estimated for each commodity as a logarithmic linear function
of domestic demand by commodity, relative prices by commodity, and a given foreign
production ratio by commodity. The formulation of relative prices in the import func-
tions makes it possible to explicitly consider the effect of import duties and the ex-
change rate on imports. The real GDP is determined by identity as the sum of real fi-
nal demand components. Government expenditures such as public investment are given
exogenously as policy variables.

In the output block, the final demand components are fed into the commodity–by–
commodity IO submodel and the output is determined for each commodity. The input
coefficients and the bridge matrix coefficients allocating each domestic final demand
component to each commodity are treated as exogenous.

The labor block determines the employment and wages by industry, and the un-
employment rate. Employment by industry is determined by the labor demand function
based on the first postulate in the classical school using a Cobb–Douglas production
function and the partial adjustment mechanism concerning how employment is adjusted
to the optimal employment level. Average wages are determined on the basis of the ex-
pectations–augmented Phillips curve and wages by industry are determined on the basis
of the labor productivity principle.

In the supply block, private housing stock and capital stock by industry are first
determined by an accumulative approach. Then, the linear homogeneous Cobb–Douglas
production function is estimated for each industry. The primary factors are assumed to
be capital by industry, defined as the product of its lagged capital stock and its capital
operating ratio, and labor by industry, defined as the product of its employment and its
working hours. Production capacity by industry is determined by assuming full opera-
tion in its estimated production function, and operating ratio by industry is then de-
fined as the ratio of its actual production determined through the demand side of the
economy to its production capacity.

The price block determines the price variables and the nominal final demand com-
ponents. Price of product by industry is estimated as a function of its operating ratio
and its cost price, defined as its total cost per unit of output, on the basis of the mark–
up pricing principle. The import price in dollars before including tax by commodity is
given exogenously and the export price by commodity is determined by its cost price,
its import price, and the exchange rate. Other price variables are determined using
these price variables.

The value added block determines value added components by industry such as
wage income by industry, defined as the product of its wages and its employment.

The monetary block determines the money supply, interest rates, and the exchange
rate. The short–term interest rate is given exogenously as a policy variable and the long
–term interest rate is determined by the increase rate of the GDP deflator (expected in-
flation rate factor), the ratio of general government's net lending to the nominal GDP
(fiscal deficit factor), and the term structure of interest rates. The lending and deposit
rates are determined by assuming that the trend of the short– and long–term interest
rates is reflected in them. The exchange rate is determined on the basis of the assets
preference approach and is estimated as a function of the ratio of the wholesale price
index in Japan to that in the U.S. (equilibrium exchange rate derived from the theory

of purchasing power parity), the difference between the real long-term interest rate in Japan and that in the U.S., and the ratio of the cumulative current account surplus to the nominal GDP (risk premium). The stock and land prices are treated as exogenous.

In the income and assets block, the income components and the saving-investment balance are first determined for each institutional sector on the basis of the income and outlay accounts and the capital finance accounts in the SNA, respectively. Then, the financial assets/debts components are determined for each institutional sector. Real households' disposable income and real households' net financial assets are fed back into the households' expenditures. Net tax revenue is defined as the sum of the direct tax and the net indirect tax, which affects general government's net lending.

3.2. Macro Econometric (ME) Model

Most of the general characteristics of the MSE model can be applied to the ME model; it has the general characteristics of the disequilibrium dynamic structure, the marginal relationships, and the data-oriented structure. In addition, the ME model can consider the induced effect because of the introduction of the Keynesian-type closure mechanism. It is true that the ME model can show the aggregate effect, but it does not describe the repercussion channel, i.e. the production inducement effect, in detail.

The basic structure of the ME model used in this study is shown in Figure 2. This model is developed on the basis of the same samples as the MS-JMACRO model and takes over the characteristics and structure of the MS-JMACRO model to a great extent. In concrete terms, this model has the characteristics of the consistency with economic theory and the econometric method, and of the good fitting with the actual economy as well as those of transparency and easy operation. The behavioral equations in this model are estimated taking into consideration structural robustness and the prevention of specification errors as well as traditional evaluation criteria. Furthermore,

**Figure 2: Basic structure of the ME model**
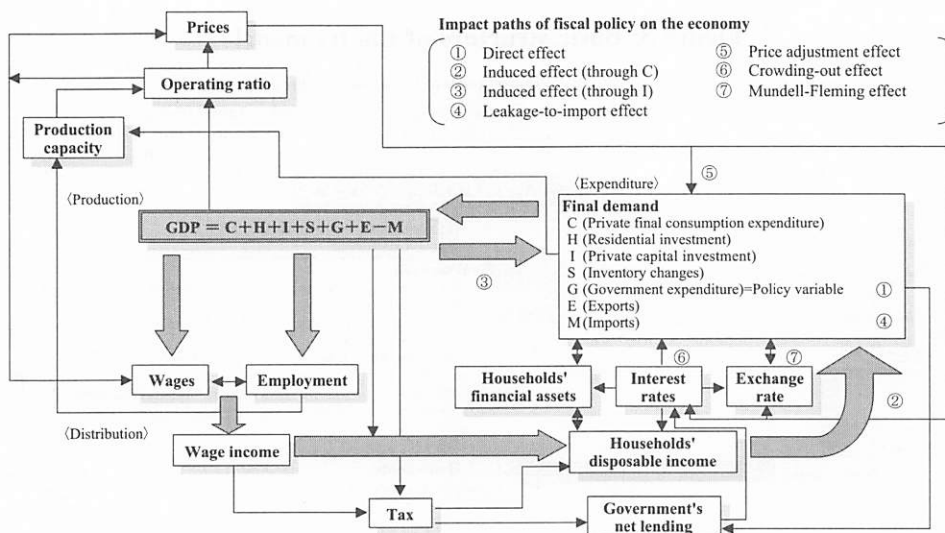
structural changes are analyzed in detail on the basis of the results of the Chow and CUSUM tests and they are reflected in the model using dummy variables. This model can consider almost all of the short–term economic impact paths of fiscal policy, although the interindustry linkages are not explicitly specified. This model comprises the final demand block, the labor block, the supply block, the price block, the value added block, the monetary block, and the income and assets block. Since this model is specified at the macro level, i.e. it is not disaggregated into sectors, functions such as the investment, export/import, labor demand, wage, production, price, and value added functions are specified at the macro level based on the same theoretical models as those adopted by the MS–JMACRO model. In the price block, the price deflators for the final demand components and the consumer/wholesale price index are determined by the econometrically estimated equations where average wages, average operating ratio, and other relevant price variables are mainly used as explanatory variables. In the income and assets block, incorporated enterprises' income is determined on the basis of the Kaldorian distribution theory. This model consists of 97 equations, and the structure of this model is almost the same as that of the notable ME models of the Japanese economy developed so far.

3.3. Input–Output (IO) Model

In the IO model, the supply side of the economy is not specified and the price and monetary side factors are not taken into consideration. Furthermore, the conventional IO model does not adequately consider the induced effect; the simple IO model with the exogenous household sector (type I) does not even consider the induced effect through consumption expenditure and Leontief's closed IO model with the endogenous household sector (type II) does not usually consider the induced effect through capital investment. Moreover, the income components other than wage income and the consumption expenditure by the unemployed are usually treated exogenously or ignored in the IO model, although it has been recognized that they can contribute significantly to

Figure 3: Basic structure of the IO model
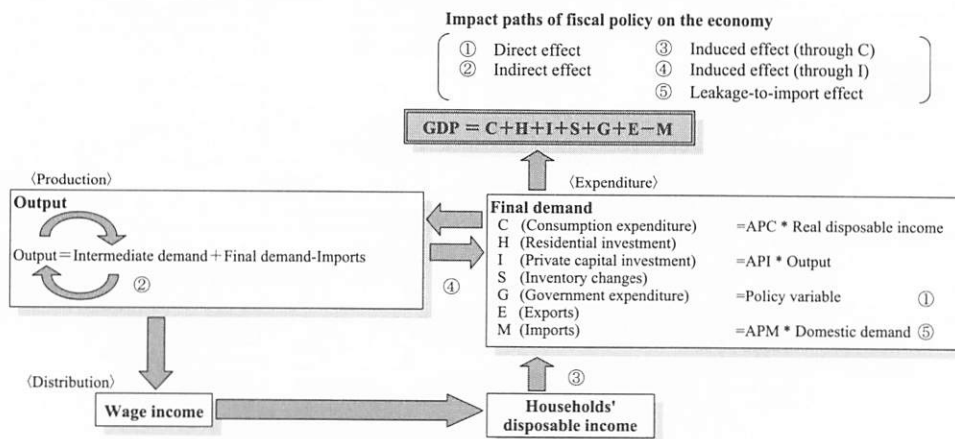
Notes: APC, average propensity to consume; API, average propensity to invest; APM, average propensity to import.

the overall economy. The IO model is usually static, thus it does not track the dynamic time path of the economy in response to external shocks. The IO model is based on average coefficients such as employment coefficients, income coefficients, and the average propensity to consume. It has been found that the models based on average coefficients have a possibility of overestimating the economic impact of external shocks (Trigg and Madden, 1994; West, 1995). In this way, the IO model has a simple structure and a lot of limitations as compared with other model types.

The basic structure of the IO model used in this study is shown in Figure 3. This model is developed on the basis of the same samples as the MS-JMACRO model and is disaggregated into 17 sectors similarly to the MS-JMACRO model. This model is based on Leontief's closed IO model with the endogenous household sector and the households' consumption expenditure is determined endogenously in this model using the average propensity to consume and the wage income coefficients by industry, defined as the ratio of its wage income to its output. In addition, capital investment by industry and imports by commodity are also determined endogenously in this model using the capital investment coefficients by industry (i.e. the average propensity to invest by industry), which is defined as the ratio of its capital investment to its output and the import ratio by commodity (i.e. the average propensity to import by commodity), which is defined as the ratio of its imports to its domestic demand, respectively. Therefore, the GDP can be determined endogenously in this model with private final consumption expenditure, private capital investment, and imports treated as endogenous. To summarize, among the short-term economic impact paths of fiscal policy, the direct, indirect, induced, and leakage-to-import effects can be taken into consideration in this model based on average relationships.

4. Analysis of Structural Changes

As pointed out by Yoshino and Nakajima (1999), in order to properly analyze the annual change in the government investment multiplier, it is necessary to reflect the structural changes in the behavioral equations in the model. In fact, the Japanese economy has undergone several structural changes, such as the oil crises in the 1970s, the deregulation of finance in the 1980s, the Plaza Accord in 1985 and the yen appreciation recession that followed, the bubble economy in the late 1980s, and its burst in the early 1990s. Moreover, since 1997, the Japanese economy has been in the deepest recession in the postwar period due to factors such as the financial system crisis, referred to as the financial system recession in this paper, and the unemployment rate reached its highest level. It is recognized that structural changes were moderate in the private sector for a short while after the burst of the bubble economy, partly because the Japanese economy performed relatively well from 1995 to 1996. However, since the financial system recession, the negative economic impact of the burst of the bubble economy has been becoming tangible and the expected growth rate of households and firms has been declining. As a result, it is pointed out that significant structural changes have been taking place in the private sector since that time because of the increasing pressure on restructuring in that sector. Taking into consideration these circumstances, in

developing the MSE and ME models used in this study, structural changes are analyzed in detail using an econometric method and they are reflected in these models using dummy variables. Therefore, these models are advantageous to this study.

This section first describes the procedure of specifying the time points and patterns of structural changes, and that of reflecting them in the models. Then, the results of the analysis of the structural changes in the behavioral equations which are likely to have a significant effect on the government investment multiplier are described. Taking into consideration the short–term economic impact paths of fiscal policy summarized in Section 2, the focus is placed on the results of the households' consumption function and the labor demand functions (the factor corresponding to the induced effect through consumption expenditure), the investment functions (the factor corresponding to the induced effect through capital investment), and the import functions (the factor corresponding to the leakage–to–import effect).

4.1. Flow of the Procedure

Before carrying out the procedure of specifying the time points and patterns of structural changes, the structural changes that have occurred in the Japanese economy are investigated in detail by referring to reports such as white papers on the economy (EPA, 1998, 1999, 2000). The procedure is then carried out with the careful examination of the policy implication of the results.

First, in addition to the CUSUM test, the repetitive Chow test is performed for each behavioral equation where each year within the sample period is assumed to be the time point of structural changes. The time points of structural changes in behavioral equations and their patterns are specified on the basis of the results of the repetitive Chow and CUSUM tests. If the CUSUM statistic moves in the plus/minus direction at the time point of a structural change, it is assumed that the structural change occurs in the plus/minus direction. It is also assumed that structural changes in a behavioral equation may occur more than once within the sample period. It is difficult to analyze structural changes near the endpoint of the sample period, although it is indicated that significant structural changes have taken place in the Japanese economy in recent years. This is because it is impossible to apply the ordinary Chow test due to the insufficient degrees of freedom in the latter split sample period and because only a few samples reflect such structural changes. However, the second Chow test is applicable to this case (Wago and Ban, 1995). The second Chow test is based on the statistic defined as

$$C_2 = \left(\frac{SSR_T - SSR_1}{SSR_1} \right) \left(\frac{T_1 - K}{T_2} \right) \tag{1}$$

where T_1/T_2 denotes the number of observations in the sample before/after the assumed time point of a structural change, SSR_1/SSR_T denotes the sum of squared residuals of the regression within the sample before the assumed time point of a structural change/ within the whole sample, and K denotes the number of estimated coefficients. If $T_2 < K$, the statistic C_2 is distributed as $F(T_2, T_1 - K)$ under the null hypothesis of the stability of the parameters between two time periods.

The specified structural changes are then reflected in the model using dummy variables, which take the value $1/{-}1$ at the time point of the structural change in the plus/minus direction. The explanatory variable to which the dummy variable is attached is chosen in the light of the t-statistic for the dummy variable.

4.2. Results of the Analysis of Structural Changes

In the case of the households' consumption function, it is found that the marginal propensity to consume declined after the burst of the bubble economy. The magnitude of its decline due to the structural change is 8%. This implies that consumer behavior became defensive during the same period. According to the result of the Chow test where it is assumed that structural changes occurred within the period 1997—1998 in the financial system recession, it is found that the structural changes in the minus direction cannot be rejected completely during this period. However, the t-statistic for the dummy variable representing such a structural change is not significant. Therefore, it can be concluded that the structural changes in the minus direction did not take place during the financial system recession.

Table 2 summarizes the results of the analysis of the structural changes in the investment and labor demand functions at the macro and industry levels. In addition, the historical trend of private capital investment, overall employed persons, and private output (i.e. the main explanatory variable for capital investment and labor demand) over the sample period is also shown in Figure 4 for ease of interpretation. Here, the results are compared with the description in the Economic Survey of Japan (EPA, 1998, 1999, 2000) that the rapid structural changes in the minus direction have occurred in the activities of the private corporate sector such as investment and employment since the financial system recession, whereas structural changes were relatively moderate in that sector for a short while after the burst of the bubble economy.
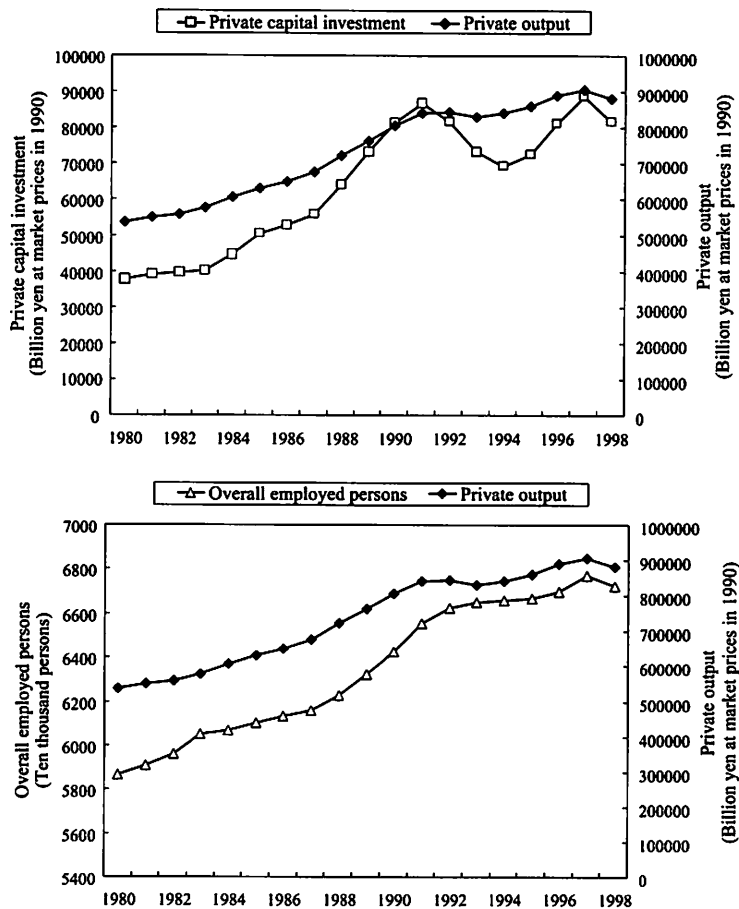
In the case of the investment functions, as expected from Figure 4, the structural changes in the plus direction are observed during the bubble economy and those in the minus direction are observed after the burst of the bubble economy as a whole, especially in the secondary industries. During the financial system recession, though the structural changes in the minus direction are observed in a few industries, those in the plus direction are accepted in most of the industries such as the fabricated metal products and machinery industry and the services and other tertiary industries. Perhaps this implies that these industries made capital investment actively to introduce new technologies, such as information technology, during the same period. It is not because a structural change took place but because private output declined that private capital investment declined in 1998. The results suggest that the structural changes in investing activities took place in the form of changes in the constant term and that the changes in the marginal propensity to invest are not observed at all. These results are in conflict with the description in the Economic Survey of Japan, but it is possible that the process of capital stock adjustment after the burst of the bubble economy is regarded as a structural change in this analysis, because the investment functions are estimated using relatively small samples and they do not necessarily consider medium— and long— term factors.

In the case of the labor demand functions, it is found that the output elasticity of

labor demand declined during the financial system recession as a whole. The magnitude of its decline due to the structural changes is 5–10% in the upstream industries such as the mining industry, the food and beverage industry, and the pulp, paper and paper products industry; in contrast, it decreases at most by 1–2% in the other industries. These results are consistent with the description in the Economic Survey of Japan. The results also suggest that employing activities became exceptionally active in the transportation and communication industry after the burst of the bubble economy where it is found that the constant term increases. This may be because new markets such as mobile communication emerged and expanded remarkably in this industry during the same period.

In the case of the import functions, structural changes are not observed as a whole. This may be because the year 1985 was chosen as the starting point of the sample period of the import functions when the Plaza Accord was reached and the change in the structure of trade began to occur due to the yen appreciation.

Figure 4: Historical trend of private capital investment, overall employed persons, and private output over the sample period

**Table 2: Results of the analysis of the structural changes
in the investment and labor demand functions**

	Investment function	Labor demand function
Macro level	2(-) 3(+)	3(-)
Industry level		
(1) Agriculture, forestry and fishery	3(-)	-
(2) Mining	2(+) 3(-)	3(-)
(3) Food and beverage	1(+) 2(-)	3(-)
(4) Textiles	1(+) 2(-)	2(-)
(5) Pulp, paper and paper products	1(+) 2(-) 3(+)	3(-)
(6) Chemicals	2(-) 3(+)	1(+) 3(-)
(7) Petroleum and coal products	-	3(-)
(8) Non-metallic mineral products	2(-)	3(-)
(9) Basic metal	2(-)	1(+) 2(-)
(10) Fabricated metal products and machinery	3(+)	2(+) 3(-)
(11) Other manufacturing industries	3(+)	-
(12) Construction	1(+) 2(-) 3(-)	-
(13) Electricity, gas and water supply	1(+) 2(+)	-
(14) Transportation and communication	2(+) 3(+)	2(+)
(15) Services and other tertiary industries	3(+)	-

Notes:
1, during the bubble economy (-1991);   2, after the burst of the bubble economy (1992-1995);
3, during the financial system recession (1996-1998);
(+), structural change in the plus direction; (-), structural change in the minus direction.

5. Policy Simulations and Discussions

5.1. Flow of the Analysis

In this study, the additional public investment case is set up for policy simulations, where the public investment is increased by 1 trillion yen at constant prices temporarily in each year from 1986 to 1998; it is allocated to each commodity similarly to the share of each commodity in the public investment in the corresponding year. Then, this case is simulated for the period 1986–1998 using the MSE, ME, and IO models. On the basis of the simulation results derived from these models using this case, the annual change in the government investment multiplier in the Japanese economy (defined as equation (2)) is discussed quantitatively, and the factors causing such a change are analyzed in detail through the following process:

$$Government\ investment\ multiplier\ = \frac{\Delta GDP}{\Delta IG} \qquad (2)$$

where $\triangle$IG is the increase in the public investment (i.e. 1 trillion yen at constant prices in these policy simulations), and $\triangle$GDP is the increase in the real GDP.

(1) *A comparative analysis of the simulation results taking into consideration the structural differences among the MSE, ME, and IO models*: First, the government investment multiplier derived from the MSE model is regarded as the baseline result because this model explicitly considers almost all of the short-term economic impact paths of fiscal policy. Then, by comparing the baseline result with the result derived from the ME/IO model, the effect of the influencing factors that are not considered in the ME/IO model on the annual change in the government investment multiplier is analyzed quantitatively.

(2) *A comparative analysis of the simulation results derived from the cases where a certain influencing factor is treated as endogenous/exogenous*: By comparing the result derived from the case where all the influencing factors are treated as endogenous with that derived from the case where a certain influencing factor is treated as exogenous, the effect of this influencing factor on the annual change in the government investment multiplier is analyzed quantitatively.

(3) *A causality analysis focusing on the correlation between a certain influencing factor and its determinant factor*: By focusing on the correlation between the trend of the time series variable corresponding to a certain influencing factor and that of its determinant factor (i.e. its explanatory variable that is statistically significant), the discussions try to identify what kind of trends of the Japanese economy cause the annual change in the government investment multiplier.

It is widely recognized that the government investment multiplier is largely affected by the assumptions about the finance of public investment and the monetary policy. Taking into consideration Japanese fiscal and monetary policy management, it is assumed that the additional public investment is financed with the issue of public bonds and the short-term interest rate is fixed in the models as a policy variable in carrying out fiscal policy simulations. The assumption of the fixed short-term interest rate implicitly assumes that the monetary policy is managed in cooperation with fiscal policy and that it is simultaneously eased in implementing the expansive fiscal policy.

5.2. Annual Change in the Government Investment Multiplier

Figure 5 shows the comparison of the government investment multiplier derived from the MSE, ME, and IO models using the additional public investment case from 1986 to 1998. As shown in this figure, the government investment multiplier derived from the MSE and ME models exhibits a continuous downward trend. Therefore, it can be concluded that the government investment multiplier in the Japanese economy is declining over time. The government investment multiplier in 1998 derived from the MSE and ME models declined by approximately 20% and 25%, respectively, as compared with the largest value within the simulation period. In contrast, the government investment multiplier derived from the IO model exhibits an upward trend until 1991, a downward trend from 1991 to 1996, and a slight upward trend from 1996 to 1998. Similarly to the result derived from the IO model, the government investment multiplier derived from the MSE model also exhibits a slight upward trend from 1996 to 1998.

With regard to the magnitude of the government investment multiplier derived

Figure 5: Government investment multiplier derived from the MSE, ME, and IO models for the period 1986-1998
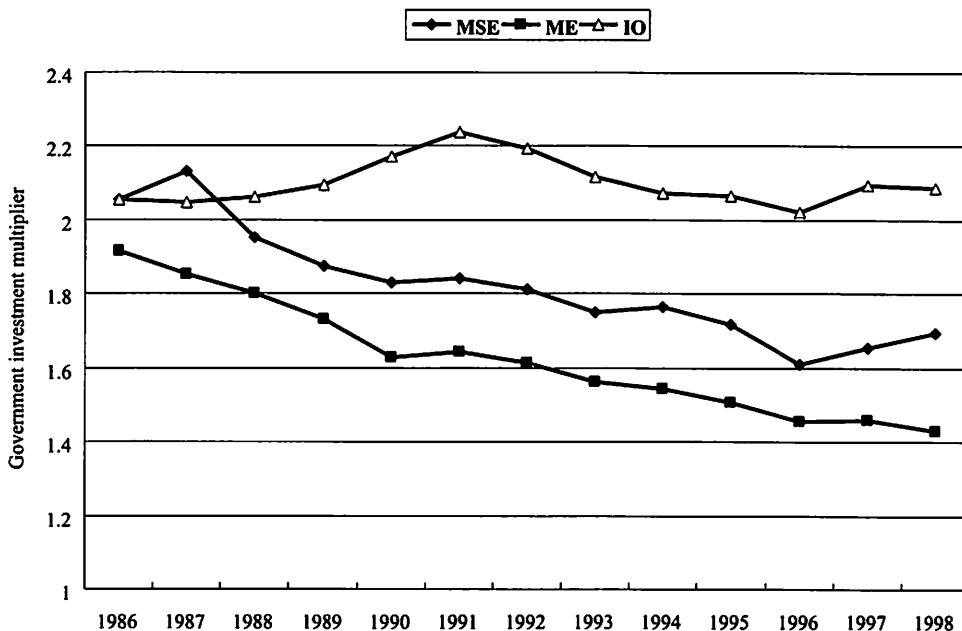
from several model types, West (1995) has made a comparative analysis of the difference in the multiplier among the IO, MSE, and applied general equilibrium (AGE) models developed on the basis of the same samples by introducing the same external shock to these models. Then, considering the structural differences among these models, he discussed the factors causing such a difference in the multiplier in detail. As a result, it has been pointed out that the multiplier derived from the IO model tends to be larger than that derived from other model types, because the supply constraint is not considered at all in this model and because this model is based on average coefficients. In contrast, in the case of this study, it can be argued that there is not a great difference in the government investment multiplier among the MSE, ME, and IO models, if the continuous downward trend of the government investment multiplier derived from the MSE and ME models is not taken into account. The reasons for the relatively small difference in the government investment multiplier among these models can be summarized as follows. First, the government investment multiplier derived from the IO model is decreased by its exogenous treatment of a few final demand components such as private residential investment. Secondly, the government investment multiplier derived from the MSE and ME models is increased by the assumption that the monetary policy is eased in implementing the additional public investment to enhance its economic impact.

5.3. Factor Analysis of the Annual Change in the Government Investment Multiplier

5.3.1. Factor analysis focusing on the real side

In order to identify the factors causing the continuous downward trend of the govern-

ment investment multiplier derived from the MSE and ME models, the influencing fac-
tors of the real side of the economy are first analyzed. Figure 6 shows the contribution
of each final demand component to the change in GDP derived from the MSE and ME
models, excluding public investment whose contribution is constant over the simulation
period. As shown in this figure, the continuous downward trend of the private capital
investment induced by the additional public investment makes the largest contribution
to the continuous downward trend of the government investment multiplier derived
from these models. It is found that the annual change in the induced private final con-

**Figure 6: Contribution of each final demand component to the change in GDP
derived from the MSE and ME models for the period 1986-1998
(excluding public investment)**

(MSE)

(ME)
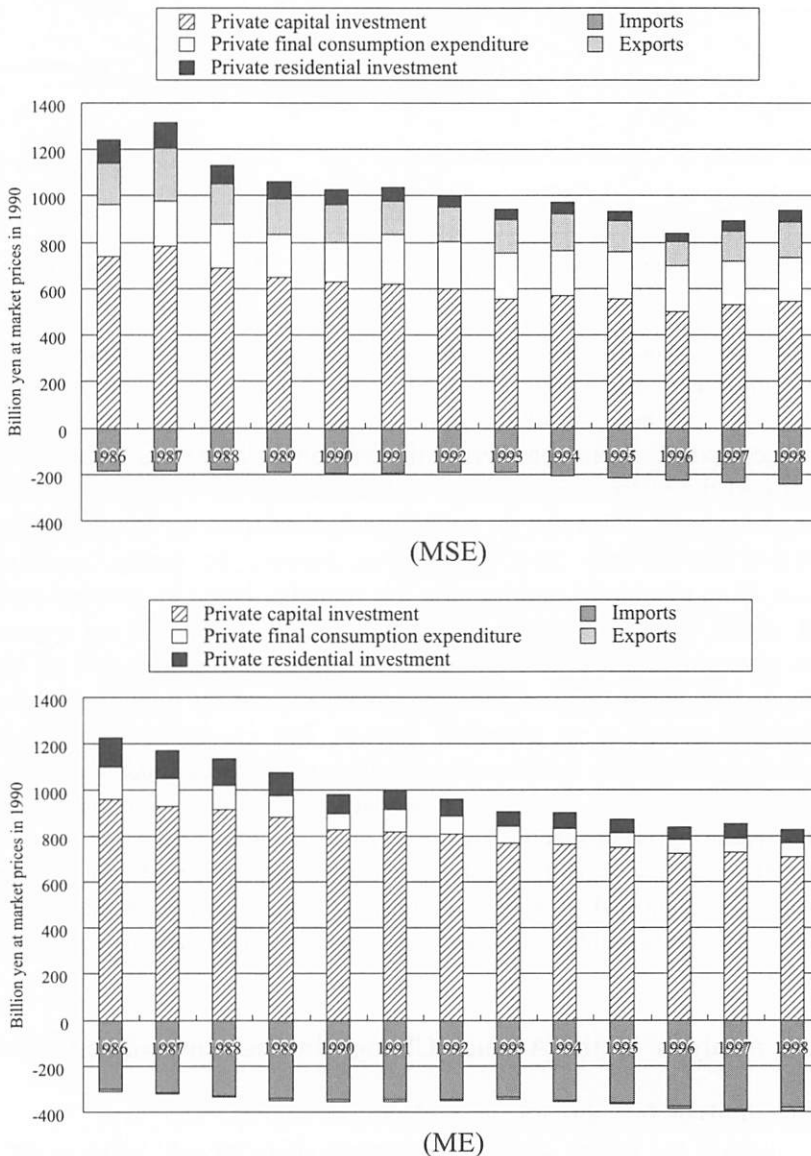
sumption expenditure is very small and does not make a significant contribution to the continuous downward trend of the government investment multiplier.

Next, in order to identify the factors causing the continuous downward trend of the induced private capital investment, the focus is placed on the trend of the induced output, which is the major real side determinant factor for the investment function of acceleration principle type adopted by the MSE and ME models. From the simulation results of the MSE model, the ratio of the value in the corresponding year to that in 1986 is shown in Figure 7 with regard to the government investment multiplier, the induced private capital investment, and the deviation rate from the observed value, re-

Figure 7: Ratio of the value in the corresponding year to the value in 1986: the government investment multiplier, the induced private capital investment, and the deviation rate for private output derived from the MSE and ME models, and the production inducement coefficient derived from the IO table
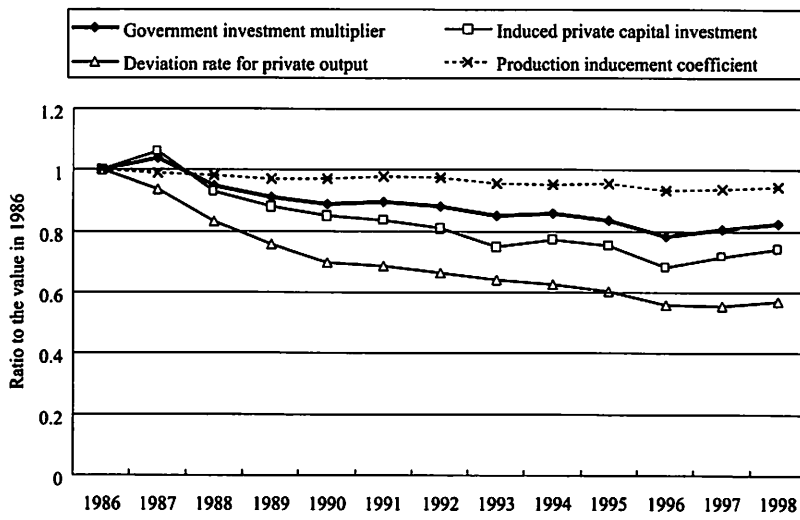
(MSE)
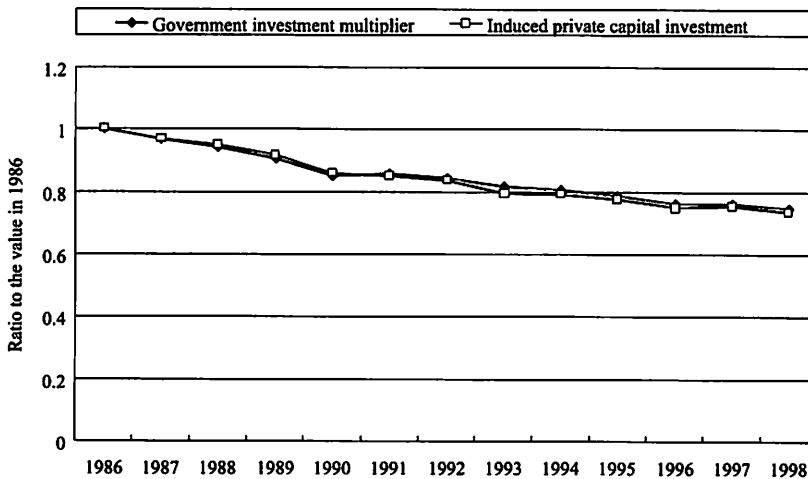
(ME)

Table 3: Correlation coefficients between each couple of the time series variables: the government investment multiplier, the induced private capital investment, and the deviation rate for private output derived from the MSE and ME models, and the production inducement coefficient derived from the IO table

(MSE)

	Government investment multiplier	Induced private capital investment	Deviation rate for private output
Induced private capital investment	0.994	-	-
Deviation rate for private output	0.968	0.966	-
Production inducement coefficient	0.941	0.926	0.920

(ME)

	Government investment multiplier
Induced private capital investment	0.996

ferred to as the base case in this paper, for private output. The same index is also shown with regard to the production inducement coefficient by public investment derived from the IO table. From the simulation results of the ME model, the same index is shown in this figure with regard to the government investment multiplier and the induced private capital investment. Table 3 shows the correlation coefficients between each couple of the time series variables shown in Figure 7. It should be noted that the government investment multiplier corresponds to the major real side determinant factor for the induced private capital investment in the ME model (i.e. the government investment multiplier corresponds to the difference in the explanatory variable for private capital investment between the base case and the additional public investment case) because the increment in GDP from the previous year is used as an explanatory variable for private capital investment in that model.

In the simulation results of the MSE model, it is found that the trend of the government investment multiplier is quite similar to that of the induced private capital investment over the simulation period. Furthermore, it can be confirmed that the deviation rate for private output and the production inducement coefficient also exhibit a continuous downward trend[3], and that the trend of these time series variables is quite similar to that of the government investment multiplier and the induced private capital investment over the simulation period. As shown in Table 3, there is a strong positive correlation between each couple of these time series variables. These results indicate that it is possible that the continuous decline in the production inducement effect by the additional public investment causes the continuous decline in the induced private

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[3] It is pointed out that the major reasons for the continuous downward trend of the production inducement coefficient by public investment are the increase in import ratio and the increasing share of tertiary industries, whose intermediate input ratio is relatively small, in the Japanese economy (e.g. Yoshino and Nakajima, 1999).

capital investment and that the continuous decline in the induced private capital investment causes the continuous decline in the government investment multiplier. Therefore, the reason for the slight upward trend of the government investment multiplier derived from the MSE model from 1996 to 1998 is considered to be the similar slight upward trend of the production inducement coefficient during the same period. It is worth noting that the downward trend of the deviation rate for private output, the induced private capital investment, and the government investment multiplier is more obvious than that of the production inducement coefficient. This implies that the economic impact of the continuous decline in the production inducement coefficient is amplified by the ripple effects such as the production inducement and multiplier effects.

In the simulation results of the ME model, it is found that the trend of the government investment multiplier nearly corresponds to that of the induced private capital investment over the simulation period, and that the correlation coefficient between these time series variables is approximately equal to unity[4]. The simulation results of the MSE model suggest the importance of the annual change in the production inducement coefficient in terms of causing the annual change in the government investment multiplier. However, the government investment multiplier derived from the ME model that does not describe the production inducement effect in detail also exhibits a continuous

**Figure 8: Ratio of the value in the corresponding year to the value in 1986:
the government investment multiplier derived from the IO model
and several coefficients**

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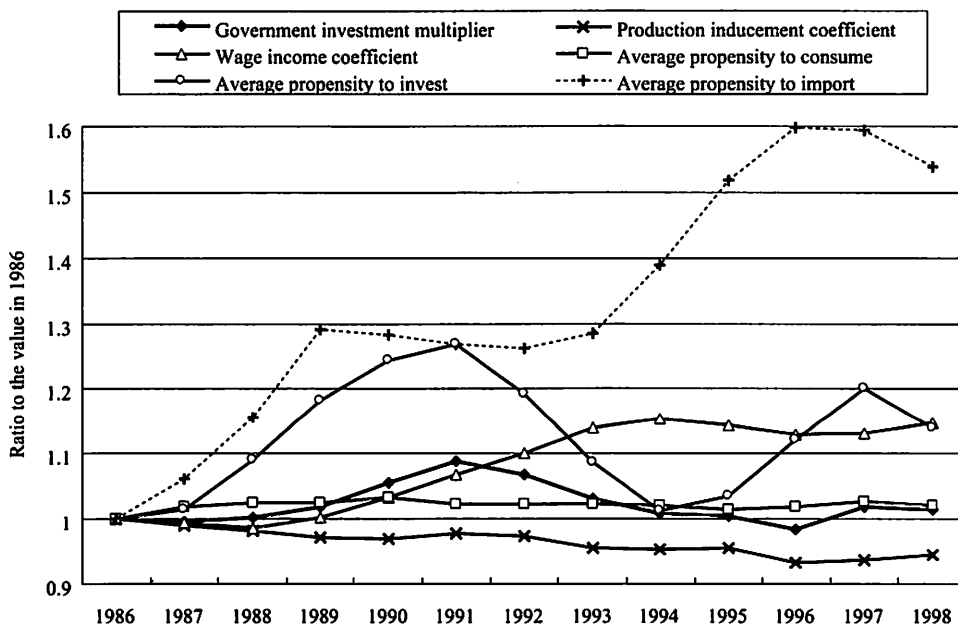
[4] The empirical analysis of the annual change in the government investment multiplier in the Japanese economy using the ME model (Yoshino and Nakajima, 1999) also pointed out that the trend of the induced private capital investment is an important factor for the annual change in the government investment multiplier.

Table 4: Correlation coefficients between the government investment multiplier derived from the IO model and each of the coefficients: the production inducement coefficient, the wage income coefficient, and the average propensities to consume, invest, and import

	Production inducement coefficient	Wage income coefficient	Average propensity to consume	Average propensity to invest	Average propensity to import
Government investment multiplier	0.183	0.016	0.417	0.756	-0.113

downward trend whereas that derived from the IO model that explicitly describes the production inducement effect does not exhibit a continuous downward trend. This implies that the production inducement effect, i.e. whether or not the interindustry linkages are incorporated into the model, is not the only real side determinant factor for the annual change in the government investment multiplier. As for the other real side determinant factors for the annual change in the government investment multiplier, the factor analysis is made in more detail in Section 5.3.3.

In order to identify the factors that affect the annual change in the government investment multiplier derived from the IO model, the ratio of the value in the corresponding year to that in 1986 is shown in Figure 8 with regard to the government investment multiplier derived from the IO model, the production inducement coefficient by public investment, the wage income coefficient, and the average propensities to consume, invest, and import. Table 4 shows the correlation coefficients between the government investment multiplier derived from the IO model and each of these coefficients. The results suggest that the annual change in the government investment multiplier derived from the IO model is affected by the average propensities to invest and consume rather than the production inducement coefficient.

5.3.2. Factor analysis focusing on the price and monetary side and the structural changes

Although the IO model endogenizes private capital investment that is found to be the largest contribution to the continuous downward trend of the government investment multiplier derived from the MSE and ME models, the same result is not obtained from the IO model. It is possible that such an inconsistency is caused by the influencing factors such as the price and monetary side factors and the structural changes in households' and firms' behavior, because these factors are not considered in the IO model whereas they are considered in the MSE and ME models. In order to analyze the effect of these influencing factors on the annual change in the government investment multiplier, the ratio of the value in the corresponding year to that in 1986 is shown in Figure 9 with regard to the government investment multiplier derived from the MSE and ME models using the case where the price and monetary side is treated as exogenous[5] and that derived from the ME model using the case where the structural changes in the

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[5] In the case where the price and monetary side is treated as exogenous, the model is calculated with price variables, interest rates, and the exchange rate treated as exogenous.

**Figure 9: Ratio of the government investment multiplier in the corresponding year
to that in 1986 derived from the MSE and ME models using the case
where the price and monetary side is treated as exogenous and the case
where the structural changes are not reflected in the model**
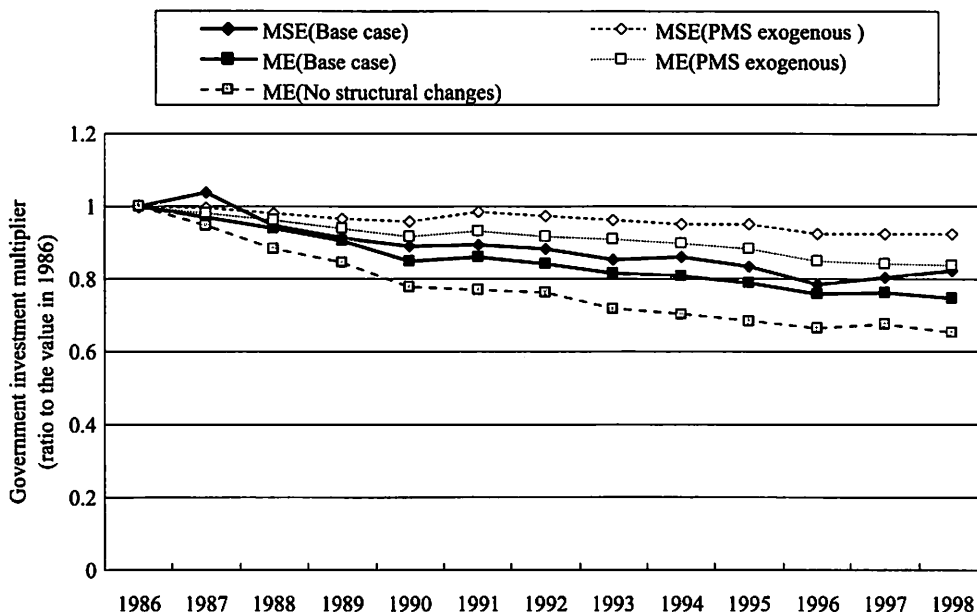
Notes: PMS, price and monetary side.

behavioral equations which are regarded as the major factors causing the change in the government investment multiplier in Section 4 (i.e. households' consumption function, investment functions, and labor demand functions) are not reflected in the model[6].

As shown in this figure, the continuous downward trend of the government investment multiplier derived from the MSE and ME models is moderated remarkably in the case where the price and monetary side is treated as exogenous. This implies that the price and monetary side factors make a significant contribution to the continuous downward trend of the government investment multiplier. On the other hand, according to the results of the analysis of structural changes described in Section 4, the structural changes that are likely to decrease the government investment multiplier were observed such as the decline in the marginal propensity to consume after the burst of the bubble economy and the decline in the output elasticity of labor demand during the financial system recession. However, in the case where these structural changes are not reflected in the model, the continuous downward trend of the government investment multiplier derived from the ME model is not moderated at all. This implies that the structural changes in households' and firms' behavior do not make a significant contribution to the continuous downward trend of the government investment multiplier. One possible

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[6] As a result of the calculation of the MSE model using this case, the spread of errors is observed in the model. Hence, only the simulation results of the ME model are shown here. Although import functions are also regarded as one of the major factors causing the change in the government investment multiplier, structural changes are not observed at all in the import functions as described in Section 4.

reason for this is that the magnitude of the decline in these parameters due to the structural changes is relatively small.

In order to analyze the price and monetary side factors in more detail, Figure 10 shows the ratio of the value in the corresponding year to that in 1986 with regard to the deviation rate for GDP deflator, lending rate, and exchange rate (based on ¥/$) derived from the MSE and ME models. The deviation rate for the GDP deflator derived from the MSE and ME models exhibits a continuous downward trend. In other words, the extent of the increase in prices due to the additional public investment is declining

**Figure 10: Ratio of the value in the corresponding year to the value in 1986:
the deviation rate for GDP deflator, lending rate, and exchange rate
derived from the MSE and ME models**

(MSE)

(ME)
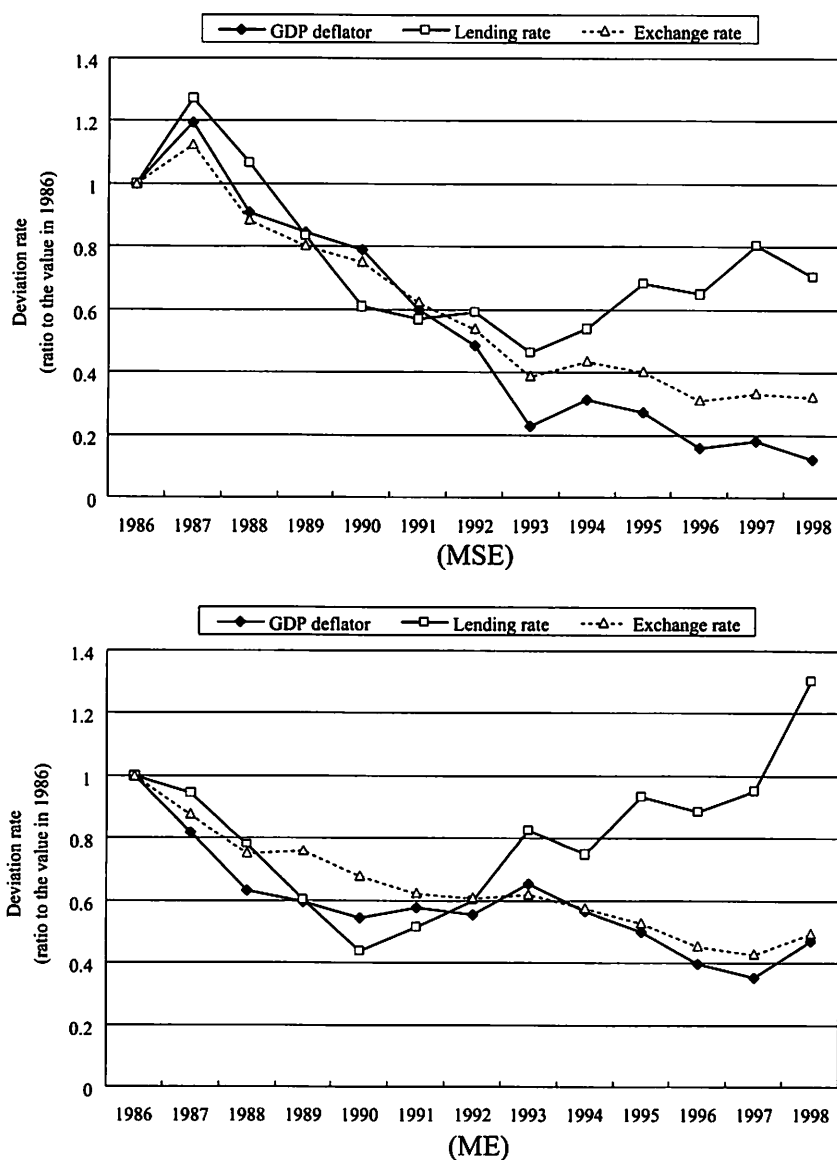
over time[7]. This implies that price rigidity has been prevalent in the Japanese economy since the burst of the bubble economy. The deviation rate for the lending rate derived from the MSE and ME models exhibits an upward trend since the burst of the bubble economy. Taking into consideration the continuous downward trend of the deviation rate for prices as well, this implies that the extent of the increase in the real lending rate due to the additional public investment is increasing over time. The deviation rate for the exchange rate derived from the MSE and ME models exhibits a continuous downward trend. According to the simulation results of the MSE and ME models, the exchange rate depreciates due to the additional public investment[8], because the increase in domestic interest rates is moderate due to the assumption of the fixed short–term interest rate whereas the increase in domestic prices is observed in implementing the additional public investment. Taking into consideration this result, the continuous downward trend of the deviation rate for the exchange rate implies that the extent of depreciation of the exchange rate due to the additional public investment is declining over time.

The continuous downward trend of the increase in prices due to the additional public investment suggests the possibility that the government investment multiplier is increased over time by the decreasing price adjustment effect. On the other hand, the upward trend of the increase in the real lending rate due to the additional public investment suggests the possibility that the government investment multiplier is decreased over time by the increasing crowding–out effect. Moreover, the continuous downward trend of the depreciation of the exchange rate due to the additional public investment suggests the possibility that the government investment multiplier is decreased over time by the increasing leakage–to–import effect. Considering the simulation result that the continuous downward trend of the government investment multiplier is moderated remarkably in the case where the price and monetary side is treated as exogenous, the upward trend of the crowding–out and leakage–to–import effects as described above contributes to the annual change in the government investment multiplier more than the downward trend of the price adjustment effect.

Next, in order to identify the factors causing these trends of the price and monetary side factors, i.e. the downward trend of the increase in prices, the upward trend of the increase in the lending rate, and the downward trend of the depreciation of the exchange rate, Table 5 shows the correlation coefficients between the deviation rate for GDP deflator, lending rate, or exchange rate derived from the MSE and ME models and the time series variable corresponding to its determinant factors. According to the results, the major factors causing these trends can be summarized as follows. First, the major factor for the continuous downward trend of the increase in prices due to the additional public investment is the continuous decline in operating ratio. This implies that the expanding supply–demand gap caused by the prolonged recession since the burst of

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[7] The empirical analysis using the ME model of the Japanese economy (Hori et al., 1998) reached the same conclusion, describing that the sensitivity of prices to the additional public investment was obviously declining in the 1990s as compared with the 1980s.

[8] This result is in line with the results derived from the previous studies that have analyzed the economic impact of the additional public investment with a fixed short–term interest rate (e.g. Hori et al., 1998).

Table 5: Correlation coefficients between the time series variable derived from the MSE and ME models and its determinant factors: the deviation rate for GDP deflator, lending rate, and exchange rate

|	Determinant factor	Correlation coefficient (MSE)	Correlation coefficient (ME)
Deviation rate for GDP deflator	Average operating ratio	0.906	0.449
Deviation rate for lending rate	Ratio of general government's net lending to nominal GDP	-0.397	-0.931
Deviation rate for exchange rate	Deviation rate for GDP deflator	0.996	0.944
	Deviation rate for long-term interest rate	-0.699	-0.258

the bubble economy contributes to the price rigidity in response to the additional public investment. Secondly, the major factor for the upward trend of the increase in the lending rate due to the additional public investment since the burst of the bubble economy is the continuous decline in the ratio of general government's net lending to the nominal GDP. This implies that the deteriorating fiscal circumstances caused by the steady implementation of large–scale expansive fiscal policy measures during the same period contribute to the upward trend of the increase in the lending rate in response to the additional public investment. Thirdly, the major factor for the continuous downward trend of the depreciation of the exchange rate due to the additional public investment is the downward trend of the increase in prices and the upward trend of the increase in interest rates as described above. The former corresponds to the appreciation of the equilibrium exchange rate derived from the theory of purchasing power parity and the latter means the increasing Mundell–Fleming effect.

5.3.3. Comprehensive analysis

The factor analysis in Section 5.3.1. does not reveal the reason for which only the government investment multiplier derived from the IO model does not exhibit a continuous downward trend. Thus, the following discussion attempts to identify the real side factors causing the continuous downward trend of the government investment multiplier derived from the MSE and ME models. For this purpose, Figure 11 shows the ratio of the value in the corresponding year to that in 1986 with regard to the government investment multiplier derived from the MSE and ME models using the case where the price and monetary side is treated as exogenous and where each of the final demand components that are likely to have a significant effect on the government investment multiplier, i.e. private final consumption expenditure (the factor corresponding to the induced effect through consumption expenditure), private capital investment (the factor corresponding to the induced effect through capital investment), and imports (the factor corresponding to the leakage–to–import effect), is also treated as exogenous.

As shown in these figures, in the case where the price and monetary side and imports are treated as exogenous, the continuous downward trend of the government investment multiplier is not observed at all. If the focus is limited to the real side factors, it is true that the continuous decline in the induced private capital investment makes

Figure 11: Ratio of the government investment multiplier in the corresponding year to that in 1986 derived from the MSE and ME models using the case where the price and monetary side and a certain final demand component are treated as exogenous

(MSE)

(ME)
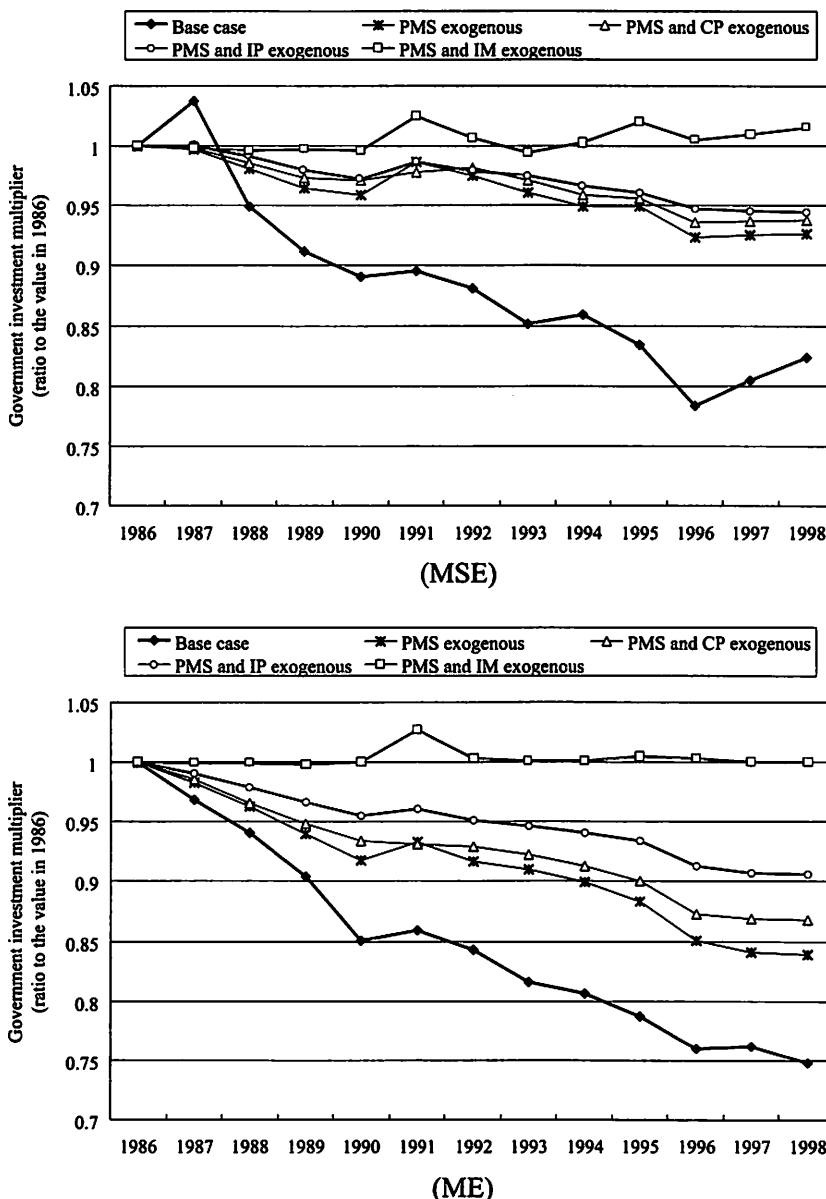
Notes: CP denotes the private final consumption expenditure, IP denotes the private capital investment, and IM denotes the imports.

the largest contribution to the continuous downward trend of the government investment multiplier as shown in Figure 6. However, this result implies that the continuous downward trend of the government investment multiplier is caused by the continuous increase in the induced overall imports in the first place and that this trend is then amplified by the decline in the induced domestic final demand components such as private

capital investment.

Taking into consideration this result, the following discussion attempts to identify the factors causing the continuous increase in the induced overall imports. The import functions in the MSE and ME models used in this study are a logarithmic linear function of domestic demand, relative prices, and foreign production ratio. According to the results of the analysis of structural changes, structural changes are not observed at all in the import functions. Foreign production ratio is given exogenously. Relative prices cannot be regarded as a contributing factor because the continuous downward trend of the government investment multiplier is observed even in the case where the price and monetary side is treated as exogenous. In addition, domestic demand does not cause the continuous increase in the induced overall imports because the simulation result that the government investment multiplier is declining over time means the continuous downward trend of the induced domestic demand due to the additional public investment. Therefore, it is considered that the functional form of the import functions, i.e. the import functions are formulated as a logarithmic linear function, causes the continuous increase in the induced overall imports. In order to analyze the annual change in the induced overall imports due to the additional public investment, it is necessary to focus on the annual change in the marginal propensity to import. The marginal propensity to import can be derived as the product of the domestic demand elasticity of imports and the average propensity to import (i.e. the import ratio) as given in equation (3).

$$\frac{\partial IM}{\partial Fd} = \frac{(\partial IM / IM)}{(\partial Fd / Fd)} * \frac{IM}{Fd} \tag{3}$$

where IM denotes imports and Fd denotes domestic final demand. The first term of the right side of equation (3) is the domestic demand elasticity of imports. In this study, this can be regarded as a constant term because the import functions in the MSE and ME models used in this study are formulated as a logarithmic linear function. Hence, the annual change in the marginal propensity to import corresponds to that in the second term of the right side of equation (3), i.e. the average propensity to import. Figure 12 shows the ratio of the value in the corresponding year to that in 1986 with regard to the average propensity to import and the induced overall imports derived from the MSE and ME models. Table 6 shows the correlation coefficients between the average propensity to import and the induced overall imports or the government investment multiplier derived from the MSE and ME models. As shown in this figure, the average propensity to import exhibits an upward trend and, as expected from equation (3), this trend is quite similar to that of the induced overall imports derived from the MSE and ME models over the simulation period. Furthermore, as shown in this table, there is a strong positive correlation between these time series variables and a strong negative correlation between the average propensity to import and the government investment multiplier derived from the MSE and ME models. These results imply that the marginal propensity to import exhibits a continuous upward trend in these models because of the introduction of the import functions of logarithmic linear type and that such an upward trend of the marginal propensity to import causes the continuous increase in the induced overall imports and the continuous decline in the government investment

Figure 12: Ratio of the value in the corresponding year to the value in 1986: the induced overall imports derived from the MSE and ME models and the average propensity to import
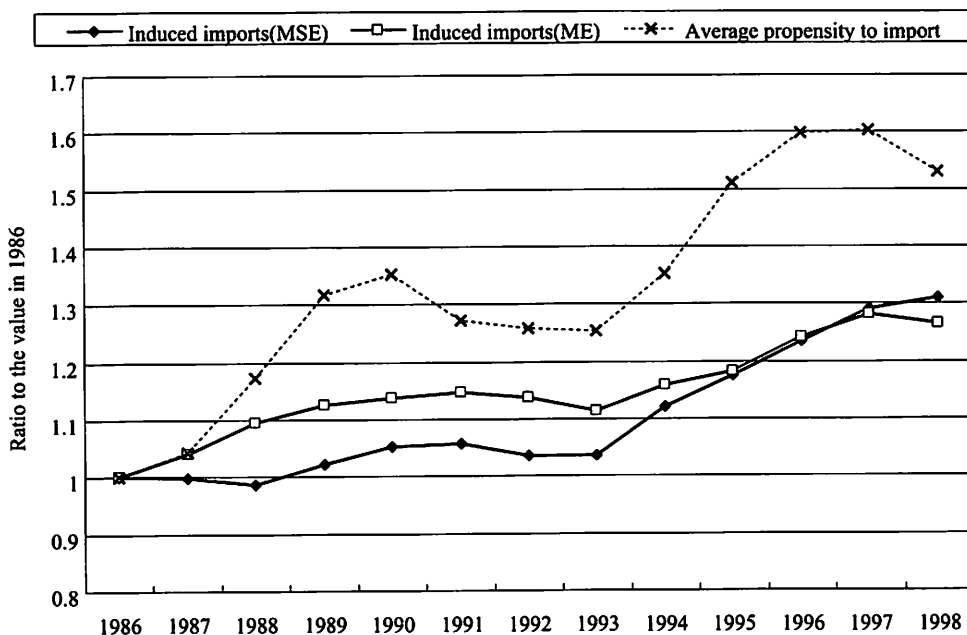

Table 6: Correlation coefficients between the time series variable derived from the MSE and ME models and the average propensity to import: the induced overall imports and the government investment multiplier

	Correlation coefficient (MSE)	Correlation coefficient (ME)
Induced overall imports - average propensity to import	0.889	0.965
Government investment multiplier - average propensity to import	-0.931	-0.924

multiplier.

Next, in order to confirm this hypothesis, Figure 13 shows the ratio of the value in the corresponding year to that in 1986 with regard to the government investment multiplier derived from the MSE and ME models using the case where the import functions are formulated as a linear function instead of a logarithmic linear function. It should be noted that the introduction of the linear import functions implicitly assumes the marginal propensity to import as a constant term. The policy simulations are carried out on the basis of the cases where the price and monetary side is treated as endogenous and exogenous, respectively.

As shown in these figures, as expected, the continuous downward trend of the government investment multiplier is not observed at all in the case where the import

Figure 13: Ratio of the government investment multiplier in the corresponding year to that in 1986 derived from the MSE and ME models using linear import functions

(MSE)

(ME)
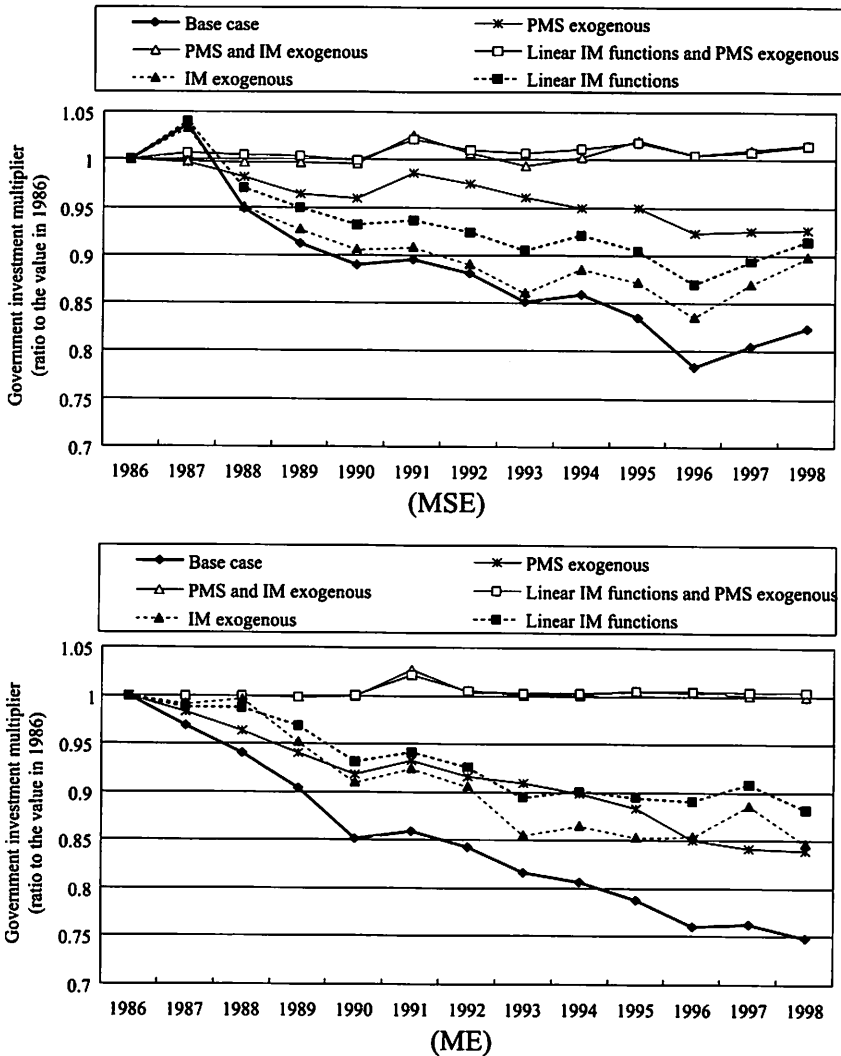
functions are formulated as a linear function and where the price and monetary side is treated as exogenous, similarly to the results of the case where the price and monetary side and imports are treated as exogenous. Therefore, it can be concluded that the continuous downward trend of the government investment multiplier is caused by the price and monetary side factors and the continuous upward trend of the marginal propensity to import. In addition, it can be argued that the government investment multiplier derived from the IO model does not exhibit a continuous downward trend though private capital investment and imports are endogenized in this model, because the price and monetary side is not considered at all in this model and because imports are defined for each commodity as the product of its import ratio and its domestic demand in this model.

On the other hand, the contribution of the real side factors (e.g. the upward trend of the induced overall imports and the downward trend of the induced private capital investment) to the continuous downward trend of the government investment multiplier can be compared with that of the price and monetary side factors by comparing the extent of the mitigation of the continuous downward trend of the government investment multiplier in the case where imports are treated as exogenous with that in the case where the price and monetary side is treated as exogenous. In the simulation results of the ME model, the contribution of the price and monetary side factors is almost the same as that of the real side factors. In contrast, in the simulation results of the MSE model, the contribution of the former is larger than that of the latter.

As described above, it is found that the functional form of the import functions has a significant effect on the annual change in the government investment multiplier derived from the MSE and ME models. Thus, the following discussion attempts to examine from a theoretical and empirical point of view whether or not the introduction of the import functions of logarithmic linear type is acceptable. From a theoretical point of view, the import function of logarithmic linear type can be derived from the theoretical model based on the cost minimization principle of firms where it is assumed that domestic and foreign raw materials are purchased so that the cost will be minimized under the constraint of their production function (Takagi et al., 1997). From an empirical point of view, according to the econometric theory, the P_E test is useful for making the choice of a functional form. In making a choice between a linear function (equation(4)) and a logarithmic linear function (equation(5)), the procedure of the P_E test is explained as follows (Greene, 1997).

$$H_0: \ y = x'\beta + \varepsilon \tag{4}$$

$$H_1: \ lny = ln\,(x)'\gamma + \varepsilon \tag{5}$$

The P_E test for H_1 as an alternative to H_0 is carried out by testing the significance of the coefficient $\hat{\alpha}$ in the regression defined as

$$y = x'\beta + \alpha[ln\hat{y} - ln\,(x'\beta)] + \varepsilon \tag{6}$$

The second term is the difference between predictions of y obtained directly from the logarithmic linear function and obtained as the logarithm of the prediction from the linear function. The roles of the two formulas are then reversed and H_0 is tested as the alternative. The compound regression is defined as

$$lny = ln\,(x)'\gamma + \alpha'[\hat{y} - exp\{ln\,(x)'\gamma\}] + \varepsilon \tag{7}$$

If the absolute value of the t-statistic for α in equation (6) is smaller/larger than that

for a' in equation (7), a linear/logarithmic linear function is accepted. Thus, this test is performed for every import function at the macro and commodity levels in the MSE and ME models used in this study. Table 7 shows the comparison of the absolute value of the t-statistic for a and a' derived from each of the import functions at the macro and commodity levels in the MSE and ME models used in this study. As shown in this table, the logarithmic linear import function is accepted for the macro level and for eight of 13 commodities. Therefore, it is almost justified from a theoretical and empirical point of view that the import functions of logarithmic linear type are adopted in the MSE and ME models[9].

Table 7: Results of the P$_E$ test for all the import functions at the macro and commodity levels in the MSE and ME models

	Absolute value of the t-statistic for α (linear model)	Absolute value of the t-statistic for α' (logarithmic linear model)
Macro level	1.62184	0.943590
Commodity level		
(1) Agriculture, forestry & fishery	0.700875	0.966678
(2) Mining	2.46597	1.83216
(3) Food & beverage	1.50650	2.76619
(4) Textiles	1.46188	0.256101
(5) Pulp, paper & paper products	1.18820	0.847019
(6) Chemicals	1.92814	1.66333
(7) Petroleum & coal products	0.522778	0.110244
(8) Non-metallic mineral products	0.510536	1.57257
(9) Basic metal	0.195801	0.471823
(10) Fabricated metal products & machinery	4.05701	0.828887
(11) Other manufacturing industries	4.13370	2.74072
(14) Transportation & communication	1.30848	0.534398
(15) Services & other tertiary industries	0.498036	0.903120

6. Concluding Remarks

Using the MSE, ME, and IO models developed on the basis of the same samples, this study quantitatively discussed the annual change in the government investment multiplier in the Japanese economy and analyzed the factors causing such a change in detail through the following process: (1) a comparative analysis of the simulation results taking into consideration the structural differences among these models; (2) a comparative analysis of the simulation results derived from the cases where a certain influencing factor is treated as endogenous/exogenous; and (3) a causality analysis focusing on the

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[9] The import function of logarithmic linear type has generally been adopted by the notable econometric models developed so far (e.g. Economic Council, 1996; Hori et al., 1998).

correlation between a certain influencing factor and its determinant factor. The MSE and ME models used in this study have several advantages. Most importantly, in order to consider the effect of the structural changes in households' and firms' behavior on the annual change in the government investment multiplier, structural changes were analyzed in detail in developing these models and they were reflected in these models using dummy variables. In addition, the MSE model explicitly considers almost all of the short-term economic impact paths of fiscal policy, i.e. the factors causing the change in the government investment multiplier, including the price and monetary side factors as well as the real side factors. The models with these characteristics can be the analytical frameworks suitable for the purpose of this study.

The major findings derived from this study can be summarized as follows. The government investment multiplier in the Japanese economy exhibits a continuous downward trend. The price and monetary side influencing factors make a significant contribution to its continuous downward trend such as the upward trend of the increase in real interest rates due to the additional public investment and the downward trend of the depreciation of the exchange rate due to the additional public investment, which are caused by the expanding supply-demand gap and deteriorating fiscal circumstances. Among the real side influencing factors, the continuous increase in the induced overall imports caused by the continuous increase in the marginal propensity to import and the continuous decline in the induced private capital investment caused by the continuous decline in the production inducement coefficient contribute to the continuous down-ward trend of the government investment multiplier. The structural changes that are likely to decrease the government investment multiplier are observed in the Japanese economy such as the decline in the marginal propensity to consume after the burst of the bubble economy and the decline in the output elasticity of labor demand during the financial system recession. However, it is found that these structural changes are rela-tively small and that they do not make a significant contribution to the continuous downward trend of the government investment multiplier.

In this way, this study could make it clear that the production inducement effect is the important factor causing the change in the government investment multiplier though it was not explicitly considered by the previous empirical studies that used the ME model. In this sense, it can be said that this study could provide the views that are dif-ferent from those of the previous studies for this controversial issue. In addition, it has been found that the specification of a behavioral equation such as its functional form would have a significant effect on the annual change in the government investment multiplier. This finding may be one of the points that should be kept in mind in ana-lyzing this issue using econometric models.

The major future issues can be summarized as follows. First, in order to discuss the annual change in the government investment multiplier more accurately, it is neces-sary to explicitly consider the process of economic agents' forward-looking expecta-tions formation by extending the model to a forward-looking model because it is often indicated that the forward-looking expectations/risks formed/recognized by households and firms are becoming increasingly important in the Japanese economy, as explained in the Ricardian equivalence theorem. This extension requires the extension to a long-term model and a detailed specification of the financial and assets market. Such a di-rection corresponds to the dynamics and micro-foundation of the macroeconomic

model where the behavior of economic agents is modelled on the basis of the dynamic optimization principle with the consideration of their future expectations. Secondly, besides its demand side effect (α-effect of public investment), an analysis of the annual change in the benefit of public capital (σ-effect of public investment) using a long-term model with the supply side of the economy taken into consideration in more detail may also provide important policy implications. Thirdly, it is necessary to test the findings derived from this econometric model analysis statistically, especially the causality with regard to the annual change in the government investment multiplier. For example, the Granger causality test is useful for this purpose.

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