AN EVALUATION OF MACROECONOMIC POLICIES IN GREECE WITHIN AN OPTIMAL CONTROL THEORY FRAMEWORK

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by

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ABSTRACT

This study evaluates the effectiveness of fiscal (and monetary) policies on a set of macroeconomic objectives, giving explicit consideration to the alternative modes by which the budget deficits (or surpluses) are financed. The extent to which quantitative reductions in the share of the public sector is compatible with these objectives is also examined. The evaluation of optimal macroeconomic policies is undertaken in the context of the Greek economy, since the financial aspects of the budget have not received the necessary attention. The method of analysis is carried out within an optimization framework which employes an econometric model of the Greek economy estimated over the period 1957-75, and a quadratic objective function depicting the desires of the policy-makers.

The specific characteristics of the Greek economy necessary for the construction of the econometric model and the specification of the objective function are discussed in Chapter 2. Chapter 3 deals with the theoretical considerations of the macroeconomic model and presents the optimization approach persued in the study. Chapter 4 presents the econometric model and discusses its dynamic characteristics and structure. The specification of the objective function and the optimization results are discussed in Chapter 5. The major findings of the study are summarized in Chapter 6.

CHAPTER 1

AIM AND METHODOLOGY OF THE STUDY

The achievement of certain short-term stabilization objectives, as it has been recently recognized, depends not only on the extent of government spending, but more importantly on the mode employed to finance budget deficits. Recent literature on economic stabilization policies focuses not so much on alternative fiscal and monetary policies, but on the financial aspect of the budget, giving explicit consideration to the government budget constraint[1]. It has been established by now that it makes a difference in terms of fiscal stimulus, whether the budget deficit is financed by creation of money, by sale of government bonds to the private or banking sector, or simply by the collection of higher taxes.

The problem of deficit finance has been associated, mainly by monetarists, with the size and growth of the public sector. Accordingly, the relative expansion of the public sector (basically administrative oriented) combined with its low productivity, absorbs a fair amount of funds, and curtails the expansion of the private sector (mainly market oriented and of relatively high productivity)[2]. The result is a drop in real output on a national scale from what it would otherwise be. Also, the 'excessive' expansion of the public sector generates inflationary pressures in the economy because of the difficulties involved in financing such spending. Following this argument, it has been suggested that a reduction of the share of the public sector in the economy is desirable, giving the necessary elbow room to the private sector to expand production, absorb more funds, and

thus cut down the rate of increase in prices.

The method of analysis in this study, employs a model of the economy, expressed in mathematical (quantitative) terms. The need for such a model results from the fact that, in considering macroeconomic policies, we must have in mind a clear image of the functioning of the economic system, and the way in which the various variables interact between each other, as well as the direction of causality of their relationship. In addition, in persuing macroeconomic policies, it is also worthwhile to have quantitative estimates of the interaction of the economic variables, rather than some 'feeling' of the way things develop. Therefore, macroeconomic policy considerations (formulations) are limited by the state of macroeconomic theory and our ability to folmulate it mathematically.

Despite the careful analytical examination the subject has received, most of the major controversial issues dividing the economists are still unresolved. It seems that the diversity of results stems from the fact that they are quite sensitive to minor alterations of the model specification and, therefore, the diversity of policy measures results from different conceptions of the functioning of the economic system. Furthermore, as the complexity of the model specification evolves, with the relaxation of linearity assumptions, analytical examination of qualitative effects exhibits diminishing returns, since most of the resulting effects become indeterminate in sign[3].

Compared to the abudance of theoretical papers of analytical examination of the efficacy of alternative policies,

there is a pausity of empirical investigations on the subject in general[4]. We think that it would be useful to see the degree to which theoretical considerations are supported by empirical evidence. The purpose, therefore, of this study is to evaluate the effectiveness of fiscal (and monetary) policies on a set of explicitly defined objectives, giving full considerations to the alternative modes by which the budget is financed. Accordingly, the optimal size of the public sector is derived and we also examine the extent to which a quantitative reduction in the public sector is compatible with some predefined objectives. The economy of Greece is chosen as an example of optimal policy evaluation.

In the case of Greece, unlike the case of other countries, the financial aspects of the budget have not received the necessary attention, since none of the econometric models of the Greek economy so far published have considered explicitly the interconnection of monetary and fiscal policies. As regards to the claim that the relatively fast growth of public spending prohibits the expansion of the private sector and, therefore, the growth of the economy, creating inflation at the same time, there has not been any supporting empirical evidence[5].

Before we conclude this introductory chapter, we shall comment on the methodology followed in this study in general terms, since it is a comparatively new way of analyzing economic phenomena, with clear advantages over techniques usually employed[6].

Traditional macroeconomic analysis focuses on one indicator of economic performance, usually national income,

and aims at evaluating the efficacy of alternative policies with respect to this sole target, the implication being that targets are complementary to each other rather than competing. This kind of analysis, although merited for its simplicity, is far from an accepable way of any realistic examination. A more acceptable analytical framework is to recognize the multiplicity of macroeconomic objectives and their contradictory character, because in reality, the problem policy-makers are faced with is to coordinate a multiple of objectives employing a set of policy instruments, assuming they have sufficient hold over them.

The traditional method of obtaining optimal policies is the 'simulation approach' to economic policy which relies on testing a number of arbitrarily selected policy actions seeking to determine their respective effects on policy targets. The optimal policy is arrived at by some independent mean evaluating these outcomes.

One of the difficulties of this approach is that the achievement of some desired behaviour for the targets might result in values of the instruments that are not feasible. Any trade-off problem between objectives will determine the degree to which the realization of these objectives is possible. Under those circumstances it is necessary to account for the trade-off between conflicting requirements on the targets and instruments of the economic system. This is accomplished by the introduction into the analysis of a criterion function which gives a unique set of values for the model variables, having the primary property of being feasible and satisfying the model equations together with the imposed constraint. In this way we arrive at a systematic method of calculating the quantitative effects of targets and instruments, that is, a

quantitative policy model.

By formulating a quantitative policy model it is possible to have simultaneous measurement of the quantitative effects of all targets and instruments. Quantitative policy models consist of two basic elements:

a) An econometric model depicting the working of economic system under consideration, and

b) A social welfare function representing the desires of the policy-makers.

Thus the economic policy problem amounts to the maximization of a welfare function subject to the econometric model.

Although the proposed mathematical framework is unavoidably somewhat restrictive its practical consequence for applied work is very useful. The imposition of a mathematical framework upon policy issues, as well as the employment of an econometric model inherently forces a variety of aspects of applied problems to conform to a set structure.

As regards the econometric model, it is understood that it exhibits spurious precision and there is always the temptation to treat it as more accurate and reliable than it is. However, its precision and explicitness exposes it to open critisism and its drawbacks can be easily detected.

On the other hand, the use of a welfare (or criterion) function implies that there is a consensus as to the preferences that are to govern the policy choice. This is the point where the problem of formulating a satisfactory social welfare function arises. Its specification has to provide for the preferences of the economic system as a whole, that is, of compromising between the interests of competing social groups. This fact might lead to the conclusion that a satisfactory representation of national welfare could not be easily arrived

at. However, the difficulty in formulating a criterion function does not deprive the optimization approach of any practical relevance to the policy problem. The important contribution of the optimization approach lies in the fact that the derived optimal policies depend upon the shape of the social function and are evaluated against it. Obviously, a different shape of the objective function will result into a different set of optimal policies.

In addition, the introduction of an objective function which penalizes deviations of the targets and instruments from some desired paths results in a more efficient generation of feasible trajectories. In contrast to the 'simulation approach' the explicit optimization technique, starts with some arbitrarily determined preferences among outcomes and seeks to obtain the optimal feasible policy. Given the underlying constraints, this policy is unique among other policies. It thus becomes possible to hit the desired targets using fewer experiments. Furthermore, because of the resulting increase in computational efficiency various alternative paths can be generated and compared.

Finally, variation in the weighting specification of the objective function generates alternative policies and their consequencies are examined and analyzed. By the exploration of a range of possibilities we discover the extent to which the economic path we try to follow is feasible or if it has in fact been well selected. Whatever form of criterion function is employed it always pays to explore the consequences of varying it since the resulting increase in computational efficiency of the optimization approach makes it relatively easy to do. This kind of experimentation allows

us to discover the constraints which the model implies for the achievement of desired policies. The behavioural equations of the model are individually specified and although the endogenous variables might trace their actual path satisfactorily, there might be deficiencies in the interconnection of variables in the whole model. These model deficiencies are brought about when the model is driven to some extreme situation by varying the specification of the objective function. The consequences are felt on the model components and hence the dynamic properties are highlighted and the drawbacks detected. Any policy effects which because they were absent in the data were not considered in the specification of the model are brought to our attention. So, in effect, the optimization approach tells us as much about the properties of the econometric model, as about the optimal economic policies we ought to follow.

The results indicate that the cyclical fluctuations in aggregate economic activity can be reduced and its level increased, provided we are prepared to expand the budget adequately and undertake discretionary fiscal action. Bond financing seems to be more expansive with respect to income in the sixties, compared to money financing, which is superior in the seventies. Bond financed deficits are also preferred with respect to the stabilization of economic activity, over the whole planning horizon. Although a trade-off between inflation and the rate of change of income is revealed by the results, the objective of reducing the pace of inflation to acceptable levels, is unattainable, unless we are prepared to depress the economy.

The optimal policies call for an increase in the share of the public sector in the economy. An objective of reducing it is incompatible with the other macroeconomic objectives of price stability and fast and steady growth in real income. A policy of reducing the share of the public sector results in a reduction of economic activity, without achieving any substantial decceleration in the rate of inflation.

The study is organized as follows:

Chapter 2 deals with the specific features of the Greek economy and describes the development of the major macroeconomic magnitudes. This information is necessary for the subsequent construction of the macroeconomic model for Greece (Chapter 4) and the specification of the objective function (Chapter 5).

Chapter 3 is devided into two parts. Part one sets out the recent developments in macroeconomic analysis. The consequences of the various modifications to the macroeconomic model, highlighting the importance for the inclusion to the model of the government budget constraint, are discussed. In the second part the particular optimization approach followed in this study is formally presented. Further problems associated with the specification of the objective function and the planning horizon are also discussed.

Chapter 4 presents the construction and estimation of the econometric model of the Greek economy. The particular equations describing the model are discussed, together with the performance of the model as a whole and its dynamic properties.

Chapter 5 describes the specification of the objective function and the way the policy evaluation experiments were conducted. The resulting outcomes of optimal policies throughout the optimization period (1966-1975) are presented in detail, and the policy implications are traced out.

Finally, the conclusions derived from the whole study are sumarized in Chapter 6.

Notes to Chapter 1

1. See for example, Christ (1967, 1968, 1969).
2. See Taylor (1979).
3. See Turnovsky (1977).
4. For a survey see Chounhdry (1976).
5. The subject has been taken up by the press and is generally discussed in broad terms. See among others, 'The Guilty Sector' in the Greek daily Express (28/10/79) and the review article by Fakiolas (1980); Bacon and Karayiannis-Bacon are concerned with the longer term prospects of the Greek economy.
6. See the Report of the Committee on Policy Optimization (1978) and the comments by Johansen (1979) and Shupp (1979).

CHAPTER 2

AN OVERVIEW OF THE GREEK ECONOMY

The purpose of this chapter is to provide some information on the development of the most important elements in the Greek economy in the postwar period and in particular during the sample period 1957-1975. Although a more complete elaboration is beyond the scope of this study, we think that this brief discussion will give insights into the special features of the economic structure in Greece. The relevant information contained will be of help in understanding the logic of the building of the econometric model for Greece, presented in chapter 4 below, as well as the conducted optimal control experiments discussed in chapter 5.

2.1 Developments of Gross National Product and Expenditure

In the period 1950-75, Gross National Product increased at an annual growth rate of 6.3%. However, the growth rate was not uniform throughout the period, ranging from 5.8 % in the fifties to a high 7.2% in the sixties, falling to 5.6 % in the years 1970-75. The major production sectors, although they followed similar patterns of growth - the fastest pace recorded in the period 1960-70 - they differed significantly in magnitude. As a consequence, the relative contribution of the major sectors of GNP was altered over the years (Table 2.1).

The primary production sector registered growth rates (4.1% on average) much lower to that of GNP. Its contribution to GNP followed a declining trend from 27.7% in 1950 to a 16.3% in 1975. The secondary production sector , on the other hand, was the fastest growing (8.2% on average). Its substantial

expansion, from 20% of GNP in 1950 to over 30% in 1975, counterbalanced the contraction of the primary sector[1]. The tertiary production sector, although it expanded at rates higher than those of GNP, maintained its contribution to around 50%.

TABLE 2.1

GROSS NATIONAL PRODUCT DEVELOPMENTS (1970 prices)

	(%) contribution				growth rates		
	1950	1960	1970	1975	50/60	60/70	70/75
1. Primary Sector	27.7	22.7	17.9	16.3	3.8	4.7	3.6
2. Secondary Sector	20.0	25.4	30.7	31.1	8.4	9.3	5.8
3. Services							
a) Transportation communication	7.1	6.5	7.5	8.3	4.9	8.8	7.8
b) Trade-banking real estate	12.1	12.7	14.1	14.7	6.3	8.4	6.5
c) Ownership of dwellings	10.6	9.3	8.0	8.4	4.4	5.7	6.6
d) Other	22.0	21.8	19.7	19.0	5.7	6.1	4.8
4. G.D.P.	99.5	98.4	97.9	97.8	5.7	7.2	5.6
5. Net income from abroad	0.5	1.6	2.1	2.2	18.1	10.3	6.8
6. G.N.P.	100.0	100.0	100.0	100.0	5.8	7.2	5.6

Source: National Accounts of Greece (1976).

The result of this structural reorientation is the consequence of the industrialization process, in the course of which, the productive capacity of the economy widened[2]. The emphasis shifted from agriculture to manufacturing production suitable for exports. The reduction in size of the primary sector had also important implication in the cyclical fluctuations of economic activity. After the mid-sixties, the so-called 'two-year cycle' of agricultural production associated with the every other year fruition of olive trees was reduced, thus affecting less severely the developments in GNP. In a way, development in agricultural production were disentangled from the developments in the rest of the economy.

The developments of the finance of Gross National Expenditure of the economy are shown in Table 2.2.

TABLE 2.2

GROSS NATIONAL EXPENDITURE DEVELOPMENTS (1970 prices)

	(%) contribution				growth rates		
	1950	1960	1970	1975	50/60	60/70	70/75
1. Gross Nat. product (market prices)	87.9	95.9	94.0	95.1	6.2	7.7	5.1
2. Net Borrowing & Transfers from Rest of World	12.1	4.1	6.0	4.9	-5.8	12.2	0.7
Means for financing the Economy	100.0	100.0	100.0	100.0	5.3	7.9	4.9
3. Consumption	90.6	81.3	74.1	78.6	4.2	6.9	6.1
a. Private	77.0	67.8	62.4	64.9	4.0	7.0	5.7
b. Public	13.6	13.5	11.7	13.7	5.2	6.3	8.3
4. Gross Asset Form.	18.0	19.2	21.8	18.2	6.0	9.3	1.1
a. Enterprises	10.7	12.7	15.7	13.1	7.1	10.2	1.1
b. Public	7.3	6.5	6.1	5.1	4.2	7.3	11.1
5. Change in Stocks		-0.5	4.1	3.2	-	-	-
Gross Expenditure	100.0	100.0	100.0	100.0	5.3	7.9	4.9

Source: National Accounts of Greece (1976).

The share of total investment including stock-building, is on an ascending trend, with growth rates well above the average in the fifties and sixties, deccelarating in later years. The contribution of consumption (over 60% of the total) continually decreases, its growth rates being below average except in the years 1970-75. The development of the various components are discussed in detail in following sections (section 2.4 onwards).

2.2 Employment

After the end of World War II, the Greek economy was characterized by a chronic and massive unemployment and underemployment, estimated at about 15-25% of the total active population. It is difficult to obtain an accurate picture of the degree of unemployment in Greece, because the relevant

indicators are not accurate[3]. This is due to certain structural characteristics of Greece, mainly the large agricultural sector with a high degree of underemployment, the large share of self-employed and the numerous small scale establishments in private non-farm employment.

According to 1961 Census, unemployment or underemployment affected 23.6% of the total work in force. In the sixties, this figure was reduced to 15%, according to the 1971 Census. These figures indicate that the problem of unemployment was substantially reduced. However, this is not so much attributed to the creation of employment creating oportunities, but to large scale emigration which took place in the fifties and sixties[4].

Regarding employment, an increase in absolute and relative number of people employed in the secondary section was observed, a large proportion of which (about one third) is employed in construction. As a consequence, employment in agriculture fell significantly. Extrapolations of the 1961-71 censuses figures indicate a further decline to about 30% of the agricultural population in 1977[5].

Generally, the pattern of demand (especially in the late sixties and seventies) favoured labour intensive sectors, notably construction and services. Between 1960-70 non-agricultural employment increased by 3.25%, of which 1.6% was attributed to industrial employment and 4.8% to construction, compared to a 3.7% increase in employment in services. A related point to the increase in services is the fact that the State provided for employment to a large number of those who were leaving the countryside and wanted to be employed elsewhere

2.3. Prices

Up until 1953 the Greek economy experienced high rates of inflation of the order of 10-12%, which was the result of excessive demand due to the inability of the economy to increase the supply of resources. The past experience of hyperinflation of the War period made people sensitive to inflation and they were reluctant to divert funds to productive investment activities. During that period hoarding in gold sovereigns and investment in real estate was substantial.

In 1953 the domestic currency was devaluated by 50% and the pace of inflation started to deccelerate, and in the period 1954-56 prices rose by only 4% on average. By the mid-fifties, when the results of the devaluation worked themselves out, prices rose by only 2% on average. Since then, and up until the mid-sixties, Greece experienced a remarkable price stability. The confidence of the public to the domestic currency was restored and the private deposits with the commercial banks rose remarkably. Hoarding was reduced and the credit needs of the economy were thus satisfied without resorting to the Bank of Greece.

Towards the end of the sixties inflation rates started rising again, due to pressures on prices from the supply side (readjustments in the factors of production costs), and also demand pressures as a result of rising incomes due to rapid economic growth. Excess demand was to a large extent satisfied by increases in imports, which led to the importing of inflationary factors, reinforced by adverse economic disturbances internationally. The sharp

rise in prices abroad in 1973 affected the domestic prices severely and the Greek economy was faced with price increases well above to those of other countries.

Price differentials showed relative stability over the sample period, as it is indicated by Table 2.3 below (where P_y, P_c, P_i and P_h denote the implicit price deflators of income at factor cost, private consumption, private fixed business investment and investment on housing respectively).

TABLE 2.3

PRICE DEVELOPMENTS (1970 prices)

Year	P_y	P_c	P_i	P_h	P_c^*
1958	.698	.768	.656	.671	.783
1959	.698	.758	.700	.646	.802
1960	.725	.790	.721	.681	.814
1961	.734	.800	.724	.681	.830
1962	.770	.821	.795	.726	.827
1963	.778	.829	.815	.727	.850
1964	.812	.861	.820	.739	.885
1965	.847	.900	.835	.781	.929
1966	.888	.940	.885	.865	.945
1967	.914	.936	.910	.878	.947
1968	.931	.947	.927	.879	.948
1969	.961	.971	.934	.908	.972
1970	1.000	1.000	1.000	1.000	1.000
1971	1.032	1.026	1.067	.998	1.030
1972	1.087	1.065	1.181	1.087	1.074
1973	1.303	1.264	1.357	1.359	1.241
1974	1.597	1.617	1.649	1.750	1.575
1975	1.778	1.835	1.907	1.855	1.786

Source: National Accounts of Greece (1976); with the exception of P_c^* which is obtained from the National Statistical Service Bulletin.

2.4 Private Consumption

The rate of growth of total private consumption expenditure in the post-war period (5.5%) was lower than that of GNP (6.5%), thus allowing for inducement of savings to finance the growth of capital formation in the country. Its growth rate, however, was not uniform over the period, ranging from a 4.0% in the fifties to a 7.0% in the sixties, falling back to a 5.7% in the years 1970-75. Looking at the individual components of private consumption certain changes can be detected, illustrating changes in consumers' preferences, (Table 2.4).

TABLE 2.4

DEVELOPMENT OF TOTAL PRIVATE CONSUMPTION (1970 prices)

	1950	1960	1970	1975	growth rates 1960/70	1970/75
1.Food	46.1	43.0	35.8	33.2	4.8	3.5
2.Beverages	4.3	3.4	3.2	3.4	6.0	6.8
3.Tobacco	3.7	3.9	3.5	3.8	5.6	6.9
4.Clothing- footwear	8.4	9.1	13.0	13.3	10.5	5.6
5.Rent-water charges	12.4	12.5	11.9	12.8	6.2	6.6
6.Fuel-light	1.7	2.0	2.4	2.6	8.4	6.6
7.Furniture-furnishings	1.7	3.6	4.8	5.2	9.9	6.6
8.Household operation	5.4	4.2	4.0	4.0	6.1	5.5
9.Health-personal exp.	4.1	3.6	4.8	5.2	10.0	3.6
10.Transportation	3.9	5.5	7.2	8.7	9.7	9.0
11.Communications	0.2	0.6	1.2	1.9	14.6	15.6
12.Recreation	5.5	6.3	7.5	7.3	8.6	4.5
13.Education	1.5	2.1	1.6	1.5	3.6	3.6
14.Miscellaneous	1.0	1.1	1.1	1.0	6.9	2.2
Priv. domestic cons.	99.9	100.9	102.0	103.2	6.8	5.3
15.Exp. of residents abroad	0.3	0.6	0.8	1.1	9.8	11.9
16.Less: Exp. of non-residents	0.2	1.5	2.8	4.3	13.8	14.5
Total priv. cons.	100.0	100.0	100.0	100.0	6.7	5.0

Source: National Accounts of Greece (1976).

There is a falling tendency of the consumption of food, while the share of clothing-footwear, furnishings, travel-transportation and recreation-entairtainment is constantly increasing at fast pace, especially in the sixties. The share of services is low, depicting the fact that some of the provisions are made by the State. The overall picture of private consumption has the tendency to resemble more to that observed in developed countries, where a larger portion is devoted to activities other than the basic needs (Table 2.5).

TABLE 2.5

PERCENTAGE COMPOSITION OF PRIVATE CONSUMPTION BY CATEGORY OF CONSUMPTION GOOD (1970 prices)

	1960	1965	1970	1975
1. Durables	3.2	4.0	4.6	5.8
2. Semi-durables	11.3	13.6	15.3	15.6
3. Non-durables	55.6	53.1	49.4	47.8
4. Services	29.9	29.3	30.7	30.8
Total priv. cons.	100.0	100.0	100.0	100.0

Source: National Accounts of Greece (1976).

The share of durable goods is relatively small but increasing at a fast rate. This is largely explained by the increased expenditure for the aquisition of private cars, whose percentage contribution in the expenditure on durables rose from 2.5% in 1960 to 21.6% in 1975. With the exception of non-durables, the other categories indicate an upward development.

The ratio of private consumption to disposable income has been falling over the years[6], indicating that the above mentioned developments in the composition and growth of consumption are related to other factors, as well as to the disposable income. As a result of urbanization, the composition and source of incomes has changed, since the proportion of urban population and their incomes has increased. Further -

more, any fall in consumption due to emigration has been counterbalanced by the emigrants' remittances, which increase the demand of consumption goods (especially durable goods)[7].

The increased level of consumption expenditure in the period 1970-75 is attributed to consumption habits aquired in the past (especially in the late sixties when incomes were growing at fast rates) and carried over at times not justified by the levels of disposable incomes[8]. In addition, the prevailing circumstances of uncertainty regarding future price developments, gave rise to a substantial stockpiling, being regarded as a defence for their money incomes. This development, however, is expected to have contradictionary effects on consumption in later years.

2.5 Private Investment

The rate of growth of investment expenditure, in the post-war period, was higher (6.3% on average) than that of gross national product. It displayed similar developments to those of private consumption mentioned above. The higher growth rate was achieved in the sixties (9.3%), compared to 6.0% in the fifties, falling down to a mere 1.1% in the period 1970-75. Public investment, consisting of about 30% of the total over the period, increased at somewhat lower rates.

The percentage composition of gross fixed investment by sector of economic activity (Table 2.6) does not reveal any dominant increasing or decreasing trends over the years. The proportion of the individual components is altered according to the directives of Government policy, reflecting the changing conditions of the domestic market and the economic developments in relation to the rest of the world. This can

also be deduced from the decomposition of investment by type of capital good (Table 2.6), where about 50% of investment is absorbed by housing (Items II.1 & II.2), in the period of reconstruction. In later years, however, the emphasis was shifted towards the production of goods for the domestic market, the development of manufacturing and the sectors of transportation and communications[9].

TABLE 2.6

PERCENTAGE DISTRIBUTION OF GROSS FIXED INVESTMENT BY SECTOR AND TYPE OF CAPITAL GOOD (1970 prices)

	1951-60	1961-70	1971-75
I. Distribution by sector			
1. Agriculture-fishing	12.3	12.2	9.9
2. Mining-quarrying	1.6	1.4	0.8
3. Manufacturing	14.0	12.7	15.8
4. Electricity-gas	10.0	8.7	9.1
5. Transportation	12.4	19.3	20.3
6. Dwellings	35.4	30.6	28.5
7. Public Administration	2.1	0.9	2.0
8. Other services	12.2	14.2	13.6
II. Distribution by capital good			
1. Dwellings	35.4	30.6	28.5
2. Other Buildings	12.9	14.0	14.0
3. Other Construction	22.3	24.9	22.0
4. Transportation	5.0	8.4	9.1
5. Other Equipment	24.4	22.1	26.4
TOTAL	100.0	100.0	100.0

Source: National Accounts of Greece (1976).

Regarding investment policy over the period, there was not any definite direction towards employment creating activities, the net result being massive emigration of the most dynamic section of the labour force. In the absence of a more determined policy of industrial development, the authorities employed housing investment (a capital intensive activity) as a means of maintaining the economy on a high growth

path. This was achieved through credit restrictions/easening and fiscal measures.

The post-war housing boom, mainly explained by economic and demographic reasons, was reinforeced by the prevailing social attitudes and traditions. Consequently, the rate of return on capital invested in real estate has been superior to that of almost all other forms of assets. The induced speculative forces have diverted capital and enterpreneurial initiative from productive activities and especially away from manufacturing, which is expected to have adverse repercussions in the industrial development in the future[10].

As regards the financing of gross investment, the percentage contribution of savings is shown in Table 2.7.

TABLE 2.7

PERCENTAGE CONTRIBUTION OF SAVINGS
FINANCING GROSS INVESTMENT (current prices)

	1951-60	1961-70	1971-75
1. Domestic financing	81.1	86.7	88.9
a. Public	10.8	16.8	9.2
b. Private	70.3	70.1	79.7
2. Foreign financing	18.9	13.3	11.1
TOTAL	100.0	100.0	100.0

Source: National Accounts of Greece (1976).

The contribution of public financing is increased in periods of active fiscal policy to accentuate economic development. In the period 1970-75, however, the financing from public sources has been halted in the effort to reduce the expenditure side of the budget and curtail inflation. In these circumstances the burden of financing of investment projects has fallen on the private sector. Foreign financing follows a decreasing trend; we return to this later.

Greek industrial enterprises depend to a great extent on external sources of finance. According to a survey by the Bank of Greece[11] on a number of manufacturing firms, borrowed funds exceeded 70% of total liabilities in the three years 1958, 1966, and 1975, while their own capital accounted for less than 30% (Table 2.8).

TABLE 2.8

GREEK MANUFACTURING: PERCENTAGE DISTRIBUTION OF BORROWING

Year	No of firms	Own Capital	borrowing			total liabil.	Bank borrow.	other
			Short	Long	Total			
1958	216	27.4	55.7	16.9	72.6	100.0	58.7	41.3
1966	204	29.9	58.5	11.6	70.1	100.0	59.0	41.0
1975	189	29.1	43.2	27.7	70.9	100.0	52.8	47.2

Source: D. Halikias (1978), p.141.

The ratio of these enterprises' own capital to borrowed funds is considerably lower in Greece than it is in other industrial countries, where internal sources of finance are the most important providing in many cases as much as 50% of the total funds employed in industry[12]. Another point that emerges from Table 2.8 is that Greek industrial firms are employing short term borrowing to a greater extent. This is partly related to the relatively small size of Greek firms, implying that they lack creditworthness and hence long-term borrowing is not easily accessible to them[13]. The fact that bank lending is substantial compared to other sources of finance may be due to the underdeveloped character of the Greek capital market.

The financing of gross fixed investment from foreign sources consists basically of remittances of sailors' and emigrants' foreign borrowing in the form of suppliers' credit and finally, direct foreign capital to finance business investment, mainly under the decree 2687/53. It was not until the

late fifties and early sixties that foreign capital, under the law 2687/53 and subsequent legislation came into the country on a large scale and had a considerable impact on the structure of the economy, not because of its size, but because of its orientation. In view of the fact that Greek capital was unwilling or unable to operate in the manufacturing sector (preferring more profitable and less risky activities), foreign investment was directed towards those key industries like chemicals and metallourgy, which can contribute most to the widening of the industrial base[14].

2.6 Balance of Payments

In the process of economic development, the broadening of the domestic market is attributed to a great extent to the broadening of the foreign market. Foreign trade increased substantially in the post-war period (Table 2.9).

TABLE 2.9

FOREIGN TRADE DEVELOPMENTS (million $)

Year	imports	exports	exp/imp	balance of trade
1958	509.8	242.8	47.6	-267.0
1965	1016.5	330.9	32.5	-685.0
1970	1696.1	612.2	36.1	-1083.9
1973	4030.8	1230.5	30.5	-2800.3
1974	4635.2	1774.1	38.3	-2861.1
1975	4876.1	1960.1	40.2	-2916.0

Source: Bank of Greece, Monthly Statistical Bulletin (various issues).

Among the reasons accounting for this is the low degree of self-sufficiency in raw materials and fuel, the small domestic market, the low industrial base of the economy, as well as the over supply of agricultural products.

Both imports and exports increased by about ten times over the period 1958-75. The fast growth of imports in the late fifties and early sixties was the result of the process of rapid industrialisation resting on imported capital goods and technical equipment as well as on consumption goods, a fact reflected in the fast growth of capital formation. The accelerated growth of imports in the period 1973-75 reflects the responsiveness of Greek imports to the fluctuations of the world and domestic markets, and is indicative of the high degree of dependance of the economy on foreign developments. In terms of volume, however, imports decreased after 1973 due to the fall in domestic activity in 1974 and also due to accumulated stocks of foreign origin in previous periods.

The most considerable development in exports was the increased pace and percentage share of industrial exports which became the largest sector of the economy. Greek exports ceased to depend on a small number of agricultural products, the demand and quality of which are more or less related to the prevailing weather conditions and they have a low income elasticity in the markets abroad[15].

As regards to imports, a large proportion consists of machinery, transportation and other equipment of vital importance for the development of production and capital formation. This fact influences in a positive manner the modernization of production and consequntly the composition of exports. At the same time, however, the share of the above mentioned products in total exports is insignificant, the net result being a growing deficit in the balance of trade.

One of the main deficiencies of the balance of trade

is its chronic deficit, the increase of which over the years is related to the structural underdevelopment of the economy and its weak competitiveness. The accelerated deterioration in the trade deficit in the years 1973-75 is due to boyant demand in foreign markets and the increase in world prices [16]. This persistent deficit in the trade balance would have been able to overturn the internal and external balance of the economy, without the sizeable external inflows received from abroad[17], (Table 2.10).

TABLE 2.10

SIMPLIFIED PRESENTATION OF BALANCE OF PAYMENTS*

Category	1958	1965	1970	1972	1973	1975
imports (cif)	492	976	1696	2407	4031	5066
exports (fob)	243	331	612	836	1231	2030
Trade Balance	-249	-645	-1084	-1571	-2800	-3036
invisible receipts	218	549	949	1606	2195	2725
invisible payments	48	137	267	402	570	765
Balance on Invisibles	170	412	682	1204	1625	1960
Balance on Current a/c	-79	-233	-402	-368	-1175	-1075
Capital Movements(net)	35	182	375	841	1035	1140
Clearings & Barter a/c	-	-6	6	-24	-11	-31
Official Reserves (changes)	-21	-31	-7	501	12	7

Source: Bank of Greece, Monthly Statistical Bulletin (various issues).

* All variables are in millions of current US dollars.

It is apparent that the substantial invisible reiceipts provide for Greece an additional source for economic development. In terms of foreign exchange they diminish the balance of payments constraint creating favourable conditions for the expansion of domestic output. Without these funds, Greece would have had to cut down vital consumer goods and capital goods imports and hence, deccelerate its economic growth.

The large current capital transfers received from abroad basically consist of remittances of Greeks working abroad and tourist receipts. In the period 1960-76 total receipts in foreign currencies associated with emigration and shipping activities amounted to about 7% of GNP on average. Of this amount 3½-4% was received in the form of wages and salaries, pensions and emigrants' remittances. In addition to this, about 1¼% of GNP on average since 1960, is sent by Greeks working abroad for the purchase of real estate in Greece. Tourism contributed about 1⅓% of GNP on average over the period. In contrast, the contribution of direct inflow of foreign investment (under Law 2687/53 etc.)[18], while important being directed to the most dynamic industries, was quantitatively smaller if netted out of capital repayments and profits.

Besides its distinct advantages, the inflow of foreign exchange creates disadvantages, mostly affecting the longer term development of the economy. Although it is difficult to evaluate alternative senarios in the absence of foreign exchange receipts, the direction of development would have been towards more endogenous growth and the exceptional sensitivity of the Greek economy toward developments would have been less important. The high external value of the domestic currency encouraged the import trade and especially the importation of nearly all machinery, which led to the development of a capital intensive industry. Furthermore, the high parity of drachma makes the domestic industry and exports less competitive abroad[19] and increasing industrialization brings about a more than proportional increase in imports, screening out the expansion of a wider industrial base.

2.7 Public Sector

The main objective of fiscal policy up to mid-fifties was to meet the problem of balancing the ordinary budget. The originating inflationary pressures in the period of reconstruction, found their main outlet through the gradually reducing provision of US aid.

After 1957, fiscal policy aimed at increasing the budget surpluses and securing the means of financing an extensive government investment program. The achievement of this task was made possible through the mobilization of savings, which accomodated the capital needs of the private sector reducing inflationary pressures. The aim of official tax policy was to create government savings through increases in revenue and a more equitable distribution of tax burden[20].

TABLE 2.11

TAX REVENUE DEVELOPMENTS (current prices)

	1950	1960	1970	1975
Indirect / Total Tax Rev. (%)	67.5	60.9	59.0	57.7
Direct / Total Tax Rev. (%)	32.5	39.1	41.0	42.3
Indirect / Direct Tax Rev(ratio)	2.0	1.6	1.4	1.3
Total Tax Rev./ Total Rev. (%)	89.6	88.0	90.7	89.8
Inirect Tax Rev. / GNP (%)	10.7	13.0	16.8	16.0
Direct* Tax Rev. / GNP (%)	5.2	8.3	11.7	11.8
Total Tax Rev. / GNP (%)	15.9	21.3	28.5	27.8

Source: National Accounts of Greece (1976).
* Excluding property taxation amounting to around 7%; GNP is at factor cost.

Around 90% of public revenue originates from taxation (Table 2.11). A specific characteristic of the Greek tax system is that the ratio of indirect to direct tax yields is high. After 1960, this ratio falls substantially due to a series of amendments in tax legislation introduced towards the

end of the fifties. These amendments aimed at simplifying tax collections, increasing the yield of income tax and reducing spending on luxury articles (mainly imports)[21]. Although there is a falling tendency of the indirect to direct tax ratio over the period, the tax system has not moved towards a greater reliance on direct taxes, considering the inflation conditions in 1970-75[22]. As regards the total tax burden, although it has improved somewhat, it remains low compared to those of other countries[23].

The fiscal policy in Greece was not very successful in formulating a more equitable tax system either, since the tax structure increases (instead of improving) the inequality of income distribution. Among the reasons of such a redistributional impact is the regressive effective tax rates of almost all consumption taxes, the extensive tax evasion located mainly in high income levels and the great number of special tax privileges to various persons and social groups[24].

Public current expenditure developments are shown in Table 2.12 below.

TABLE 2.12

PUBLIC CURRENT EXPENDITURES

	percentage composition				growth rates		
	1950	1960	1970	1975	50/60	60/70	70/75
1. Total Gov. Exp.	100.0	100.0	100.0	100.0	11.0	13.6	22.6
a) Gov. Cons.	64.5	69.8	59.7	60.3	11.9	11.6	22.0
b) Other Exp.	35.5	30.2	40.3	39.7	9.3	16.9	21.0
2. GNP (market pr.)					12.5	11.0	17.9
3. Total Gov. Exp./GNP	18.8	16.5	20.8	24.5			
a) Gov. Cons./GNP	12.1	11.5	12.4	14.7			
b) Other Exp./GNP	6.7	5.0	8.4	9.7			

Source: National Accounts of Greece (1976).

The share of total government expenditure on GNP has been constantly increasing since 1960. This trend is observed not only in the case of current expenditures on goods and services, but also in the case of 'other current expenditures', which consists mainly of unilateral public transfers to individuals whose income rises. The growth rate of this item is the fastest during the sixties (16.9%), substantially higher to those of either expenditure on goods and servises or the national product. The low growth rate in the fifties (9.3%) is due to the increased share of war pensions and extended expenditure program in the period of reconstruction.

TABLE 2.13

PERCENTAGE COMPOSITION OF PUBLIC EXPENDITURES ON GOODS & SERVISES

	1950	1960	1970	1975
a. Functional (civil-defence)				
1. Defence	44.8	38.0	36.7	44.5
2. Civil	55.2	62.0	63.3	55.0
b. Goods-Wages & Salaries				
1. Wages and Salaries	65.2	73.8	73.3	63.9
2. Purchasing of Goods	34.8	26.2	26.7	36.1
TOTAL	100.0	100.0	100.0	100.0

Source: National Accounts of Greece (1976).

Regarding the functional composition of government expenditure, defence absorbs over half of the total. Its increased share in 1950 and 1975 was due to the acquisition of military equipment after the war and after the fall of the dictatorship in 1974. Also a small proportion of public spending is allocated for the purchasing of goods and a relatively large amount goes to wages and salaries due to the large share of employment in the public sector. The decreased share of wages bill in 1975 is due to the large amount of defence purchases.

2.8 Monetary Sector

At the centre of the financial system is the Bank of Greece (established in 1928), assuming the normal functions of the Bank of Issue, the Government's Bank and the bankers' Bank. Economic policy is formulated by the Currency Committee, a collective body established in 1946 and reorganized in 1951, the importance of which is associated with the absence of a pre-established framework for the coordination of economic policy. The Currency Committee acts as the watchdog of monetary and credit policy and to a large extent balance of payments policy and because of its composition[25] there is no decentralization of macroeconomic policy.

Towards the mid-fifties the public started regaining its confidence in the national currency and they gradually shifted their savings from real property and gold sovereigns to interest bearing assets. This fact led to an increase in the liquidity of the economy and the shortage of money ceased to exist. Thus, funds mobilized by the commercial banking system, provided for the working capital needs of manufacturing industry and trade. The authorities considered that there existed margins not only for providing long term loans and equity capital to private industrial firms, but also to financing part of the Government's investment program.

The issue of Treasury Bills started in 1958, when the Government resorted to the capital market to finance its development program. However, most of the Treasury Bills are to be sold to the commercial banks on a compulsory basis[26]. Thus the banks are obliged to invest a fixed percentage of their demand and savings deposits on Treasury Bills (from 16% when they were first issued to around 30% at the end of our

sample period). At around the same time (1960) the Bank of Greece started issuing Government Bonds with very attractive terms.

As regards the financing of the economy, taken from the Consolidated Balance Sheet of the whole Credit System, loans and advances to the private sector constitute about 50% of the total assets, while advances to Government constitute a substancial but falling percentage with an increasing share of Treasurey Bills and Government Bonds. On the liability side to dominant feature is the high percentage of currency in circulation[27].

The banking system, which constitutes the principal source of financing, includes a variety of well developed institutions. It has developed at high rates of growth and nowdays is considered fairly sophisticated by international standards. An important characteristic is that the State controls either directly or indirectly most of the important elements of the Commercial Banking System[28]. On the assets side of the Consolidated Balance Sheet of the Commercial Banks, the dominant item is loans and advances to the private sector (about 50% of the total). Although the majority of loans are of a short term nature, being highly remunerative, the banks also lend on a longer basis due to the absence of a well developed capital market[29]. Holdings of Treasury Bills and Government Bonds have been increasing since 1958 to about 20% of total Commercial Banks' assets. On the liability side, saving deposits are constantly increasing from 2.2% in 1953 to about 40% of the total in 1975.

The Capital Market in Greece is still underdeveloped and the factors accounting for its thinness belong to both the

supply and demand sides. During the sixties the new issue of private securities amounted to around 2% of the increase in borrowing through loans and advances. Until today, roughly less than half of the larger corporations have their securities quoted in the Stock Exchange. The reason for this is the small size of the majority of the firms and their family character. The reluctance of businessmen to resort to the capital market for finance arises from fears of losing control of the family-owned concerns and therefore oppose the sale of new shares to the public. At the same time, especially during the sixties, the prevailing legal status favouring retained profits and depreciation reserves together with tax concessions, seems to have encouraged the use of internal finance. The reluctance of the public to invest in securities, besides the bitter experience of the war and post-war period when a wide range of defaults occurred, arises from lack of sufficient long term managerial stability of the firms to make their shares a reliable investment[30].

Notes to Chapter 2

1. Besides this structural reorientation, the contribution of the primary sector is still high compared with the EEC average (8%, excluding Ireland). The same applies to the secondary sector, which compares unfavourably to the EEC average of 40% .
2. According to Mouzelis(1978), despite the high growth rates of the Greek economy, Greece exemplified the classical characteristics of underdevelopment, that is an extended services sector, an industrial sector unable to absorb the excess agricultural labour force and to be directed into capital goods production.
3. Of the two relevant indicators 'Employment in Manufacture' and 'Number of Vacancies', neither is accurate, but the latter is a more reliable indicator concerning the direction of change. For instance, the 1971 Census showed actual unemployment to be about three times higher than registered unemployment.
4. See Nicolinakos (1973) and also Babanasis and Soulas (1976) pp. 25-27. Estimations of the OECD Secretariat show that between 1961-71 440,000 people of active groups between 15-64 years of age emigrated. According to another OECD estimate, to the 15 years up to 1973, 800,000 people emigrated, which is about a fifth to a guarter of active population (OCDE, GRÈCE (1977), p. 13).
5. According to rural population censuses, the agricultural sector was reduced between 1961-71 by about 30%, due to low productivity and underemployment. A sample survey of the Agricultural Bank of Greece shows a further decline than that of about 24-19% in 1976-77.

6. In the years 1958, 1965, 1970, 1972, 1973 and 1974 the ratio C/Y^d was 0.96, 0.86, 0.85, 0.81, 0.91 and 0.84 respectively.
7. On this point see Babanasis and Soulas (1976), pp. 34-36.
8. X. Zolotas (1977), pp.24-30.
9. For a further elaboration on these points see Babanasis and Soulas (1976), pp.32-34, and also Zolotas (1977), pp.15-24.
10. OECD, Greece (1978), pp. 35-36.
11. For further details see Halikias (1978), pp. 137-168. A similar survey is conducted by The Federation of Greek Industries (1967), reaching to the same conclusions.
12. According to The Federation of Greek Industries (1969), internal sources of finance accounted for only 31.2% in the period 1963-65. The corresponding percentages in other countries were: Italy 57% (1960-64), Germany 80% (1959-64) and UK 96% (1961-65). See OECD, Capital Markets Study (1967), p. 41.
13. For more details see Ellis (1965), p. 61.
14. There exists an extended bibliography on the subject. For a detailed account on the effects of foreign capital inflow see among others Eliou et al. (1973), Antioxos (1975) and Grigoroyiannis (1975). For a general discussion within the framework of Greek development see Mouzelis (1978), ch. 1 and 2.
15. For an analytical discussion see Prodromides (1976). ch 5 and OECD, Greece (1978), pp. 30 f.
16. In addition, the devaluation of the domestic currency in 1973 and in 1975 together with the worsening in the terms of trade, resulted in a further widening of the trade deficit and further burdening in foreign exchange, OCDE,

Grèce (1976), pp. 20-26.

17. During the period 1960-76 the trade deficit was about 11% of GDP and about 7% of GDP was covered by Greeks living or working abroad, OECD, Greece (1978), p. 32.

18. See section 2.5 above and also chapter 4 sections 4.1.2, 4.1.5. For a detailed discussion see references cited in footnote 14 above.

19. An exchange rate policy was not applied until 1975. Prior to this the drachma was pegged to the american dollar at a fixed rate of $1 = 30 drs. since 1953.

20. See Zolotas (1965), pp. 99-106.

21. A unified progressive income tax was introduced in 1955-56 replacing the defective schedular systems and the surtax on total personal income exceeding a certain amount. Further steps were taken in 1959. In 1958-60 new consumption taxes were introduced and the old ones increased.

22. This view is also adopted by Tatsos (1977), pp. 267-69.

23. Total tax burden as a percentage of GNP for Greece was 21.6%, 24.6% and 23.8% in the years 1965, 1970 and 1974 respectively. For other countries these percentages were as follows: Germany 34.0, 35.5, 39.6; Canada 26.2, 32.1, 34.8; Portugal 18.3, 22.6, 21.6. (National Accounts of OECD Countries, 1974)

24. An elaboration is provided by Karageorgas (1973), p. 447.

25. It consists of the Ministers of Co-ordination, Finance, Agriculture, Trade, Industry and the Gocernor of the Bank of Greece. In the postwar period bodies with similar functions were set up in other countries (Italy, France etc)

26. Commercial Banks avoid investment on Treasury Bills,because

their earnings from such investment are far lower than those from lending to the private sector, especially short term.

27. See the Monthly Statistical Bulletin of the Bank of Greece, Table 9 (various issues).

28. Note that the system is even more centralized since two banks, namely the Commercial Bank of Greece and the National Bank, handle about 80-90% of total banking business. See Lolos (1966), Halikias (1978), ch. 3 & 4 and also World Banking (Greece), The Financial Times, 21/5/79.

29. The existing highly complex system of credit controls and regulations is favouring bank lending to industry restricting lending to trade and other sectors.

30. See Phsilos (1964), Ellis (1965) for a detailed discussion.

CHAPTER 3

In this chapter we discuss two separate issues. The first section (3.1) is concerned with the behaviour of a macroeconomic model when the financial implications of budgetary policy are incorporated into it explicity and in a consistent manner.

In the second section (3.2), we deal with the optimization approach pursued to analyze the properties of the macroeconomic model.

3.1 Theoretical Underpinnings for Policy Analysis

3.1.1 An 'extended' IS-LM Model

One of the shortcomings of the traditional IS-LM model[1], is that it fails to incorporate the financing implications of the budget deficits and surpluses. It runs into a problem of internal inconsistency, because it does not account for the changes in asset stocks when the budget is unbalanced. This problem can be overcome by introducing into the model a Government Budget Constraint, which formally involves adding the condition that the deficit adds to the net total of money (M) plus bonds (B)[2]. It is obvious that the addition of the government budget constraint imposes a dynamic structure on the system, even though the underlying relationships are static. According to Turnovsky (1977, p.68), it constitutes part of the intrinsic dynamics of the system. This is in contrast to what can be described as ad hoc dynamic systems, where the dynamic structure results from assuming arbitrary lags in behaviour.

In addition, since the stock of bonds does not enter

the model (except in the budget constraint), changes in this variable are not accounted for, whereas changes in the stock of money are accomodated in the model through the LM curve. If the stock of bonds and money constitute private wealth (capital stock is excluded, assumed constant throughout), then any changes in private wealth will initiate effects on both the private expenditure functions and the demand for money function[3].Excluding, therefore, wealth effects from the above mentioned functions means that an increase in private wealth is spent entirely on bonds. This follows from Walras' Law, signifying that the implied demand function for bonds has a wealth coefficient of unity.

The discussion will be complete only if consideration of the supply side is also undertaken, which involves the analysis of the labour market behaviour. Unless the nature of the supply curve is known, the system cannot be solved. The problem lies in lack of interdependence of the system equations. The system described in 3.1.1, consists of two equations, the IS and the LM curves and three unknowns, namely Y, r and P. Unless one is known, or exogenously determined, the system cannot be solved. Monetarists assume that output is exogenously given by the full employment level and treat r and P as endogenous, while Keynsians tend to treat the money wage rate as exogenously given and, therefore prices, and solve for Y and r[4].

A way of overcoming the problem and instead of working on extreme assumptions (reverse L-shaped aggregate supply curve), is to add an equation to the system to represent the relationship between P and Y, that is, an aggregate supply curve, thereby making the price level endogenous. The general case,

therefore, is one where increases in aggregate demand affect prices and output, depending on the responsiveness of aggregate supply curve. As full employment is approached, the aggregate supply curve is expected to steepen up, where the inflationary effects will tend to dominate.

There is no need to elaborate in the case where the rate of inflation is determined independently of pressures in demand (cost-push inflation in the absence of supply constraints), since the analysis reverts to the fixed price case. Difference in analysis arises only when inflation is demand determined and we, therefore, focus on this.

In what follows we discuss the behaviour of a theoretical macroeconomic model similar to the one estimated in Chapter 4 below, in a more general fashion. In the course of the discussion, we make additional simplifications mostly related to the characteristics of the Greek economy so that the analytic results become relevant to the structure of the estimated model.

The theoretical model incorporates a Government Budget Constraint identity, wealth effects in the consumption and the demand for money functions, a foreign sector and accounts for the effects of sterilization. Also, the rate of inflation is determined endogenously in the model[5]. A detailed discussion of the formulation of the behavioural equations is deferred until Chapter 4, and only fairly standard forms are used in the model that follows without any loss of analytical exposition. The analysis is basically static, although certain elements impose a dynamic structure to the model.

Assuming endogenous direct taxes[6], the condition

for equilibrium in the goods market is given by[7]:

$$Y - C((1-t_1)Y, W/P, \dot{p}) - I(Y, r) - G - X + Q(Y) = 0 \qquad (3.1.1.a)$$

$0<C_y<1$, $0<C_w<1$, $C_{\dot{p}}<0$, $0<I_y<1$, $I_r<0$, $0<Q_y<1$ and $0<t_1<1$

where, private consumption depends on real disposable income, real wealth and the expected rate of inflation, approximated by $\dot{p}$. Private investment depends on the rate of interest and real income, and demand for imports is related to the level of income, independant of price differentials.

The nominal supply of money consists of the domestic component (D) and the volume of foreign reserves (F), i.e.

$$L = L_{t-1} + \Delta D + \Delta F \qquad (3.1.1.b)$$

and the government budget constraint becomes:

$$\Delta D + \Delta Bonds = P(G - t_1 Y) \qquad (3.1.1.c)$$

Equation (3.1.1.c) implies a corresponding adjustment in the stock of bonds to finance government deficits. If ρ is the proportion of the budget deficit covered by an addition to the money stock and the monetary authorities engage in open market operations directed at offsetting changes in the money supply originating from fluctuations in the balance of payments, then ΔD becomes:

$$\Delta D = \rho P(G - t_1 Y) - (1-s)\Delta F + M_0 \qquad (3.1.1.d)$$

where M_0 denotes exogenous changes in monetary policy, and s the sterilization coefficient. Then, from (3.1.1.b) and (3.1.1.c), we obtain:

$$L = \rho P\ (G - t_1 Y) + s\Delta F + M_0 + L_{t-1} \qquad (3.1.1.e)$$

Thus by employing the identity:

$$P = P_{t-1}(1+\dot{p}) \qquad (3.1.1.f)$$

we obtain the condition of equilibrium in the money market in terms of rates of inflation ($\dot{p}$):

$$L(Y, r, W/P_{t-1}(1+\dot{p}), \dot{p}) + \frac{\rho(1+\dot{p})P_{t-1}(G - t_1 Y) + s F + M_0 + L_{t-1}}{P_{t-1}(1+\dot{p})} = 0 \quad (3.1.1.g)$$

$L_y>0$, $L_r<0$, $L_w>0$, $L_{\dot{p}}<0$, $0\leq s\leq 1$, $0\leq\rho\leq 1$

The first term represents the demand for money associated with the level of income, the rate of interest, real wealth and the expected rate of inflation, and the second term represents the supply of money incorporating the sterilization effect. The definition of wealth is given by:

$$W - L - \text{Bonds} = 0 \quad (3.1.1.h)$$

The balance of payments ($\Delta F = B$), consists of the balance of trade and the capital movements. Assuming a fixed exchange rate regime, applicable to the case of Greece over the period of examination, and prices for imports and exports to be determined abroad (pure small country case), the balance of payments is given by:

$$B - XP_{x_{t-1}}(\dot{p}_x+1) + Q(Y)\bar{q}_{t-1}(\dot{q}+1) - K(r) = 0 \quad (3.1.1.i)$$

$0<Q_y<1$, $0<K_r$

where net capital movements (K) are assumed to be a simple increasing function of the rate of interest. Note that as in equation (3.1.1.g) the prices of imports ($\bar{q}$) and exports (P_x) are expressed in terms of their inflation rates, employing analogous identities to (3.1.1.f). Finally, the price adjustment equation is given by:

$$\dot{p} - Z((Y-\bar{Y}), \dot{q}) = 0 \quad (3.1.1.j)$$

$Z_y>0$, $0<Z_{\dot{q}}<1$

The rate of inflation depends on demand pressures, approximated by the deviations of actual output to full employment level, and imported inflation.

If we now substitute (3.1.1.h) into (3.1.1.a) and (3.1.1.g), and we define P_{t-1}, $\bar{q}_{t-1}$, $P_{x_{t-1}} = 1$, without loss of generality, since we are only interested in one-period effects, the complete macroeconomic model becomes:

$$Y - C((1-t_1)Y,\ (L + Bonds)/(\dot{p}+1),\ \dot{p}) + - I(Y,\ r) - G - X + Q(Y) = 0 \qquad (3.1.1.k_1)$$

$$L(Y,\ R,\ (L + Bonds)/(\dot{p}+1),\ \dot{p}) + - \frac{\rho(1+\dot{p})(G-t_1Y) + sB + M_0 + L_{t-1}}{(\dot{p}+1)} = 0 \qquad (3.1.1.k_2)$$

$$B - X(\dot{p}_x+1) + Q(Y)(\dot{q}+1) - K(r) = 0 \qquad (3.1.1.k_3)$$

$$\dot{p} - Z(\ (Y-\bar{Y}),\ \dot{q}) = 0 \qquad (3.1.1.k_4)$$

3.1.2. Policy Analysis

Differentiating totally the macroeconomic model (3.1.1.k) and expressing it in matrix notation, we obtain:

$$\begin{bmatrix} 1-C_y(1-t_1)+C_wt_1 \\ -I_y+Q_y \end{bmatrix} \quad -I_r \quad -(C_p+C_wA) \quad \frac{sC_w}{(\dot{p}+1)}$$

$$L_y+t_1(\rho-L_w) \quad L_r \quad L_p+L_w \quad \frac{s(L_w-1)}{(\dot{p}+1)}$$

$$-Z_y \quad 0 \quad 1 \quad 0$$

$$Q_y(1+\dot{q}) \quad -K_r \quad 0 \quad 1$$

$$\begin{bmatrix} dY \\ dr \\ d_{\dot{p}} \\ dB \end{bmatrix} =$$

$$\begin{bmatrix} 1+C_w & Y(C_y+C_w) & 1 & 0 & 0 & \frac{C_w}{\dot{p}+1} \\ (1+\dot{p})(L_w-o) & -Y(\rho-L_w) & 0 & 0 & 0 & -\frac{L_w-1}{\dot{p}+1} \\ 0 & 0 & 0 & Z_{\dot{q}} & X & 0 \\ 0 & 0 & \dot{p}_x+1 & Q(Y) & 0 & 0 \end{bmatrix} \begin{bmatrix} dG \\ dt_1 \\ dX \\ d_{\dot{q}} \\ d_{\dot{p}_x} \\ dM_o \end{bmatrix}$$

The determinant of the coefficient matrix is the following:

$$J = \left\{L_r + \frac{s}{\dot{p}+1}(L_w-1)K_r\right\}\left\{\xi - Z_y(C_{\dot{p}} + C_w(C_{\dot{p}} + A))\right\} > 0$$

where $\xi = 1 - C_y(1-t_1) + C_w t_1 - I_y + Q_y$

$$A = -(sB+M_o+L_{t-1})/(\dot{p}+1)^2$$

and is verified for $sB+M_o+L_{t-1} > 0$ (3.1.2.a)

The effects of changes in exogenous shocks on the system are described by the impact multiplier given by:

$$dY = (\partial Y/\partial G)dG + (\partial Y/\partial W)dW \qquad (3.1.2.b)$$

which consists of two elements, the direct expansionary effect of an increase in government spending and the indirect effect related to the financing of the budget. The second element (term $(\partial Y/\partial W)dW$), consists of the expansionary effect due to an increase in money stock (if $\rho > 0$), the expansionary effect due to an increase in wealth in the consumption function and the contractionary effect due to an increase in wealth in the demand for money function[8].

If we characterize fiscal policy by a change in government expenditure, the impact effect of a change in G on income is given by:

$$\frac{dY}{dG} = \frac{1 + N}{\mu + Z_y(A\nu(L_w-1)-C_w+C_p)+\nu L_y + L_p Z_y(\tau+I_r/L_r) + t_1 N} \qquad (3.1.2.c)$$

where $\mu = 1 - C_y(1-t_1) - I_y + Q_y((\dot{q}+1)+1)$

$$N = C_w + (\rho-L_w)\nu$$

$$\tau = \frac{C_w - (I_r/L_r)(L_w-1)}{(\dot{p}+1)/s + (K_r/L_r)(L_w-1)}$$

$$\nu = (I_r/L_r) + \tau(K_r/L_r)$$

The sign of the multiplier (3.1.2.c) depends on the parameters of the system. For the system to be stable not only the multiplier must be positive, but also the term $(\partial Y/\partial W)dW$ in (3.1.2.b), i.e. $N>0$ in (3.1.2.c), since any deficit remaining after the initial impact period reduces income and any additional reduction in income tends to increase the deficit. It is obvious that as $\rho \to 0$ the system tends to become unstable[9].

The relative effectiveness of fiscal to monetary policy is given by:

$$\frac{dY/dG}{dY/dM} \doteq \frac{1 + C_w + (\rho-L_w)\nu}{C_w + (1-L_w)\nu} (\dot{p}+1) \qquad (3.1.2.d)$$

and thus, as $s \to 1$, ceteris paribus, the effectiveness of fiscal policy with respect to monetary policy is reduced. Conversely, in the absence of sterilization, as assumed in the case of our estimated model, the effectiveness of fiscal policy relatively to monetary policy is enhanced.

In the case of a balanced budget change, the total impact on income is given by:

$$dY = (\partial Y/\partial G)dG + (\partial Y/\partial t_1)dt_1 = \frac{1-C_y}{E} < 1 \qquad (3.1.2.e)$$

where E is the denominator of (3.1.2.c)[10]. Provided that $N > 0$, the balanced budget method is more restrictive to both money and bond financing.

We shall now make some additional assumptions about the structure of the model above, which approximates more closely to that presented in Chapter 4. These assumptions are rationalized on the evidence provided in Chapter 2 above. We thereby assume that capital movements are independent of the domestic levels of the interest rates and the authorities do not undertake sterilization policies. We also assume wealth effects away, because they add with a lag of one period and their exclusion does not alter the first period impact multipliers[11]. Hence equation (3.1.2.c) becomes:

$$\frac{dY}{dG} = \frac{1 + \rho(I_r/L_r)}{\xi + Z_y C_p + (I_r/L_r)(L_y + 2L_p Z_y - AZ_y) + t_1\rho(I_r/L_r)} \qquad (3.1.2.f)$$

which is positive for plausible values of the parameters of the system. In the case of money financing ($\rho=1$) a larger impact multiplier is provided than in the case of bond financing ($\rho=0$)[12], if

$$Q_y - I_y + Z_y C_p + (I_r/L_r)(L_y + 2L_p Z_y - AZ_y) \gtrless -(C_y - 1)(t_1 - 1)$$

Note that the size of the multiplier is larger, the smaller they are the price expectations coefficients in the consumption function (C_p) and the demand for money function (L_p), and also the smaller the demand responsiveness of the rate of inflation (Z_y).

As it appears at this level of analysis, the relative effectiveness of fiscal and monetary policies, as given by the simplified equation (3.1.2.d), depends upon the

interest responsiveness of the demand for money function and the interest responsiveness of the investment demand function. So, the greater the value of L_r/I_r, the greater the value of the monetary multiplier and the less the value of the fiscal multiplier and, therefore, a higher degree of crowding-out of fiscal policy prevails[13].

We exposed analytically some basic properties related to the behaviour of a macroeconomic model similar to the one presented in Chapter 4 below. In Chapter 5 we shall return to these points in order to examine the degree to which the analytic results conform with or differ from the actual behaviour of the Greek economy.

In what follows we discuss the optimization approach employed in the study for the evaluation of alternative macroeconomic policies.

3.2 An Optimization Framework for Policy Analysis

3.2.1 An Outline of Optimization Approaches

The first attempt at solving systematically the policy problem was made by Tinbergen (1952), setting the origins of the targets-instruments approach to economic policy. For purposes of economic policy planning the basic classification of the variables comprising the economic model is extended. Accordingly, the endogenous variables are subdivided into 'policy target variables' of direct interest to the policymaker and the 'irrelevant variables', not of direct policy interest in themselves. Similarly, some of the exogenous varibles assumed under the control of the policy makers are termed 'policy instrument variables' and the remaining, beyond the influence of the authorities, are called 'data variables'. For the solution of the policy planning one-period problem, we must find the values of the instrument variables, which render the values of the target variables equal to some desired values.

The Tinbergen analysis, considers plausible, but generally non-optimal policies. Besides demanding excesively restrictive requirements[14], it abstracts from any increasing costs associated with the adjustments of instruments. The search for optimal policies belongs to the sphere of optimal stabilization theory. The first systematic treatment of optimal policies was given by Theil (1958, 1964), using an explicit criterion function, which reflects economic and political constraints upon the policy process, but more importantly insures uniqueness of the optimum. Thus, the solution to the problem is that of choosing values for the instruments in each

time period so as to minimize the T-period quadratic criterion function, subject to a set of linear equality constraints representing the economic system[15].

In recent years, with the development of mathematical theory of optimal control quantitative model building for economic stabilization has gained renewed interest and elegance[16]. Among the recent contributions to the solution of the optimization problem, is the minimization of a cost functional subject to a system of difference equations[18], by applying Pontryagin's maximum principle[17].

Alternatively, a solution to the problem is developed using the method of Lagrange multipliers[19]. Again, the performance ot the system is judged by a quadratic expected loss function, which can be decomposed into the deterministic and stochastic components to obtain a complete solution to the optimization problem[20].

A general point related to the solution of the macroeconomic policy problem is the number of available instruments and their effectiveness. Generally speaking the larger the number of instruments the more free we are to control the target variables since an increase in the number of instruments will 'distribute the pressure' on them[21]. Besides the number of instruments, of greater importance is their effectiveness by which we mean the smallness of change in an instrument for the achievement of a given change in an objective in relation to institutional or other constraints, and not just the partial derivative of the target variables with respect to the instruments[22]. Thus, the sensitivity of an instrument to the change in a target depends on what other targets are set and what other instruments are available[23].

3.2.2 The Objective Function

As it is already mentioned the formulation of a criterion (objective) function is an essential first step in any optimization approach to policy problems. The objective function is a scalar and measures the desirability of the included variables and is used as a criterion to judge the outcome of a specified policy by introducing natural constraints on both instruments and targets.

Like an econometric model which is an approximation of the economic system the objective function is an approximation of the preferences of the policy maker. Even if the objective function is imperfect in certain aspects it enables us to aquire useful information and provides us with results that would have otherwise been unattainable.

In principle, the objective function can always be made more complex to depict more realistically the desires of the policy-makers. However, the analysis becomes more complicated and quite often there is the constraint of the computer capacity to solve the problem. In general, we are faced with the choice of an approximate solution to an elaborate formulation of the problem and an exact solution to an approximate formulation of the problem. We have chosen the latter, since the central aspect of this study is not the exact form of the objective function, but rather the way it is employed in imposing varying trade-offs between the accuracy with which selected desired objectives are to be fulfilled.

A mathematically convenient formulation of the objective function is a quadratic objective function which

penalizes for the quadratic departure of the target variables included as arguments in the function from some selected desired path[24]. Besides the selected target variables, quadratic measures of control instrument variables are added due to the fact that they also impose 'costs' to the economic system[25]. The quadratic objective function penalizes systematically deviations of the optimal trajectories from the desired ones. Hence, penalization occurs regardless of the possibility that the optimal trajectory may have an even better value than the desired one, since positive deviations from desired targets are assigned the same cost as negative deviations of the same magnitude,

These objections to the symmetric nature of the quadratic objective function can be corrected in a number of ways. The first involves the employment of a piecewise quadratic objective function, offering a more general framework for policy optimization. It is in general asymmetrical and only convex (as opposed to strictly convex). The piecewise quadratic function amounts to three distinct functions added together in order to relax some of the most restrictive requirements operational in the quadratic form[26]. The use of this kind of formulation is essential when the optimal path oscillates around the desired path. In the case that the desired path is always above the optimal path, the deficiency is absent[27]. A second method of correcting the undesirable properties of the objective function is by respecifying the weighting matrix of the quadratic function. Accordingly, the criterion function is altered systematically by an iterative procedure until an acceptable solution for the policy maker is reached[28]. Deviations of the desired trajectories from the current

optimal ones are regarded as a 'mispecification'[29] of the desired trajectories. If the desired trajectories are corrected accordingly the problem of the symmetric nature of the quadratic criterion function is no longer present[30]. Alternatively, one can impose inequality constraints on the original problem, but this might not be always computationally feasible.

Finally, another shortcoming of the objective function is its additive form, which means that an expectation is taken for the sum of functions of variables in different periods. This can be overcome by incorporating multiplicative terms in the objective function. However, the additive form is accurate enough for most purposes because the mean of the sum is more important than its variance[31].

3.2.3 The Planning Horizon

The question of the length of the planning horizon over which the optimization is to be carried out is also important since it affects the resulting optimal paths. Considerations of an infinite optimization horizon, a line usually adopted in optimal growth theory, is practically and also conseptually inapplicable for our purposes of stabilization policies evaluation.

The use of a computer and hence, a numerical solution to the problem, makes it impossible to consider an infinite time span. A too short horizon is inadequate for the various interrelationships in the economic system to manifest themselves. Such examples are various trade-offs implicit in the economy and their associated lags. On the other hand, allowing for a too long time horizon involves structural

changes in the system not captured by the model and also changes in the supply aspects of the economy,which are not adequately modelled. Consequently, it seems that some medium term economic policy would be useful to formulate which, while indicating any inadequacies in the supply side of the model, will allow for the role of the short-term economic policy in adjusting the demand side of the economy.

Although the emphasis is shifted towards medium-term policy making and the difficulties in deciding upon the relevant time horizon for the optimization are somewhat alleviated, the question of the exact planning horizon still remains. This is so because the impact of the desired optimal policies is completely ignored after the terminal period of the optimization. The implicit assumption usually made is that the system stops to function after the terminal date of the plan. In the case of a dynamic model, however, there are policy effects which will occur after the optimization span and therefore, not accounted for by the objective function. This means that the optimization results are biased towards the end of the planning period, depending on the dynamic structure of the model. This is not all that damaging since planning policies are never actually carried out until the final stages, being substituted by a new plan.

3.2.4 The Optimization Approach (Rustem and Zarrop)

The above mentioned methods for solving the optimization problems (section 3.2.1), are somewhat restrictive, because they require the model constraint to be expressed in its reduced form, or in other words, they require the employment of a linear (or linearized) economic model. Their use is, therefore, constrained by the computational complexity demanded by the optimization algorithm and the size of the model[32]. In the case of large scale models, the derivation of the reduced form is not an easy matter and is not readily available, involving the inversion of large matrices. In addition, most economic phenomena, as reflected in economic models, are at least quasi-linear in structure and quite often most of their interesting aspects arise from non-linearities. Besides a certain element of arbitrariness entailed in the specification of the objective function we think that working with linear models we are deprived from studying these non-linear characteristics[33].

The search for optimal policies within an optimization framework, usually involves the evaluation of a large number of different policies. Consequently, the specification and solution to the problem, must be such that it will make it possible to obtain efficiently adequate computational results for various policies. We think that the method due to Rustem and Zarrop (1979), fulfils the requirements and is, therefore, used in the empirical investigation of economic policies in this study.

Formally the non-linear econometric model is written as:

$$f_i(\underline{y}(t), \underline{y}(t-1),\ldots, \underline{y}(t-s), \underline{u}(t), \underline{u}(t-1),\ldots, \underline{u}(t-r))=0 \quad (3.2.4.a$$

where $i = 1,\ldots,p$; p is the number of endogenous variable
s is the maximum lag in the endogenous variables
m is the number of exogenous variables
r is the maximum lag in the exogenous variables
and $t = 1,\ldots,N$; N is the number of control periods over which the problem is to be solved

For compactness, we can define the pN- vector of endogenous variables as:

$$\underline{Y} = (\underline{y}(1)', \underline{y}(2)',\ldots, \underline{y}(t)',\ldots, \underline{y}(N)') \qquad (3.2.4.b)$$

and the mN- vector of instruments in the same form as:

$$\underline{U} = (\underline{u}(1)', \underline{u}(2)',\ldots, \underline{u}(t)',\ldots, \underline{u}(N)') \qquad (3.2.4.c)$$

Therefore, the model is given by:

$$\underline{F}(\underline{Y}, \underline{U}) = 0 \qquad (3.2.4.d)$$

The quadratic cost function is given by:

$$J = \tfrac{1}{2}\sum_{t=1}^{N} \underline{y}(t)A(t)\,\underline{y}(t) + \underline{u}(t)B(t)\,\underline{u}(t) \qquad (3.2.4.e)$$

where $\underline{y}(t) = \underline{y}(t) - \underline{y}^d(t)$ and $\underline{u}(t) = \underline{u}(t) - \underline{u}^d(t)$

the superscript denoting desired values and $A(t) \geqslant 0$, $B(t) > 0$, are the weighting matrices on the targets and instruments respectively.

In compact form the objective function (assuming for simplicity time constant weighting matrices) is given by:

$$J(\underline{Y}, \underline{U}) = \tfrac{1}{2}(\underline{Y} - \underline{Y}^d)Q_{\underline{Y}}(\underline{Y} - \underline{Y}^d) + \tfrac{1}{2}(\underline{U} - \underline{U}^d)Q_{\underline{U}}(\underline{U} - \underline{U}^d) \qquad (3.2.4.f)$$

where the symmetric matrices $Q_{\underline{Y}}$ and $Q_{\underline{U}}$ are assumed to be positive semi-definite and strictly positive definite respectively.

Hence, given the econometric model $\underline{F}(\underline{Y}, \underline{U}) = \underline{O}$, the problem of policymaking is to choose the values for the endogenous variables ($\underline{Y}$) and the policy instruments ($\underline{U}$), so as to minimize the value of a specified cost functional $J(\underline{Y}, \underline{U})$, over a given time period (1, N). For reasons already alluded, the cost function is taken to be quadratic in deviations of the targets and instruments from some desired ($\underline{Y}^d$ and $\underline{U}^d$) paths over time.

Thus, the problem becomes:

$$\min \left\{ J(\underline{Y}, \underline{U}) \mid \underline{Y}, \underline{U} \subset F \right\} \qquad (3.2.4.g)$$

where $F \subset R^{(p+m)N}$ is the feasible set of paths defined by the model equations, thus:

$$F = \left\{ \underline{Y}, \underline{U} \mid \underline{F}(\underline{Y}, \underline{U}) = \underline{O} \right\} \qquad (3.2.4.h)$$

For any econometric model, the solution program computes values for the endogenous variables, given the values for the exogenous variables, that is:

$$Y = g(\underline{U}) \qquad (3.2.4.1)$$

By substituting (3.2.4.i) into (3.2.4.g), we obtain:

$$\min \left\{ G(\underline{U}) \mid \underline{U} \subset R^{mN} \right\} \qquad (3.2.4.j)$$

where

$$G(\underline{U}) = J(g(\underline{U}), \underline{U}) \qquad (3.2.4.k)$$

Therefore, the previously (3.2.4.g) constrained problem is reformulated as an unconstrainod problem in the policy instruments, the minimum of which can be computed interactively by successively generating suitable descent

directions. The algorithm used was a modified Gauss-Newton one of the form[34]:

$$\underline{U}_{k+1} = \underline{U}_k - \alpha H_{\underline{u}_k}^{-1} \nabla G(\underline{U}_k) \qquad (3.2.4.1)$$

where $\nabla G(\underline{U})$ is an approximation to the gradient of $J(\underline{Y}, \underline{U})$ and $H_{\underline{u}}$ is an approximation to the Hessian, assumed to be positive definite. The subscript k refers to successive values of the instrument vector. In general, $G(\underline{U})$ is non-quadratic in $\underline{U}$, and by choosing a suitable α, the relationship $G(\underline{U}_{k+1}) > G(\underline{U}_k)$ is always maintained. The gradient and approximate Hessian, written explicitly, are given by:

$$\nabla G(\underline{U}_k) = N' Q_{\underline{Y}}(g(\underline{U}_k) - \underline{Y}^d) + Q_{\underline{U}}(\underline{U}_k - \underline{U}^d) \qquad (3.2.4.m)$$

and

$$H_{\underline{U}} = N' Q_{\underline{Y}} N + Q_{\underline{U}} \qquad (3.2.4.n)$$

where $N = \begin{bmatrix} M(0) & 0 & \dots & 0 \\ M(1) & M(0) & \dots & 0 \\ \vdots & \vdots & & \vdots \\ M(N-1) & M(N-2) & \dots & M(0) \end{bmatrix}$

where M( ) is the pxm matrix of dynamic multipliers at lag α calculated from the first interval of the period over which policy is to be optimized.

3.2.5 Policy Optimization and Simulations

We have already said (Chapter 1) that the optimization approach is a more general way of dealing with the problem of policymaking, than the simulation approach. We shall now show in a formal way, that the simulation approach can be regarded as a special case of the optimization approach[35].

Discretionary policy simulations assume values for the policy instruments $\underline{U}^*$ and compute the corresponding values for the endogenous variables $\underline{Y}^*$ of the econometric model. Thus, $\underline{F}(\underline{Y}^*, \underline{U}^*) = \underline{0}$ and if any part of $\underline{Y}^*$, $\underline{U}^*$ is not satisfactory, another set of $\underline{U}$ values will be specified for subsequent policy simulations. Hence, the simulation of the model is equivalent to the simple optimization problem:

$$\min \left\{ J_u(\underline{U}) \;\middle|\; \underline{F}(\underline{Y}, \underline{U}) = \underline{0} \right\} \qquad (3.2.5.a)$$

for given $\underline{U}^*$, where $J_u(\underline{U})$ is a non-linear function with a unique minimum at $\underline{U}^*$.

This can be obtained from the first order condition of optimality for (3.2.5.a), forming the Langrangian:

$$L(\underline{Y}, \underline{U}, \underline{\lambda}) = J_u(\underline{U}) + \underline{F}'(\underline{Y}, \underline{U})\underline{\lambda} \qquad (3.2.5.b)$$

where $\underline{\lambda}$ is the vector of Lagrange multipliers. The conditions are:

$$\frac{\partial L}{\partial \underline{U}} = \frac{\partial J_u}{\partial \underline{U}} + \left[\frac{\partial \underline{F}}{\partial \underline{U}}\right]' \underline{\lambda} = \underline{0} \qquad (3.2.5.c)$$

$$\frac{\partial L}{\partial \underline{Y}} = \left[\frac{\partial \underline{F}}{\partial \underline{Y}}\right]' \underline{\lambda} = \underline{0} \qquad (3.2.5.d)$$

and $\underline{F}(\underline{Y}, \underline{U}) = \underline{0}$ (3.2.5.e)

implying that:

$$\frac{\partial \underline{F}}{\partial \underline{U}} = \frac{\partial \underline{F}}{\partial \underline{Y}} \cdot \frac{\partial \underline{Y}}{\partial \underline{U}} = \underline{0} \qquad (3.2.5.f)$$

Using (3.2.5.f) and (3.2.5.c), we obtain:

$$\frac{\partial J_u}{\partial \underline{U}} - \left[\frac{\partial \underline{Y}}{\partial \underline{U}}\right]' \left[\frac{\partial \underline{F}}{\partial \underline{Y}}\right]' \underline{\lambda} = \underline{0} \qquad (3.2.5.g)$$

and together with (3.2.5.d), becomes:

$$\frac{\partial J_u}{\partial \underline{U}} = \underline{0} \qquad (3.2.5.h)$$

In contrast to $J(\underline{Y}, \underline{U})$ the objective function $J_u(\underline{U})$ reflects the preferences of the policy maker in the policy variables only. Thus, while in the general optimization approach the optimal values of $\underline{Y}$ are influenced and controlled by the preferences $J(\underline{Y}, \underline{U})$, in the case of policy simulations the optimal values of $\underline{Y}$ are allowed to take values dictated by $\underline{U}^*$, given the equations of the econometric model.

Notes to Chapter 3

1. See for example, Allen (1968), Ch. 8.
2. Two early efforts to account for the impact of the budget balance have been made by Lerner (1948) and Friedman (1948). The idea is fully established by the works of Ritter (1965), Ott and Ott (1965), Christ (1967), etc.
3. See Ott and Ott (1965) and Silber (1970).
4. See Friedman (1970). Note that, this distinction only represents extreme cases. For an elaborate discussion on this and related issues, see Burrows (1979). For a better understanding of the assumptions Keynesians and Monetarists make, see Tobin and Buiter (1976), Brunner and Meltzer (1976), McGrath (1977) and Crystal (1979).
5. Similar models are constructed by Benavie (1973), Turnovsky (1974), Burrows and Hitiris (1974), Buiter (1976). The model presented here, draws on Turnovsky (1977), Ch.10.
6. In reality income tax rates vary progressively (in general) with nominal incomes, thus preventing us to express real disposable income in terms of real income and tax parameters. This necessitates to work in terms of money income and prices separately, but the analysis becomes rather complex. For simplicity we assumed that taxes vary proportionally with real income in the theoretical model, but this assumption is relaxed in the estimated model of Chapter 4.
7. In the mathematical relations appearing in this chapter all symbols have their usual meanings i.e., C = private consumption, I = investment expenditure, etc. Also $C_y = \partial C/\partial Y$, $I_r = \partial I/\partial r$, etc. All coefficients are assumed to have their a priori expected signs.

8. Note that, $(\partial Y/\partial W)dW = (\partial Y/\partial M)dM_g - (\partial Y/\partial M)L_w dW_g + (\partial Y/\partial G)C_w dW_g$ where dM_g, dW_g are changes in money stock and wealth, associated with the policy of increasing government spending from a position of initial balance by dG; L_w and C_w are the wealth effects on the money and consumption function (see Artis, 1979).

9. Clearly, in the money financed deficit ($\rho=1$), the multiplier is positive, since the negative wealth effect in the demand for money cannot exceed the increase in wealth due to the deficit financed through money creation.

10. Obviously the 'balanced budget multiplier theorem' (Lange, 1944; Haavelmo, 1945) is not applicable in the case of our 'extended' model.

11. Note that although the first period multiplier is not affected, the subsequent period multipliers are altered. In the long-run, to the extent that the budget is balanced, the multiplier is equal to the inverse of the marginal tax rate. When bond coupon payments are introduced into the model (Blinder and Solow, 1973), the long-run multiplier will depend on all parameters of the system and not just the tax parameter. However, if in the definition of government expenditure we include coupon payments (considered as government transfers) or government spending is redefined net of taxes, then the size of the multiplier is invariant of the method of financing (Tobin and Buiter, 1976).

12. When the effects of interest payments on the bonds issued by the goverment are taken into consideration (Blinder and Solow, 1973), bond financing results into higher long-run multipliers, compared to money financing, but the possibility

of instability is enhanced (under money financing the system is almost certainly stable, while under bond financing stability becomes an empirical matter). However, Sparks (1976) and Miller (1976), argue that the inclusion of bond coupon payments involves a double counting of bonds, first as a stock and then as a flow.

13. For the significance of the crowding out, see Taylor (1979), Burrows (1979), Currie (1978), etc.
14. It requires that the number of instruments is equal to the number of targets.
15. Thus, the criterion function enables us to choose among the infinite number of policies all of which the Tinbergen procedure treats as equally satisfactory.
16. Kendrick (1976), lists about 80 studies, carried out recently, utilizing an optimization approach.
17. See Pontryagin et al. (1962).
18. Although the control theory framework was initially formulated in continuous time, most applications employ a discreet time framework. See Pindyck (1973), Garbade (1975), Wall and Westcott (1974), Holly et al. (1979), etc.; an exception is Livesey (1971).
19. Chow (1972; 1975, Ch. 7).
20. The method involves forming a linear feedback equation, linking current policy variables with past performances; see Chow (1975), p. 117 ff.
21. Tinbergen (1952), p. 41.
22. Johansen (1965), p. 13.
23. Note that the various instruments, though legally distinct, are not economically distinct. Thus, one more instrument may increase the number of available instruments, but may

add little to the set of possibilities open to us. In principle, there is no shortage of instruments, but their usefulness is limited by the extent to which they influence relevant targets.

24. See Livesey (1973), for the usefulness and validity of working with a quadratic criterion function, and Theil (1964), for an economic justification.
25. An optimal policy is evaluated with respect to the values of the instruments as well as the degree of fulfilment of the objectives. By including instruments in the objective function, we can avoid unacceptable values for them.
26. The entire range of possible values of the arguments of the objective function, consists of three disjoint convex sets. The middle range, a closed and bounded set, bears zero preference loss. The two extreme ranges, bounded on one side only, bear non-zero but different preference losses, according to independent patterns (Friedman, 1975; Ch. 7).
27. For example, if the optimal level of inflation, say at 7%, is always above the desired level, of say 3%, than the imposed penalty is desirable. If, however, the optimal inflation rate is 2%, the quadratic function still imposes an undesirable penalty.
28. For a further elaboration, see Rustem et al. (1978). They provide for a dialogue between the model builder and the policy-makers for the generation of more acceptable optimal paths, by updating the weighting matrix.
29. For example, if the optimal level of inflation is at 5% and the desired level is at 7%, the quadratic function penalizes wrongly for the -2% deviation. If the desired level of inflation is set to a level less than 5%, then

all departures from the desired trajectories are in a desirable direction.

30. See for example, Livesey (1973, 1976).

31. See Chow (1975), p. 155.

32. Livesey (1971), approached the optimal stabilization policy problem via dynamic programming, employing a continuous-time non-linear model for the U.K. Even with this fairly small model (15-states), the computational time involved was too large, making it too costly to reach a true optimum.

33. Linearizing an estimated non-linear model creates a degree of suboptimality in the process of linearization. For an example, see Friedman (1975), Ch. 3.

34. See Rustem and Zarrop (1979).

35. For a further discussion see Karakitsos and Rustem (1980).

CHAPTER 4

THE EMPIRICAL MODEL

The process of industrialization of the Greek economy has been a slow one. The whole period under study is characterized by an inadequate allocation of resources between the various sectors and an undesirable distribution of investment between manufacturing and the other industries. Contrary to what was expected, this picture has not changed dramatically to the present. Nevertheless, the growth rates of the various sectors were quite respectable compared to those of other countries.

Besides the necessity of a long-run planning model, designed to alleviate some of the existing structural imbalances of the economy, there is a strong case for the usefulness of a short-term model designed to bring out the short-term reactions of the economy. Since the long-run growth path of economic activity is affected by the short-run fluctuations of the economy, stabilization policy aiming at influencing the short-term adjustment of the economy is of great importance. It is our belief that a short-term model will be useful in coping with such short-run adjustments. It will also improve our knowledge about the quantitative relations between policy instruments and the objective variables of the policy makers.

With our interest focused on macroeconomic policy, the model should explain the major macroeconomic policy targets and involve the most important instruments for conducting such policies. In other words, the model should highlight the effects of certain key fiscal and monetary

instruments on some target economic variables.

In connection with the formulation of economic policy, it is always desirable to construct a disaggregated large-scale model, involving analytically the various economic activities at a sectoral level, representing the real decision channels which refer to a large number of instruments[1]. This kind of project, however, is beyond the scope of the present study involving the contribution of a specialized group of people. We think that the structural small-scale model although it does not incorporate in detail the various targets and instruments, will be useful for analytical purposes employing broad aggregates of targets and instruments which are clear indicators of policy.

We shall present the empirical model first and we will subsequently comment on its structure and properties.

4.1 The Model[2]

$$1a.\quad C_t = \underset{}{4515} + \underset{(4.27)}{0.153Y^d_t} + \underset{(14.0)}{0.762C_{t-1}} + \underset{(2.28)}{0.350M_{t-1}} - \underset{(3.44)}{3.150\dot{P}_t} + u_{1t}$$

$$S = 2146 \qquad p = -0.889 \qquad x^2_1(3) = 1.83$$
$$S/M = 0.0125 \qquad (2.93)$$

$$1b.\quad C_t = \underset{}{4592} + \underset{(4.20)}{0.153Y^d_t} + \underset{(13.9)}{0.762C_{t-1}} + \underset{(1.60)}{0.353M_{t-1}} - \underset{(3.39)}{3.110\dot{P}_t} + u_{1t}$$

$$S = 2146 \qquad p = -0.887 \qquad x^2_2(9) = 16.8$$
$$S/M = 0.0125 \qquad (2.92)$$

$$2a.\quad I_t = \underset{}{-19682} + \underset{(3.63)}{0.275Y_{t-1}} + \underset{(1.95)}{0.626CRI_t} + \underset{(1.73)}{1.279KI_t} - \underset{(1.40)}{5.795R_t}$$

$$- \underset{(2.60)}{0.143K_{t-1}} + u_{2t}$$

$$DW = 1.69 \qquad S = 1886 \qquad x^2_1(5) = 3.8$$
$$R^2 = 0.977 \qquad S/M = 0.083$$

2b. $I_t = -19430 + \underset{(3.64)}{0.276Y_{t-1}} + \underset{(1.85)}{0.604CRI_t} + \underset{(1.66)}{1.242KI_t} - \underset{(1.52)}{6.360R_t}$

$$- \underset{(2.57)}{0.142K_{t-1}} + u_{2t}$$

$DW = 1.67 \quad S = 1886 \quad x_2^2(11) = 16.0$

$S/M = 0.083$

3a. $H_t = 11203 + \underset{(4.69)}{1.725CRH_t} + \underset{(5.09)}{2.874KH_t} - \underset{(2.30)}{12.01R_t} + u_{3t}$

$S = 1620 \quad p = 0.483 \quad x_1^2(3) = 2.42$

$S/M = 0.1003 \quad (1.81)$

3b. $H_t = 11660 + \underset{(4.53)}{1.721CRH_t} + \underset{(5.14)}{2.915KH_t} - \underset{(2.34)}{12.89R_t} + u_{3t}$

$S = 1623 \quad p = 0.488 \quad x_2^2(8) = 16.9$

$S/M = 0.1005 \quad (1.89)$

4a. $\Delta S_t = -14928 + \underset{(3.64)}{0.102Y_t} + \underset{(2.59)}{4.357\dot{P}_t} - \underset{(2.29)}{0.190S_{t-1}} + u_{4t}$

$DW = 2.63 \quad S = 2768 \quad x_1^2(3) = 7.51$

$R^2 = 0.810 \quad S/M = 0.4940$

4b. $\Delta S_t = -14789 + \underset{(3.57)}{0.101Y_t} + \underset{(2.80)}{4.781\dot{P}_t} - \underset{(2.32)}{0.194S_{t-1}} + u_{4t}$

$DW = 2.64 \quad S = 2775 \quad x_2^2(10) = 12.9$

$S/M = 0.4953$

5a. $Q_t = -8771 + \underset{(2.25)}{0.100Y_t^d} + \underset{(6.92)}{0.860Q_{t-1}} + u_{5t}$

$DW = 2.50 \quad S = 5222 \quad x_1^2(1) = 0.96$

$S/M = 0.1019$

5b. $Q_t = -8765 + \underset{(2.22)}{0.100Y_t^d} + \underset{(6.87)}{0.860Q_{t-1}} + u_{5t}$

$DW = 2.50 \quad S = 5223 \quad x_2^2(9) = 17.2$

$S/M = 0.1019$

6a. $M_t^d = -2576 + 0.161Y_t - 8.246R_t - 1.437\dot{P}_t + 0.405M_{t-1}$
(4.69) (3.14) (1.60) (2.80)

$+ 4283D_{67} + u_{6t}$
(3.21)

DW = 2.33 S = 1256 $x_1^2(4) = 3.49$
$R^2 = 0.997$ S/M = 0.0284

6b. $M_t^d = -2676 + 0.161Y_t - 8.098R_t - 1.437\dot{P}_t + 0.405M_{t-1}$
(4.69) (3.02) (1.63) (2.80)

$+ 4283D_{67} + u_{6t}$
(3.21)

DW = 2.32 S = 1257 $x_2^2(10) = 17.8$
S/M = 0.0284

7a. $NM_t^s = -397 + 1.095\ NBA_t + u_{7t}$
(83.3)

DW = 2.04 S = 1710 $x_1^2(1) = 1.18$
$R^2 = 0.998$ S/M = 0.0357

7b. $NM_t^s = -397 + 1.095\ NBA_t + u_{7t}$
(83.3)

DW = 2.04 S = 1710 $x_2^2(1) = 1.18$
$R^2 = 0.998$ S/M = 0.0357

8a. $NT_t^d = -2712 + 0.067NY_t - 3347D_{66} + u_{8t}$
(22.3) (4.06)

S = 1858 p = -0.720 $x_1^2(2) = 1.25$
S/M = 0.1710 (2.35)

8b. $NT_t^d = -2712 + 0.067NY_t - 3347D_{66} + u_{8t}$
(22.3) (4.06)

S = 1858 p = -0.720 $x_2^2(9) = 17.2$
S/M = 0.1710 (2.35)

9a. $NT_t^i = 2941 + 0.104NY_t + 7117D_{66} + u_{9t}$
(15.0) (3.35)

DW = 1.87 S = 3186 $x_1^2(2) = 4.21$
$R^2 = 0.976$ S/M = 0.1016

9b. $NT_t^i = 2941 + \underset{(15.0)}{0.104NY_t} + \underset{(3.35)}{7117D_{66}} + u_{9t}$

$DW = 1.87 \qquad S = 3186 \qquad x_2^2(10)=17.2$

$S/M = 0.1016$

10a. $\dot{P}_t = \underset{(8.30)}{0.195\ \dot{NM}_t} + \underset{(14.8)}{0.474\ \dot{P}_t^m} + u_{10t}$

$S = 2.03 \qquad p = -0.517 \qquad x_1^2(2) = 3.32$

$S/M = 0.3814 \qquad (2.47)$

10b. $\dot{P}_t = \underset{(8.26)}{0.198\ \dot{NM}_t} + \underset{(14.6)}{0.471\ \dot{P}_t^m} + u_{10t}$

$S = 2.029 \qquad p = -0.514 \qquad x_2^2(8) = 9.3$

$S/M = 0.3814 \qquad (2.45)$

11. $Y_t = C_t + I_t + H_t + \Delta S_t + G_t + X_t - Q_t - T_t^i + e_{1t}$

12. $NY_t^d = NY_t - NT_t^d + e_{2t}$

13. $\Delta NF_t = NX_t - NQ_t + NKZ_t$

14. $\Delta PB_t = NG_t - NT_t^d - NT_t^i + \Delta NF_t - \Delta NBA_t + e_t$

15. $NM_t^s = M_t^d \times P_t = M_t \times P_t$

16. $K_t = I_t + (1 - \delta) K_{t-1}$

17. $S_t = \Delta S_t + S_{t-1}$

18. $P_t = P_{t-1} (1 + \dot{P}_t / 100)$

19. $\dot{NM}_t = (NM_t - NM_{t-1}) \times 100 / NM_{t-1}$

20. $NY_t = Y_t \times P_t$

21. $NQ_t = Q_t \times P_t$

22. $X_t = NX_t / P_t$

23. $Y_t^d = NY_t / P_t$

24. $T_t^i = NT_t^i / P_t$

25. $G_t = NG_t / P_t$

26. $CRI_t = NCRI_t / P_t$

27. $CRH_t = NCRH_t / P_t$

28. $KI_t = NKI_t / P_t$

29. $KH_t = NKH_t / P_t$

List of Variables[3]

a. Endogenous[4]

C_t : Private consumption expenditure

I_t : Fixed business investment (excluding housing investment)

H_t : Private investment in residential construction

ΔS_t : Inventory investment (changes)

Q_t : Imports on goods and services

M_t^d : Demand for money

NM_t^s : Money supply

NT_t^d : Total direct taxes (net)

NT_t^i : Total indirect taxes (less subsidies)

$\dot{P}_t$: Rate of change of the implicit deflator of GNI

NY_t : Gross national income

NY_t^d : Personal disposable income

ΔNF_t : Change in foreign reserves

R_t :(Rate of interest of saving deposits with commercial banks) x 100

K_t : Private capital stock

S_t : Level of inventory investment

P_t : Implicit deflator of GNI

ΔPB_t : Change in government bonds and treasury bills

b. Policy Instruments[5]

NBA_t : Monetary base

NG_t : Total government expenditure

$NCRI_t$: Change in credit to the private sector (less credit to housing)

$NCRH_t$: Change in credit to housing

c. Pure Exogenous

NKI_t : Total capital inflow for fixed business investment

NKH_t : Total capital inflow for real estate purchases

NX_t : Exports of goods and services

NKZ_t : Net invisible receipts and movements of capital

$\dot{P}^m_t$: Rate of change in import prices

D_{67} : Dummy variable (D_{67} = 1 in 1967 and zero elsewhere)

D_{66} : Dummy variable (D_{66} = 0 in 1957-65 and D_{66} = 1 in 1966-1975)

e_{1t}, e_{2t}, e_{3t} : Discrepancies

The model includes variables both at constant 1970 prices and at current prices. There is, therefore, a differentiation between real and nominal effects. The variables which are in fact deflated, are deflated by the implicit deflator of the Gross National Income (P_t). We have adopted this procedure on the assumption that all price deflators fluctuate in the same manner[6]. This enables us to examine the general price effect, but not the relative price effect. Much the same logic is adopted for the various interest rates entering the equations. We do not differenciate between the long-run and short-run interest rates and we have introduced a representative interest rate. The interest rate used was that of the saving deposits with the commercial banks.

The model is dynamic and therefore both short-run

and long-run effects between targets and instruments can be analyzed. The dynamics of the model do not arise only from the inclusion of lagged endogenous variables in the behavioural equations, but also from the incorporation of the government budget constraint, that is, by fully considering the intrinsic dynamics of the system. This is the dynamics inherent in the economy even if the underlying behavioural relationships are static.

The model of the Greek economy, outlined above consists of 29 behavioural equations and identities. It includes 29 endogenous variables, 6 potential policy instruments, 10 pure exogenous variables and 6 predetermined variables. Thus the system is complete, since there are as many endogenous variables as there are equations in the model.

The model is built around the Gross National Income identity and includes a real sector and a public sector so as both automatic and discretionary tax changes can be incorporated. It also includes a monetary sector and an explicit government budget constraint identity, so that the monetary effects of fiscal changes can be allowed for. Changes in the price level are also dealt explicitly in the model.

The real sector (equations 1-5) dinstinguishes between total private consumption (equation 1), private investment (equations 2-4), total imports (equation 5) and total exports. All real sector equations are estimated at constant 1970 prices. Private consumption, includes consumption on durables, non-durables and services. Private investment expenditure is a strategic component of national income, since it adds to the productive capacity of the economy. It is characterized by a diversification of economic activity and

becomes difficult to account for general factors determining total investment expenditure. For this reason we have dissagregated investment expenditure into fixed business investment (equation 2), Private housing investment (equation 3) and inventory investment (equation 4). Exports of goods and services are considered exogenous, since Greek exports on goods constitute a small fraction of World production and are not affected by its fluctuations. Exports of services (e.g. tourism) conform easily with the exogeneity assumption and the inflow of foreign capital is determined by government policies rather than the interest rate differential [7]. Imports on goods and services constitute an important leakage in the circular flow of income and therefore are treated endogenously.

The monetary sector of the model does not distinguish between the various markets. It consists of an aggregate demand for money function (equation 6), estimated at constant 1970 prices, an equation for the supply of money (equation 7) estimated at current prices, and an identity depicting the equilibrium position of the demand for and the supply of money (equation 15). Equation 10 is the price adjustment equation.

The fiscal sector includes two endogenous tax revenue functions (equations 8 and 9) estimated at current prices. Government expenditure on goods and services, including government investment, is taken to be a policy variable. The model also includes some definitional equations as well as some technical relationships to close the system.

We now turn into the analytical discussion of each of the equations constituting the model.

4.1.1 Private Consumption Expenditure (C_t)

The original idea of the consumption function was expressed in Keynes's "Fundamental Psychological Law", that, "men are disposed, as a rule, and on the average, to increase their consumption as their income increases, but not so much as the increase in their income"[8].

Recalling the discussion in Chapter 2 Section 4, the development of consumers' behaviour cannot be justified by developments on income alone. The majority of the investigators have emphasised the importance of wealth as a determinant of consumers' patterns. However, lack of adequate information on wealth series, forced us to employ different proxies accounting for the wealth effects on consumption. Liquid assets can be measured more reliably than total wealth and they constitue the most important component of it in determining consumers' expenditure. Additionally, consumers may have a desired amount of liquid balances to satisfy both precautionary and transactions motives, and any deviation from this amount acts as a restraint upon their consumption expenditure[9].

Although we experimented with different formulations, it is our contention that the 'narrow' definition of liquid assets is the most relevant in the case of Greece, since currency in circulation plus demand deposits constitute a large proportion of total liquid assets[10]. We used previous period's money stock, since, working with end of period data, current period consumption is affected by the existing wealth at the beginning of the period i.e. last period's wealth[11].

The consumption function is estimated at constant-1970 prices. We have thus allowed for price changes, assuming that they reflect inflation and not quality changes[12]. To obtain

the real explanatory variables we used the implicit price deflator of GNP instead of that of private consumption[13], on the already mentioned assumption that price deflators move more or less together.

In addition to the above, we made the assumption the increase of income spent is related directly to inflation[14]. We have thus assumed that prices are important in spending decisions not through their indirect impact, but in a direct way. Since consumers are not able to distinguish between the relative price increases and the general price level increase, there is a mass illusion that goods are relative more expensive than before and in an attempt to adjust purchases, the level of real consumption falls[15]. To account explicity for the effect of price increases on consumption expenditure, we included in the equation a variable representing the expected rate of inflation, approximated by the current period rate of change in prices (P_t).

An effort was also made to include the rate of interest in the consumption function, to allow for a more direct effect of monetary policy upon private consumption[16], but the results did not support this hypothesis. The effect of high purchases on consumption is sometimes thought to be significant, since any credit given to consumers will increase the level of their consumption, but the non-availability of any kind of information prior to 1970 prevented us testingthis contention empirically.

To allow for habits and past standards of living which affect the level of consumption, we assumed that the level of actual consumption adjusts itself only partially to the difference between equilibrium consumption and previous period's actual consumption[17], that is:

$$C_t - C_{t-1} = \alpha(C_t^* - C_{t-1})$$

where α is the rate of adjustment to equilibrium consumption (C_t^*), depending on the aforementioned factors, i.e.

$$C_t^* = c_0' + c_1' Y_t^d + c_3' M_{t-1} + c_4' \dot{P}_t$$

Combining these two equations and adding a disturbance term, we obtain the reduced-form equation:

$$C_t = c_0 + c_1 Y_t^d + c_2 C_{t-1} + c_3 M_{t-1} + c_4 \dot{P}_t + u_{1t}$$

where $c_i = \alpha c_i'$ for $i = 0, 1, 3, 4$ and $c_2 = (1 - \alpha)$

There is a last point to mention before we conclude the discussion on the consumption function, namely the distinction between consumption on durables and non- durables. It is recognized in economic theory that different factors govern the consumption on durables as opposed to consumption on non-durables and services, since the former are purchased for their flow of services they provide the owner in the future. In our case, however, the proportion of consumption on durables to total consumption is very small , increasing, but not erratic.Therefore, it is not thought necessary to estimate different equations for the two categories of consumption goods.

The estimated consumption functions are shown in equations 1a and 1b above. An indication of the goodness of fit is provided by the standard error of the regression. [Note that in the case of the existence of autocorrelation R^2 is not given by the estimation procedure]. In the I.V. estimate (equation 1b) S = 2146, indicating that the percentage error, measured by (S/M), is only 1.25%. All parameters bear the a priori expected sign and their coefficients are significant at 1% confidence level. The equations are corrected for first

order serial correlation. In the I.V. equation the estimated short-run marginal propensity to consume is 0.153, while the suggested long-run marginal propensity to consume is 0.64 (= 0.153/(1-0.762)), which is on the low side. It must be pointed out that there is no general agreement on the values of the marginal propensity to consume in Greece, among the investigators[18], some studies even reporting a long-run marginal propensity to consume greater than unity. This might quite likely be the result of data deficiencies, especially during the period 1967-74 of the military dictatorship. The coefficient of adjustment of desired to equilibrium comsumption α is 0.238 (=1-0.762), indicating a slow rate of adjustment, since only 24% of desird consumption is realized within the first year.

Besides income effects, empirical evidence supports the view that the real stock of money has a significant effect on the level of real consumption expenditure, over the sample period[19]. The influence of the expected change in prices is clearly born out by the results. The negative sign of the coefficient, indicates that in periods of inflation the level of real consumption is depressed, possibly due to unanticipated price changes which restrain consumers' spending.

The inclusion of the rate of interest enters with a negative sign, therefore associated with negative income effects, but it does not render a significantly different from zero coefficient, without improving the fit of the equation. The results, therefore, are inconclusive about the possibility of monetary policy directly influencing the pattern of consumers' expenditure through the rate of interest.

4.1.2 Fixed Business Investment (I_t)

Although there exists a considerable number of investment studies, there is not a generally accepted theoretical explanation for investment expenditures[20]. The appropriate form of investment expenditure functions should be decided on empirical grounds, since institutional factors play a determining role in explaining enterpreneurial motives in each country.

A convenient framework for the analysis is to consider the problem of investment demand (I_t) in two stages:

a. What determines the optimal capital stock (K_t^*),

b. How the economy (or the firm) adjusts itself from its actual capital stock (K_t) to optimal capital stock (K_t^*),

or otherwise stated, if $I_t = F(K_t^*, K_t)$, the problem is equivalent to determine K_t^* and specify F.

As regards the factors determining the level of optimal capital stock, the theory emphasizes the fact that expected sales (or profits) determine business investment in fixed capital, on the assumption of sales' (or profits') maximization[21]. Lack of information on these variables, forced us to choose the level of national income as a proxy variable, representing the expected level of sales.

The problem of lags is also very crucial, since investment decisions taken in the past manifest themselves in the present or in the future. Although it is understood that the first period effects on investment are stronger, quickly diminishing in time, there is no a priori evidence for the investment lag structure[22]. This has to be decided on empirical grounds. Our data (annual series) does not permit any detailed

treatment of the investment lag structure and we rely on the level of GNI lagged one period, on the assumption that firms' decisions for investment plans are taken a year in advance on information presented normally every year.

However, including only real variables in the determinants of investment in fixed capital, would mean that investment decisions are carried out once decided. This would mean that firms either have or can acquire the necessary funds, through the financial intermediaries or directly from abroad. The degree of self-financing of Greek firms is limited, due to their small size and they rely, to a large extent, on the availability of long-term loans allocated to them by the banking system, at the prevailing interest rate[23] When firms undertake investment decisions they give full consideration to the availability of financing and the cost of funds. In an economy like Greece, the growth of fixed capital formation is considered of vital importance and the authorities, along with other objectives, aim at controlling directly private investment expenditure.

In these circumstances, the level of fixed capital stock is effectively determined partly by the market forces and partly by the authorities' policies. Since it is more profitable for the commercial banks to lend short, the authorities intervene in the distribution of funds through rationing and preferential credit allocation[24]. It is thus plausible to regard the amount of credit allocated to the private sector (CRI_t) as supply determined, a policy instrument, reflecting the authorities' strategy towards not only monetary managment, but also investment decisions[25].

These factors do not curtail the ability of the firms to acquire the necessary funds through the market

mechanism of the banking system, that is to obtain loans at the prevailing market interest rate (R_t)[26]. As a result, we expect both the rate of interest and the allocation of credit to explain the desired level of capital stock, since investment decisions are affected in a more direct way than just via the general monetary squeeze and ease.

Another factor that determines the level of desired fixed capital stock is the degree of firms' financing directly from foreign funds. This is measured by the amount of foreign capital inflow for fixed capital formation (KI_t). The continual effort of the Greek authorities to attract foreign capital has been facilitated by a series of incentive legislation initiated by the Legislative Decree 2687/53 about 'Investment and Protection of Foreign Capital' and extended by supplementary legislation in later years[27].

The adjustment process assumes a capital-stock adjustment mechanism, that is, the actual capital stock adjusts only partially to the discrepancy between desired capital stock and actual capital stock of the previous period, i.e.

$$K_t - K_{t-1} = \gamma(K_t^* - K_{t-1})$$

where γ is the rate of adjustment to equilibrium capital stock, postulated as:

$$K_t^* = i_0' + i_1' Y_{t-1} + i_2' CRI_t + i_3' KI_t + i_4' R_t$$

The level of gross investment expenditure is given by:

$$I_t = I_t^{net} + \gamma K_{t-1} = K_t - K_{t-1} + \gamma K_{t-1}$$

Combiming the above equations and adding an error term, we obtain:

$$I_t = i_0 + i_1 Y_{t-1} + i_2 CRI_t + i_3 KI_t + i_4 R_t + i_5 K_{t-1} + u_{2t}$$

where, $i_j = \gamma i_j'$ ($j = 0, 1, 2, 3, 4$) and $i_5 = -(\gamma - \delta)$.

The capital stock series is calculated using data on I_t, an estimated value for the depreciation rate[28] and employing the relationship:

$$K_t = I_t + (1 - \delta) K_{t-1} \qquad \text{where } K_{1956} = 0$$

for the actual capital stock.

The empirical estimates are shown by equations 2a and 2b above. The goodness of fit is provided by $R^2 = 0.977$. In equation 2b, S = 1886, indicating that the average percentage error in explaining the variability of private investment is 8.3%. This is not as good as in the consumption function, but is quite satisfactory, considering the unpredictability of investors' behaviour. The D.W. statistic rejects the existence of autocorrelation in the residuals at the 5% confidence level.

All coefficients appear with the a priori expected signs. In the I.V. estimate the coefficients of Y_{t-1} and K_{t-1} are significant at 1% level of confidence, while those of CRI_t and KI_t at the 5% level. The interest rate variable (R_t) is retained at the 10% confidence level, since it represents the cost of borrowing funds and it is very important in determining investment decisions, considering the low degree of self-financing of the majority of the Greek firms, due to their small size and particular character[29].

The estimated equation clearly supports the capital stock adjustment hypothesis. The implied rate of adjustment $\gamma = 0.168$, ($i_5 = -0.142 = -(\gamma - 0.0256)$ therefore, $\gamma = 0.1676$), indicating that 16.8% of the desired capital stock is realized during the first year[30].

We now present the estimated partial elasticities of the I.V. equation to assess the influence of the explanatory variables throughout the sample period.

	$\eta_{I,Y_{-1}}$	$\eta_{I,CRI}$	$\eta_{I,KI}$	$\eta_{I,R}$
1957-75	2.516	0.200	0.133	-0.160
1958	3.254	0.094	0.060	-0.509
1965	2.437	0.127	0.203	-0.161
1970	2.148	0.219	0.196	-0.102
1973	2.054	0.236	0.109	-0.092
1975	2.745	0.287	0.147	-0.162

Fixed business investment seems to be elastic with respect to income (Y_{t-1}) throughout the period and inelastic with respect to the other variables (CRI, KI, R). The partial elasticities at different points of the sample period, show a tendency for the financial variables to gain more importance at the expense of the real ones. In the process of industrialization business investment seems to be financed more by bank credit and less by retained profits. The credit variable is becoming the most important factor for the boost in private investment expenditure. The interest rate gains importance when there is a shortage of bank credit in general, or when non-priority industries are willing to invest more and restrained by imposed credit rationing, seek to obtain loans through the market mechanism. The foreign capital inflow is responsible for substantial increase in investment, especially in the late 60's.

4.1.3 Private Housing Investment (H_t)

Among other factors, demographic changes are considered to be relevant determinants of private investment in residential construction. The growth of population can be thought as a relevant explanatory variable, but its importance is undermined, since population increases over the period are very small compared to increases in residential investment. The degree of urbanization would be of some importance if we

could use quantitative information, but the degree to which this can be done is limited by the scarcity of consistent data.

As a result, we have not allowed for the effects of demographic factors in the residential construction equation.

The availability of funds[32] and the cost of borrowing are considered to be the most relevant factors accounting for the short-run fluctuations in housing investment. The supply of funds for financing of residential construction, comes either through the banking system (mainly the Mortgage Bank), or directly from foreign sources. Recalling the discussion in Chapter 2, Sections 5 and 6, financing for residential construction from abroad (KH_t) plays a dominant role in determining the level of investment in housing. The importance of this factor can be highlighted by considering its structure. It consists mainly of remittances of Greek emigrant workers intended, not so much for financing of business investment, but for purchasing of real estate and houses. In addition, the prevailing market interest rate (R_t) determines the cost of borrowing for the construction of dwellings[33].

Of greater importance, however, is the shifting of credit between the various sectors (e.g. construction, manufacturing etc.). The authorities, in their effort to regulate the economy, intervene directly, imposing restrictions on the amount of credit available for construction (CRH_t). The allocation of credit for this sector has a clear countercyclical tendency, since it is a direct instrument for stabilization purposes[34]. The national income might be of some importance for the determination of investment in residential construction which is expected to decline, ceteris paribus, with falling levels of real income. In the estimated equation the income

variable was insignificant, since our sample period is too short for the income variable, taken to explain long-term shifts in housing investment, to reveal any significant effects and was therefore, omitted[35].

We, therefore, postulate that the equation takes the following form:

$$H_t = h_0 + h_1 CRH_t + h_2 KH_t + h_3 R_t + u_{3t}$$

The empirical results are shown in equations 3a and 3b above. In the I.V. equation, the standard error of estimate, S = 1623 indicates that the percentage error is about 10%. All variables enter the equation with the expected sign and are significant at the 1% confidence level. Finally, the estimating procedure identified the existence of positive first-order autocorrelation in the residuals. Judging from the estimated coefficients, a unit increase in the foreign real estate capital inflow, induces a nearly 3 unit increase in housing investment, while a unit increase in new credit results in 1.7 units increase respectively. The fact that KH is so important in determining the level of investment in dwellings, diminishes the effectiveness of CRH as a countercyclical stabilization instrument. This loss of control by the authorities can be regained through the rate of interest, to the extent that it is policy determined. Indeed, a point increase in the rate of interest depresses housing investment by more than 0.1 units.

We present below the partial elasticities of H_t with respect to individual coefficients to reveal the changes in influence of the explanatory variables, throughout the sample period.

	$\eta_{H,CRH}$	$\eta_{H,KH}$	$\eta_{H,R}$
1957-75	0.253	0.473	-0.466
1958	0.074	0.438	-1.382
1965	0.100	0.368	-0.422
1970	0.554	0.364	-0.332
1973	0.155	0.592	-0.259
1974	0.200	0.814	-0.740
1975	0.162	0.826	-0.543

The elasticity of housing investment with respect to KH has been more or less constant throughout the period, with the exception of the last three years which was nearly doubled. In the last three years, with increasing inflation and uncertainty, it became more profitable and less risky to invest in housing. Consequently, a larger proportion of savings of Greek emigrants, which constitutes mainly KH, went for purchasing of real estate and houses, that would have otherwise financed small businesses.

The elasticity of housing investment with respect to CRH starts from a very low (less than 0.1) at the beginning of the period, reaching a high value in the late sixties and dropping back in the seventies. This fact reflects the counter-cyclical/preferential allocation of credit to housing industry. At the beginning of the period, housing had a low priority until the late sixties when new credit was more easily available. The rationing of credit in the seventies counterbalances the drop in KH.

The pattern of the interest rate elasticity of housing is similar but in opposite direction to that of credit, since both variables are assigned the same role.

4.1.4 Inventory Investment (ΔS_t)

Private inventory investment (Stockbuilding) contributes 2.6% on average to total final demand. Its wide fluctuation over the cycle affects all sectors of the economy and acts as a destabilizing element on aggregate demand. It also differs from fixed business investment, being depleted rather than depreciated, while expectations play a far more important role in inventory decisions. The level of inventories can be regarded as an indicator for businessmen in the process of taking decisions about other variables, like prices, production and sales. As a result, an explicit formulation of the determinants of inventory investment is essential for the better understanding of fiscal and monetary policies.

Inventories can be classified into three categories with respect to the various forms in which they are held, that is, raw-materials, work-in-progress and finished goods. The optimum, or equilibrium, level of stocks is determined by a cost function relating the costs and benefits of holding additional stocks. Owing to the difficulties associated with the correct classification and the accuracy of measuring the stocks, there is a tendency not to specify a precise cost function[36]. It is thus assumed that desired (long run equilibrium) level of inventories depends mainly on expected sales or output, prices, interest rates and other variables.

It would be desirable to estimate disaggregated inventory investment equations to account for the fluctuations of stocks between the various sectors of the economy, but we only estimated an aggregate inventory equation, due to the unreliability of the relevant data.

The expected level of output/sales is the most

obvious candidate for the explanation of the equilibrium level of stocks and is approximated by the level of national income[37]. Also the expected price changes in the value of stocks held provides reasons for changes in the volume of stocks. A positive correlation between the two variables is explained by the precautionary or speculative motives[38] of the producers, while a negative correlation signifies that when firms find themselves with excess inventories they try to sell them at lower prices[39]. However, these facts cannot be precluded on a priori grounds, since producers may alter the composition of their stocks instead of the volume. Experimentation with the rate of interest as a possible determinant of the equilibrium level of stocks proved unsuccessful, and therefore no direct way by which the authorities could regulate the level of inventories is revealed[40].

Since changes in stockbuilding is essentially a short-run phenomenon, the 'accelerator-type model' of partial adjustment process to equilibrium is applicable. We therefore assume that[41]:

$$S_t - S_{t-1} = \theta(S_t^* - S_{t-1})$$

where θ is the rate of adjustment of actual to equilibrium stock, given by :

$$S_t^* = s'_0 + s'_1 Y_t + s'_2 \dot{P}_t$$

Substituting the second into the first of the above equations and adding an error term, we obtain:

$$\Delta S_t = s_0 + s_1 Y_t + s_2 \dot{P}_t + s_3 S_{t-1} + u_{4t}$$

where $s_j = \theta s'_j$ for $j = 0, 1, 2.$ and $s_3 = -(1 - \theta)$.

The actual level of stocks of the previous period, entering the equation, is obtained by employing the identity:

$$S_s = \Delta S_s + S_{t-1} \qquad \text{assuming} \quad S_{1956} = 0$$

The estimated equations are shown in 4a and 4b above. The explanation of changes in stocks is not very satisfactory, since the standard error of estimate is on the high side. The goodness of fit, judged by the R^2 statistic, signifies that 0.81 of the variation in ΔS is accounted for by the included explanatory variables.

All coefficients are significant at the 1% level of confidence. The rate of adjustment of actual to equilibrium stock is 0.806, which is quite high, since nearly 80% of desired stocks are realized within the first year. Finally, note that changes in stocks seem to be fairly sensitive with respect to price changes over the period under study. The average elasticity of ΔS with respect to $\dot{P}$ amounted to 0.467.

4.1.5 Import Function (Q_t)

As we have already mentioned in Chapter 2, Section 6, imports of goods and services played a decisive role in the process of economic development in Greece. Industrial activity is to a great extent dependent on the volume of imported capital goods, while the import substitution activities are not substantial. We have not made any attempts to disaggregate the volume of imports and estimate different import functions for groups of items possessing similar characteristics, because we thought that, for the purpose of this highly aggregate model, very little information is lost by working with an aggregate relationship for imports[42].

In current econometric research import functions are viewed as analogus to any commodity demand functions, where, mainly income and relative prices are the determining

factors. Due to aggregation problems, the issue of relative prices is still unresolved. Besides the critisism raised by Orcutt[43], the majority of empirical studies do not reveal any significant relative price effect, since the estimated coefficients are biased towards zero as a result of aggregation errors[44]. Some other studies, however, have reported significant coefficients for the relative prices[45].

In view of the fact that total imports are related to the level of domestic activity, it would be desirable to relate them to the individual components of domestic activity. The high degree of correlation between these components makes it impossible to disentangle their relative effects on imports, and we therefore employed a composite variable to explain variations of total imports.

After the import liberization in the mid-fifties, Greece was not faced with a foreign exchange shortage, due to the considerable amount of invisible receipts and the foreign capital inflow. For these reasons we have not included in the import function any, frequently quoted, measure of the country's stringency of foreign exchange[46].

Finally, allowing for the fact that imports are not automatically realized, due to the existence of various lags and delays (e.g. delivery[47]), we assumed a partial adjustment mechanism of the form:

$$Q_t - Q_{t-1} = \varepsilon(Q_t^* - Q_{t-1})$$

Where Q_t is the level of actual imports and the equilibrium level is given by:

$$Q_t^* = a + bY_t^d$$

Hence, the familiar reduced form is shown below:

$$Q_t = q_0 + q_1 Y_t^d + q_2 Q_{t-1} + u_{5t}$$

The estimated equations are reported in 5a and 5b above. Judged by the R^2 statistic of 0.965 (of the OLS equ.), the explained variation by the independent variables is quite satisfactory, recalling the aggregate character of the import function. The standard error of the equation is about 10% on average. All coefficients are significant at the 1% level of confidence and the results do not reveal the presence of any significant correlation in the residuals.

The coefficient of adjustment of actual to equilibrium level of imports ϵ is 0.14, which reveals a low response as a result of the existing delays.

The average short-run income elasticity of demand for imports during the sample period is 0.388. The long-run elasticity is 2.75 which is high due to the fact that a large proportion of imported goods consists mainly of luxury consumer goods and plant equipment, which have a high income elasticity. An observation of the long-run income elasticities at different points of the sample period, reveals an apparent expansion of the import substitution industries: $\eta_{58} = 3.22$, $\eta_{64} = 3.01$, $\eta_{70} = 2.96$, $\eta_{73} = 2.24$, $\eta_{75} = 1.74$.

The coefficient of relative prices did not render any significant results. A very small (near zero) relative price effect, conforms easily with the nature of the majority of the imported goods, capital goods, luxury goods, which are price inelastic. Finally, experimentation with the import credit as a possible determinant of the demand for imports, did not produce any significant results.

4.1.6 Demand for Money (M_t^d)

Modern theories of the demand for money (Keynesian, Monetarist) analyze the subject within the standard choice theory model. Both approaches regard money as a way of holding wealth, but emphasize different aspects of the problem. Keynesians formulate their analysis in terms of the demand for money, as an asset alternative to other assets, while Quantity Theorists emphsize the flow of services which money provides to its owner[48].

The demand for money function is treated as an application within the context of portfolio analysis. This is rationalized on the grounds that money, in addition to its function as a medium of exchange, serves as a store of value, which makes money an asset alternative to other assets. We have thus postulated that the main variables explaining the demand for money are interest rates, income, and expected change in prices.

The implication of the interest rate is that the adjustment of the individuals' portfolios from a position of disequilibrium to equilibrium falls, at least initially, on financial assets. The possibility of including more than one interest rate in the demand for money equation is not attempted here, since the high correlation between the various interest rates creates serious multicollinearity problems. The expected rate of interest is approximated by the current period rate of interest (R_t).

The inclusion of the income variable plays the role of a constraint in the utility maximization problem. Furthermore, the amount of cash balances one decides to hold is also dependant on the expected rate of price increases. A rise in

the expected rate of inflation will have a negative effect on the demand for money, since the opportunity cost of holding money increases. We introduced the rate of change in the price level to account for expected price rises.

Some investigators have assumed that the adjustment of the demand for money to equilibrium is instantaneous, or that the lags involved are of negligible length[49]. In this case, desired and actual money holdings are the same. Yet, if we assume that time elapses before individuals become aware of changed external conditions and rearrange their portfolios accordingly, that is, money holdings are adjusted by some fraction β of the difference between the actual and desired levels, such that:

$$M_t - M_{t-1} = \beta (M_t^* - M_{t-1}), \quad 0 < \beta < 1$$

where the equilibrium level of money balances is postulated to be:

$$M_t^* = \dot{m}_0 + \dot{m}_1 Y_t + \dot{m}_2 R_t + \dot{m}_3 \dot{P}_t$$

Combining the above equations and adding a disturbance term, we obtain the demand for money equation:

$$M_t^d = m_0 + m_1 Y_t + m_2 R_t + m_3 \dot{P}_t + m_4 M_{t-1} + u_{6t}$$

where $m_j = \beta \dot{m}_j \qquad (j = 0, 1, 2, 3) \qquad$ and $m_4 = (1-\beta)$

Finally, a dummy variable is introduced into the equation to account for the irregular increase in money demand in 1967, due to the installation of the military regime. It takes the value of one in 1967 and zero elsewhere.

The empirical results are shown in equations 6a (OLS) and 6b (I.V.) above. In equation 6b the standard error of estimate, S = 1257, indicates that the percentage error is 2.84% on average. The goodness of fit is satisfactory

if judged by the R^2 statistic (0.997). Also, the possibility of autocorrelation in the residuals is dismissed.

The coefficients of Y_t, R_t, M_{t-1}, are significant at the 1% level of confidence while that of $\dot{P}_t$ just fails at the 5% level. The implied coefficient of adjustment to equilibrium ($\beta = 0.595$), indicates that nearly 60% of the desired money balances are realized within the first year.

The estimated I.V. equation implies the following income and interest elasticities for the demand for money:

a. short-run $\quad \eta_{M,Y} = 0.801 \quad \eta_{M,R} = 0.105$

b. long-run $\quad \eta_{M,Y} = 1.346 \quad \eta_{M,R} = 0.175$

An interesting result is that the long-run $\eta_{M,Y}$ is greater than unity, which is not in accordance with evidence provided by other countries[50]. Bearing in mind the developing character of the Greek economy, the wealth owning individual faced with limited alternatives of financial assets, holds an increased proportion of his income in the form of money balances, which conforms with an income elasticity greater than one.

4.1.7 Supply of Money (NM_t^s)

The total stock of high-powered money is equal to currency held by the public (currency outside the banking system) plus the net reserves of the commercial banks, i.e.

$$BA = C^p + R$$

The supply of money is equal to currency held by the public plus demand deposits (narrow definition of money, M_1), i.e.

$$M^s = C^p + D$$

After some mathematical manipulations[51], we obtain:

$$M^S = \left[\frac{1}{(C^p/M^S) + (R/D) - (R/D)x(C^p/M^S)} \right] BA$$

Thus the money supply is proportional to the monetary base (BA) and inversely proportional to the currency ratio (C^p/M^S) and the reserve ratio (R/D). Note that both ratios are less than unity implying that $(R/D)x(C^p/M^S)$ is also less than one.

We wish to evaluate the relative contributions of the currency and reserve ratios, as well as that of the monetary base to the changes in money stock. It is equally important to analyze the factors affecting the above ratios and the monetary base, in order to see to what extent the money stock can be considered a policy instrument. We shall not undertake an analytic examination of these factors, since this is carried out comprehensively by Kasmas (1972)[52]. Our basic conclusions draw on his detailed elaboration.

An important characteristic of the Greek economy is the high ratio of currency to demand deposits, implying a low bank multiplier. Consequently, changes in money stock can be attributed to changes in the monetary base. The two ratios (C^p/M^S, R/D) have not produced significant effects on the money supply and the analysis shows that important changes in R/D were the result of deliberate monetary action. The remaining changes in R/D as well as changes in C^p/M^S, were not erratic but followed a predictable behaviour pattern. Thus, part of the supply of money becomes endogenous, although the monetary authorities do not lose control of it if they can control the monetary base. Changes in the two ratios can be anticipated and taken into account in advance, or they can be offset by making adjustments to them as they occur.

The factors more responsible for the changes in monetary base are mainly the balance of payments, direct Central Bank advances to the economy and goverment borrowing from the Central Bank. Changes in the balance of payments affect the monetary base, but the authorities have the power to exercise their influence by taking action through balance of payments controls or controls on loans and advances, when so required. Direct advances to the economy by the Central Bank, are undertaken by its own initiative, while advances to government are the outcome of a cooperative policy between the government and the Central Bank[53]. Consequently, the monetary authorities control the money supply effectively via the monetary base.

We, therefore, postulated that the money stock is determined by the monetary base, i.e. $NM^S = f\ (NBA)$. Thus, the money supply equation takes the following form:

$$NM_t^S = r_0 + r_1 NBA_t + u_{7t}$$

The empirical findings are shown in equations 7a (OLS) and 7b (I.V.) above. In 7b, the average percentage standard error of estimate is only 3.6 (S = 1710), which is satisfactory as well as the goodness of fit, as provided by the R^2 (=0.998) statistic. The coefficient of the monetary base is highly significant and the implied bank multiplier is very close to unity (1.095), as expected.

Consequently, a change in the monetary base by one unit, induces a change in the money supply by more or less of one unit. This fact has important implications for monetary policy; indeed, the authorities in 1973-74 controlled the money supply, in their effort to control inflation through the determination of the monetary base.

4.1.8 Price Adjustment Equation ($\dot{P}_t$)

Much of the earlier debate on the causes of inflation revolved around the 'demand-pull' versus 'cost-push' distinction. According to the demand-pull thesis, an inflationary gap is created by an autonomous upward shift of the aggregate demand curve, increasing equilibrium output and equilibrium price. The cost-push interpretation of the inflationary process is initiated by an upward shift in the aggregate supply curve, reducing equilibrium output and raising equilibrium price. The interaction between the demand-pull and cost-push effects accords with the traditional discussion of inflation, where the interdependence of aggregate demand and supply sides, is a central future of macroeconomic analysis[54].

The meaning of the post-war development of the Quantity Theory refers to the demand for money and in this sense explains the role of money in generating inflation. Even in the most elaborate version, the Quantity Theory is a statement of the possible factors which may influence the demand for money. When a supply of money function is specified, the analysis proceeds in the examination of the independent monetary disturbances, utilizing the method of Marshallian supply and demand analysis. Therefore, changes in the quantity of money must lead to changes in the values of some of the arguments of the demand function. The form of these relative changes in the short-run adjustment process on real income and prices cannot be satisfactorily predicted by the quantity theory.

Much of the modern day inflation theory is devoted to the analysis of such short-run problems and is related to some variance of the so-called 'Phillips curve'[55]. Although

demand pressure is a considerable factor affecting the inflation rate, the difficulty lies in the choice of the variable to depict demand forces. Following the work by Phillips (1958), the rate of unemployment became the most widely used proxy for excess demand, since the demand for labour is a derived demand and, therefore, a change in unemployment rate reflects the pressure of final demand[56].

When, at about the mid-sixties, the simple Phillips curve appeared to break down, besides the difficulties in constructing such an index for excess final demand, questions were raised about the stability of the inflation-unemployment relationship, and about whether it is more than a short-run phenomenon[56a]. In addition, not all of the unemployed exercise a pressure on the labour market, but only the 'trained unemployed'[57]. Other proxies, such as the number of unfilled vacancies, might also render biased results, because of the existence of 'concealed' unemployment on the one hand, and the practice of labour 'hoarding'[58], on the other.

In the particular case of the Greek economy, the existence of underemployment in the agricultural sector, labour 'hoarding' and also the scarcity of relevant data, prevented us using such measures for the excess demand for labour. Another proxy that has been employed for demand pressures is the discrepancies between actual and 'potential' GNP, but the definition of 'potential' GNP involves a fair amount of arbitrariness and for this reason it was not used[59].

Besides the pressures of excess demand on domestic inflation, there is the element of the effects of the world economy, Recalling that until recently the Greek economy has been under a fixed exchange rate regime and there has not

been an effective barrier to foreign inflationary pressures, this factor is mostly relevant. Some of these effects on the domestic rate of inflation, can be captured by the rate of inflation of import prices ($\dot{P}^m_t$).

Thus, the price adjustment equation takes the following form[60]:

$$\dot{P}_t = p_0 + p_1(\dot{NM})_t + p_2\dot{P}^m_t + u_{10t}$$

The rate of change of money stock ($\dot{NM}$) stands as a proxy for excess demand pressures, and is rationalized on the grounds of the specific character of the Greek economy. The holders of excess money balances tend to spend on goods and services, due to lack of adequate debt and ownership instruments, bringing about pressures on the supply of money and, therefore, increase prices.

Finally, we tested the hypothesis that the inflation rate is determined by demand pressure factors, operating within the domestic economy and by expectations about the future course of inflation rate, formed on the basis of world and domestic inflation rate. This was undertaken by employing a simple adaptive expectations hypothesis model[61]. However, the final form of the model, including lagged $\dot{P}$ and $\dot{P}^m$ variables, did not produce significant results for the expectation variables.

The estimated equations are shown in 10a and 10b above. The goodness of fit (equation 10a), provided by the R^2 (=0.87) is judged to be satisfactory. All parameters bear the a priori expected positive sign and they are significant at the 1% confidence level. The equations are corrected for first order autocorrelation.

The coefficient of $\dot{P}_m$ is 0.471, which implies that

about 50% of the rate of increase of the general price index is accounted for by increases in import prices, while the coefficient of $\dot{NM}$ is 0.198 (nearly 20%). This point has important policy implications, since the authorities might find it very difficult to control the pace of inflation and at the same avoid substantial reductions in the level of economic activity[62].

4.1.9 Tax Revenue (NT_t^d and NT_t^i)

Tax revenue is obtained by a technical relationship between the tax base and the tax yield, with the relationship provided by the tax rates. That is, tax receipts depend on the tax rate and the taxable base[63].

We have divided total tax revenue into two main groups, whether incurred by direct or indirect taxes. Direct tax revenue NT_t^d depends on a whole shedule of tax rates and allowances, income, distribution of income, demographic factors etc., while indirect tax revenue (NT_t^i) depends on a range of tax rates and the corresponding tax (expenditure) bases. Moreover, in less advanced countries, tax collections are not an automatic non-stochastic relationship based on tax rates and the taxable bases. They are affected by a number of factors, such as, changing administrative efficiency and tax effort, changing attitude of the people toward tax payments, tax evasion, avoidance of taxes etc. Accordingly, when one estimates tax equations, in these cases, does not merely estimate a summarized or technical relationship, but some kind of a mixture of behavioural, institutional and technical relationships[64].

An analytic specification of various equations accounting for disaggragated tax revenues, would be necessary if we were to compare mainly the impacts on the economy of

different instruments of fiscal policy[65]. This study, however, is directed towards appraising the integration of fiscal and monetary policies in aggregate terms, and we think that a summarized view of the responsiveness of broadly defined tax groups is highly useful , since the existence of hundreds of excise tax rates and complex personal income tax schedules inhibit an overall view of tax responsiveness.

Although we experimented with the specification of different forms of the tax equations, we think that a simple formulation is adequate for the purpose of this study. We, thus, postulate that nominal tax revenues are a function of nominal income, that is:

$$NT_t^d = d_0 + d_1 NY_t + u_{8t}$$

$$NT_t^i = t_0 + t_1 NY_t + u_{9t}$$

The empirical results are shown in equations (8a,8b) and (9a, 9b) for direct and indirect tax revenues respectively. All coefficients are significant at the 1% level of confidence. For the direct tax equation the test for the existence of autocorrelation is inconclusive, while the indirect tax equation is corrected for first-order serial correlation in the residuals. The standard error of estimate, although on the high side, (10% and 17% for NT^i and NT^d respectively), is judged to be adequate for the aggregate character of the equations.

As expected, the marginal direct tax rate is quite low both in absolute terms and compared to the indirect tax rate. The reason is to be found in the developing character of the economy. The estimated equations also bring out the regressiveness of indirect taxation and the progressiveness

of direct taxation, since the estimated indirect base tax level (t_0) appeared positive in the equation, while that of direct taxation (d_0) was negative. Note that most countries at a similar stage of development show similar values of tax parameters[66].

Tax rates are not included explicitly in the equations, since they changed very little over the sample period and their exclusion introduces minimal bias into the equations[67]. A time trend was also tried to identify any possible shifts in the functions in the long-run, but it did not render any significant results. To account for delays in tax collections, one year lags in the tax base were introduced, but again the results did not improve. Finally, the tax revenue lagged one year was included in the equations, to account for any 'non-zero base' budget effects, but again the trials were unsuccessful.

4.1.10 The Government Budget Constraint (G.B.C.)

The budget constraint is the balance of payments statement of the government. It expresses the fact that the net flow of Central Bank money from the public sector equals the net increases of the stock of Central Bank money, held by the private sector. A government deficit increases the net assets of the private sector in a similar way, as the surplus reduces the net assets of the public. Such changes are likely to affect the rate of interest and the level of income. Therefore, it becomes obvious, that all conclusions about fiscal and monetary multipliers, common in the literature, are at least biased, if no account is taken of the budget balance. It is by now established, that the total multiplier

effect of an increase in government expenditure depends on the type of financing (taxes, money creation, sales of bonds)[68].

Carl Christ (1967), emphasizes that major monetary and fiscal policies are interdependent, because of the existence of the government budget restraint, which allows the authorities only N-1 degrees of freedom in the setting of N monetary and fiscal policy variables. The effect of the change in any single policy variable depends on how the other policy variables are varied to satisfy the budget restraint[69].

The G.B.C., therefore, takes the following form:

$$G - T = \Delta BF_c + (\Delta BF_b + \Delta BF_p)$$

where G = Total government expenditure

T = Total tax revenue

ΔBF_b = Banks' net holdings of government bonds

ΔBF_p = Public's net holdings of government bonds

ΔBF_c = Central Bank's claims on the government

or otherwise written, employing the model's symbols[70]:

$$NG_t - NT_t^d - NT_t^i = \Delta NBA_t + \Delta PB_t - \Delta NF_t + e_{3t}$$

Any discrepancy on the LHS of the identity (budget deficit or surplus) is matched by an equal change of one or more terms of the RHS (type of financing). Thus, the inclusion of the G.B.C. provides us with the necessary link for the explicit analysis of the interaction of fiscal and monetary policies, within the context of the economic model. As we saw in Chapter 3.1 above, the allowance for the financial implications of the budget alters the behaviour of the economic model qualitatively. In this respect, the model presented above is an improvement in relation to model building for the Greek economy. With the exception of Koutsoyiannis (1978)[71], none of

the existing models for Greece incorporates a Government Budget Constraint[72].

One final point to be mentioned about the specification of the government budget constraint is the sterilization effect. It results from the fact that the domestic authorities engage in open market operations directed at offsetting any changes in the money supply, originating from fluctuations in the balance of payments. The sterilization effect can be accounted for by writing the domestic monetary base in the form:

$$NBA^d = -(1-s)\ NF + \psi \qquad 0 \leq s \leq 1$$

where s is the sterilization coefficient and ψ is the autonomous changes in the monetary base. In the case of s=1, no offsetting adjustment takes place and $NBA^d = \psi$. If s=0, we have complete sterilization of the balance of payments surplus (or deficit).

Concerning the Greek experience, evidence suggests that, at least until recently, no sterilization occurred, since all foreign currency was converted to drachmas[73]. Hence, we have good grounds to assume the sterilization effect away in the course of this study.

4.1.11 Other Identities

The income identity is the one around which the model is built. The Gross National Income at factor cost is equal to the individual components of Gross National Expenditure, less net indirect taxes, taking the following form (equ. 11):

$$Y_t = C_t + I_t + H_t + \Delta S_t + G_t + X_t - Q_t - T_t^i + e_{1t}$$

The disposable income is defined by subtracting total direct taxes from the GNI at factor cost (equ. 12):

$$NY^{d}_{t} = NY_{t} - NT^{d}_{t} + e_{2t}$$

The balance of payments or the change in foreign reserves of the Bank of Greece is given by (equ. 13):

$$NF_{t} = NX_{t} - NQ_{t} + NKZ_{t}$$

Equation 15 relates the real demand for money to the nominal money stock (equilibrium position):

$$NM^{s}_{t} / P_{t} = M^{d}_{t} = M_{t}$$

Equations 18 and 19, simply define the price level and the rate of change of nominal money stock:

$$P_{t} = P_{t-1} \left(1 + \dot{P}_{t}/100 \right)$$

$$\dot{NM}_{t} = \left(NM_{t} - NM_{t-1} \right) x100 / NM_{t-1}$$

Finally, identities 20 to 29, define certain deflated variables in terms of their nominal values and the price level.

Lastly, regarding the estimation of the coefficients of the whole model, we should note that the magnitude of the single equation bias is small. This is indicated by an inspection of the OLS and the I.V. estimates, where the equation coefficients are very similar in value. The aggregate character of the model, employing a small number of pure exogenous variables, enabled us to obtain efficient estimates in the second stage of the procedure, since the number of variables left-out is small. The number of pure exogenous variables including instruments in the model is 16, out of which 8 variables were used as instruments[74]. Experimentation with different sets of instruments showed that the divergence in the results is minimal.

4.2 Simulation of the Model

In the previous section, we presented the results of estimation of the components of the model. The individual equations tell us something about the determination of the various variables in the model. This is important in understanding the transmission mechanism of the model and the relative effects of individual variables in the system on other variables. What is of greater importance, however, is how the set of relationships behave as a whole in a dynamic setting, in determining economic activity. This is the result of simulating the model over the estimation period[75].

The simulation exercise is carried out over the period 1959-75, the first two observations being used for the setting of initial conditions. All exogenous variables and instruments were set to their historical values and together with the initial conditions, the whole set of endogenous variables of the model were generated.

For the simulation results to be acceptable, the generated endogenous variables must trace their historical values as close as possible. To this end, we introduced a criterion to evaluate our results, the Root Mean Square Error (RMSE), defined as:

$$RMSE = \left[\frac{1}{N} \sum_{i=0}^{N} (Y_i^S - \bar{Y}) \right]^{\frac{1}{2}}$$

where, Y^S are the simulated values of the endogenous varibles and $\bar{Y}$ are their means, for the N number of periods. One deficiency of this criterion is that the value of the RMSE depends on the units of measurement of each variable. To overcome this problem, we introduced the %RMSE, which is defined as the ratio of the RMSE of each variable over the mean of the variable, i.e.

$$\%RMSE = (RMSE / \bar{Y}) \times 100$$

The main findings of the simulation run are presented graphically in figures 4.2.a to 4.2.b below, and the numerical values are reported in Appendix A.2. Besides the high degree of aggregation of the model and the small number of variables aiming at explaining the economic phenomena, the overall performance of the model is considered to be quite satisfactory.

Of the real sector equations, the private consumption equation tracks the historical values very closely (fig. 4.2.a, % RMSE = 1.50). The developments of the private investment equations is more difficult to trace, since they reflect much more complex economic phenomena. Nonetheless, they catch most of the turnings in the historical series. The performance of fixed business investment is more satisfactory than that of housing investment (fig. 4.2.b, $\%RMSE_I = 9.20$, $\%RMSE_H = 14.1$). The former diverges slightly from the historical series in the period 1968-70, while the latter is slightly out of phase in the construction boom of 1972-73 and misses the peak of 1965. Besides factors that are not captured by the equations, some of the discrepancies can be attributed to the simulated values of the rate of interest which oscillate somewhat about their actual value.

The description of the actual development of inventory investment by the model is quite crude (Fig. 4.2.d, RMSE = 3.32). Although the general pattern is reflected in the simulated series, inventory investment misses peaks and troughs in the early 70's and it is out of phase in the mid-sixties. Regarding this equation, our model is not immune to one of the main weaknesses of most econometric models.

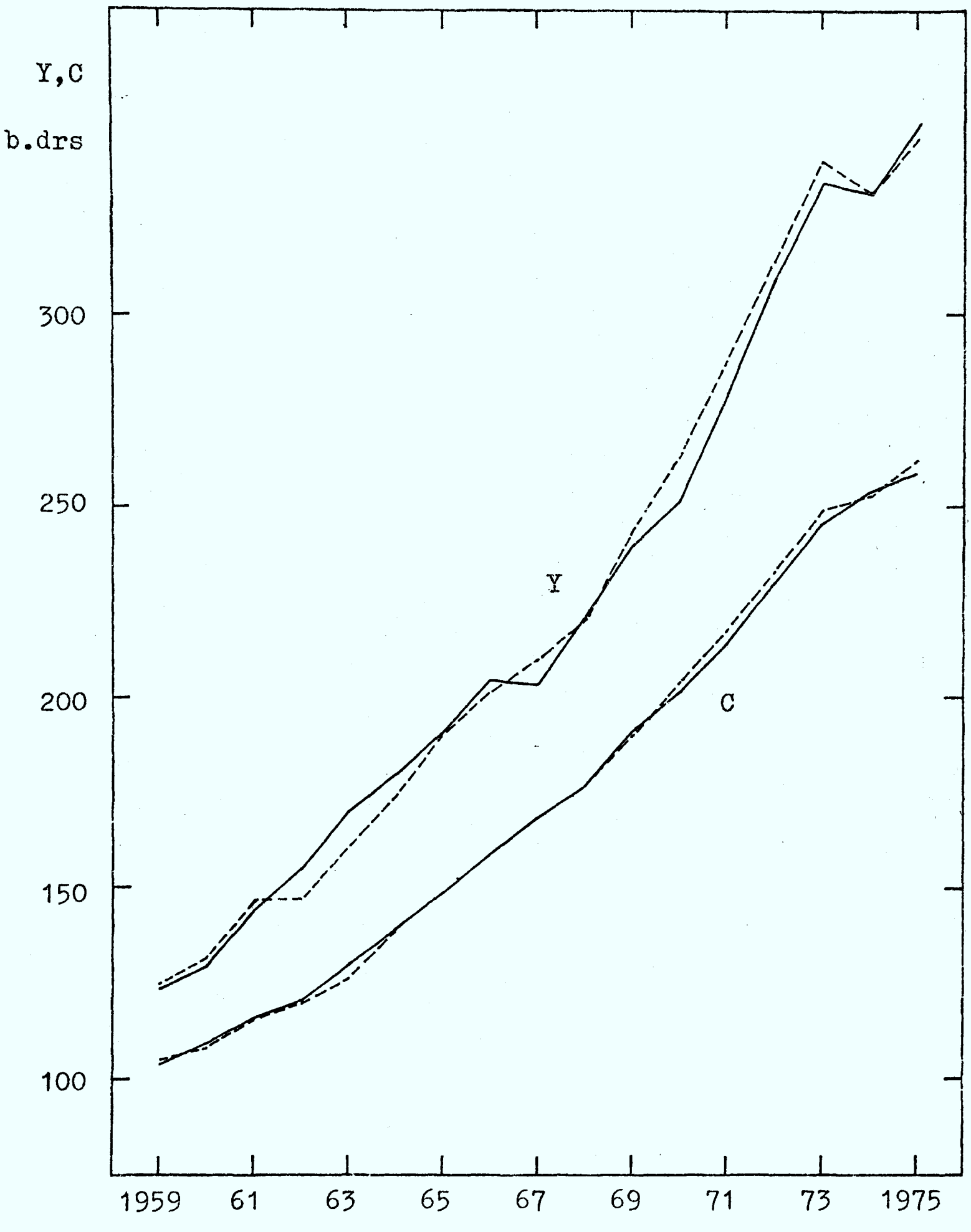
Given the aggregate character of the import function, the simulation results (Fig. 4.2.c, %RMSE = 9.15), are adequate for the purpose of this study. As regards the simulation results of the composite variable of major importance, Gross Domestic Income, it traces its actual values very closely (Fig. 4.2.a, %RMSE = 2.12). The low %RMSE of this variable is an indication of the 'goodness' of fit of the econometric model as a whole, in capturing aggregate economic activity.

The money supply variable (Fig. 4.2.c, %RMSE =3.17), traces its historical path well, as a result of the specification of the money supply equation, related to the exogenous monetary base. The simulated price adjustment equation (Fig. 4.2.d, RMSE = 2.55), catches the changes in direction of inflation well, missing out the years 1969 and 1970.

Finally, the results of the tax functions are shown in Fig. 4.2.3 ($\%RMSE_{NT}i$ = 10.4, $\%RMSE_{NT}d$ = 18.9). Recalling that the purpose of this model is not to incorporate detailed tax relationships, but simply to endogenize the effects of taxation in a general manner, the simulation results are judged to be satisfactory.

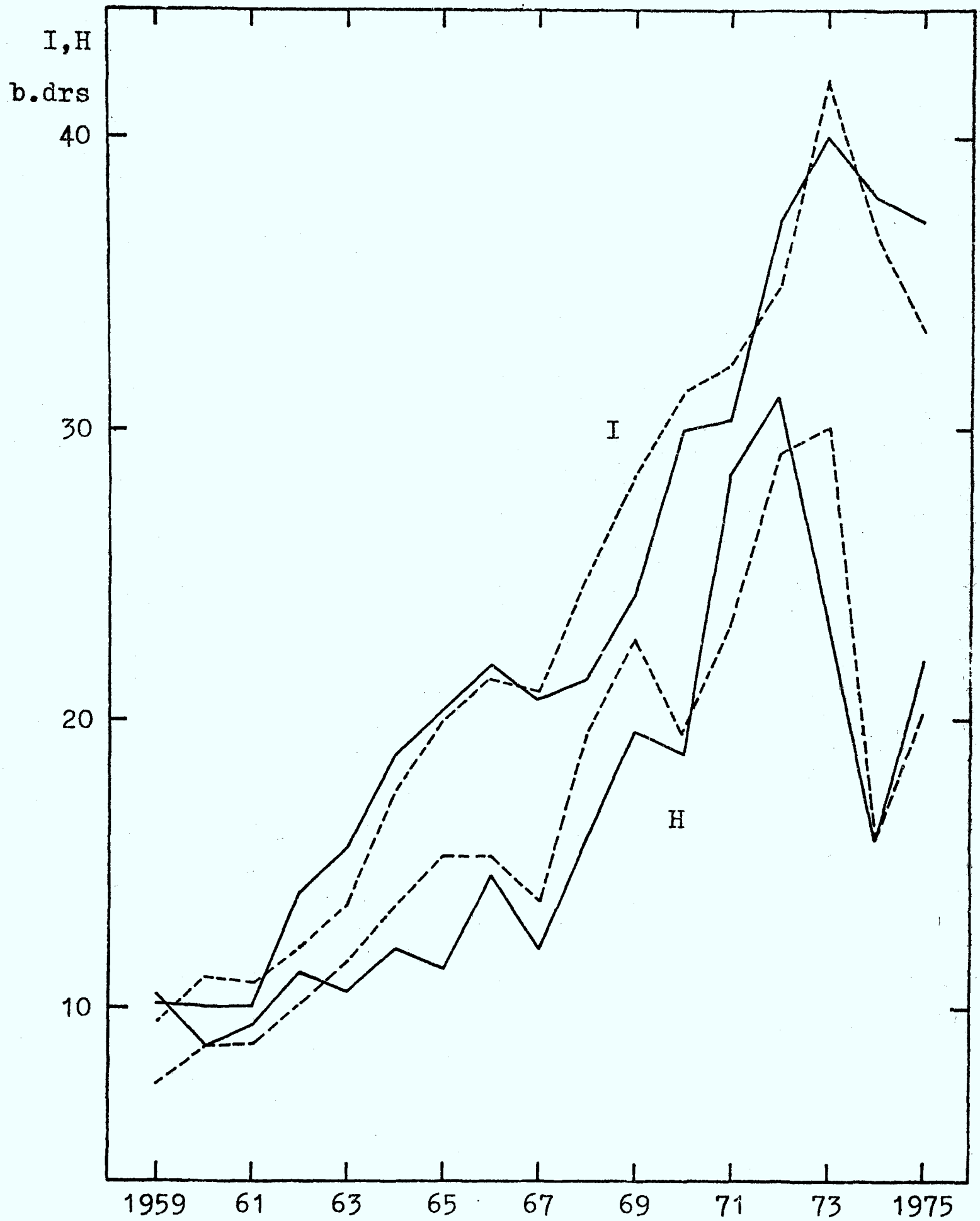
National Income &
Private Consumption

Fig. 4.2.a



Fixed Business Investment &
Housing Investment

Fig. 4.2.b

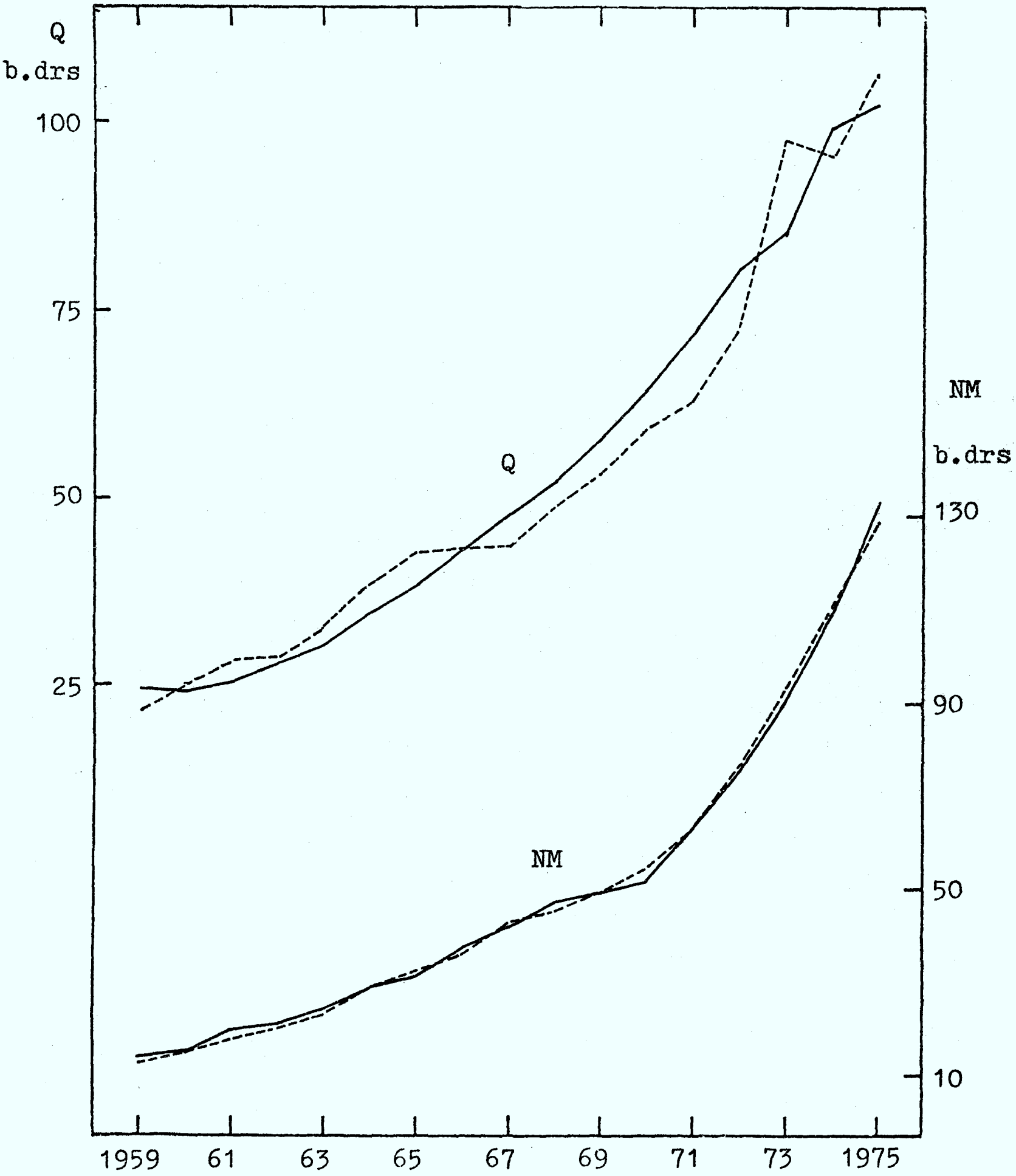


-------- actual

———— simulated

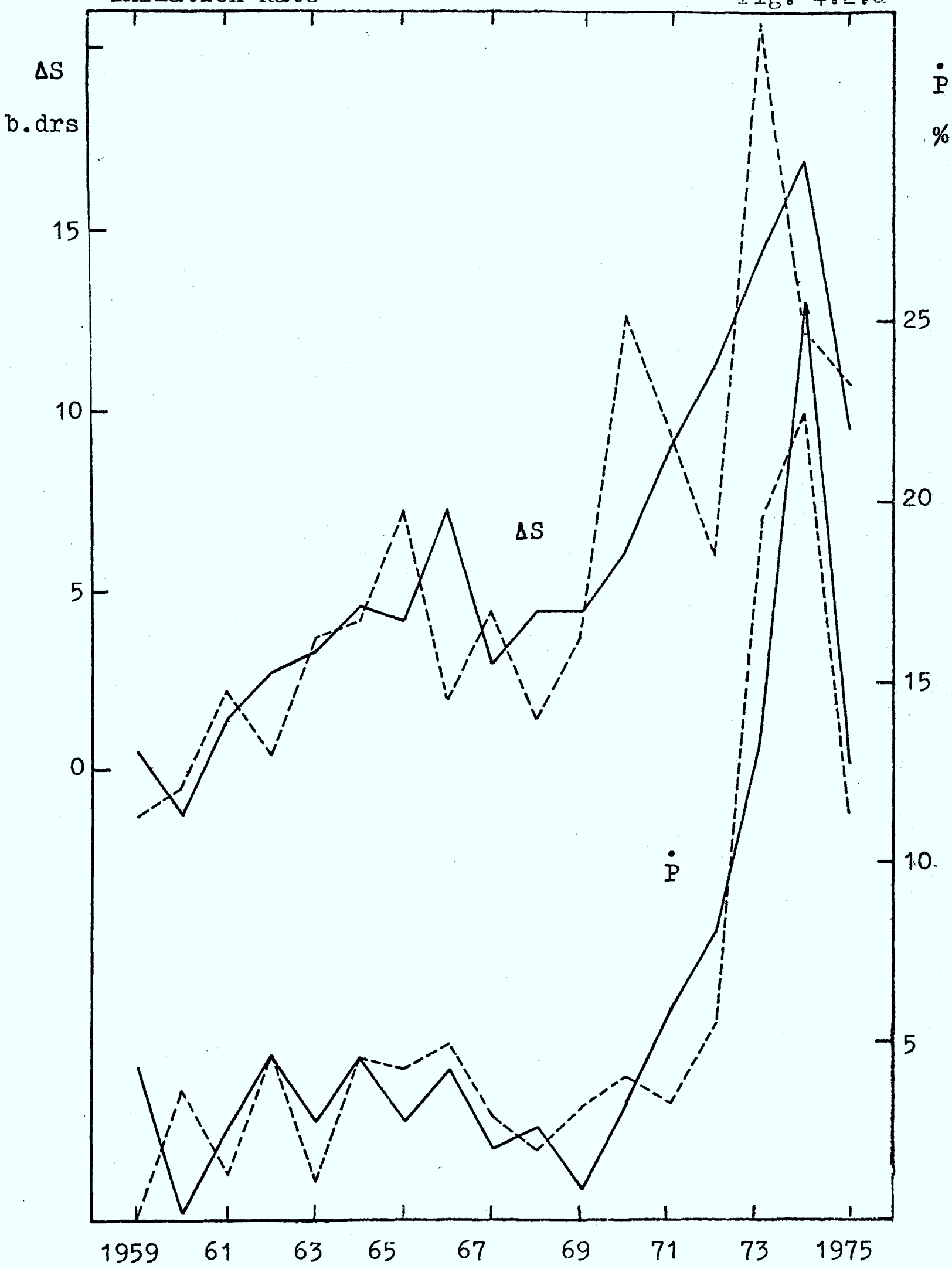
Imports &
Money Stock

Fig. 4.2.c



Stockbuilding &
Inflation Rate

Fig. 4.2.d

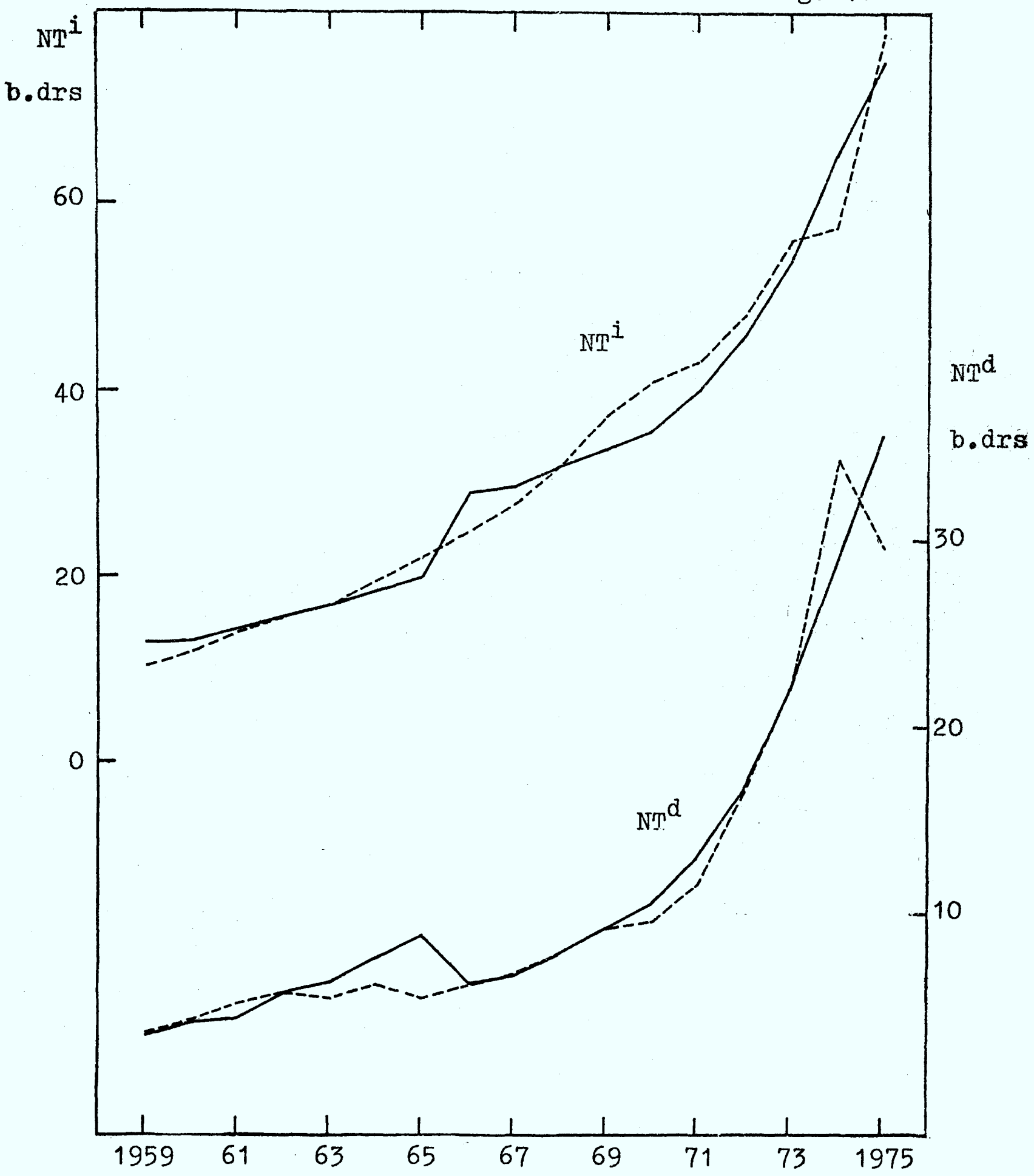


------- actual

——— simulated

Direct Taxes &
Indirect Taxes

Fig. 4.2.e



------- actual

——— simulated

4.3 The Policy Channels

The transmission mechanism of the model can be studied by analysing the effects of instruments on the targets. One way of dealing with the problem is in terms of direct effects and feedback responses of changes in instruments on the targets[76].

Direct effects, in our model, refer to the initial or first round impacts of changes in government expenditure and the associated changes, due to the way the resulting budget imbalance is financed. Feedback responses arise in response of the initial change in income and prices.

In the case of active fiscal policy, the following direct effects prevail in our model:

(1) The direct 'fiscal impact' of an increase in government expenditure on the level of income, due to the fact that government expenditure is itself a component of aggregate expenditure. Since government expenditure is measured in nominal terms, some of its impact will be diverted to real income and some to prices, in the case of endogenous price level.

(2) The direct 'wealth impact' [77], of an increase in real consumption expenditure, induced by an increase in the money supply and associated with an increase in the monetary base.

(3) The direct 'portfolio impact' of a decline in business investment and housing investment, associated with an increase in money supply on the rate of interest.

(4) The direct 'inflationary impact' of an increase in the rate of inflation, and consequently the price level, associated with increases in the rate of change of money supply.

(5) The direct negative impact on consumption expenditure and the demand for imports, due to a reduction in disposable income, associated with an increase in direct tax levels or direct tax rates.

(6) Finally, changes in the indirect base tax level work in opposite direction to changes in government expenditure and, therefore, reduce the initial fiscal impact.

It must be noted, that with the exception of the direct 'fiscal impact', which is always present when dealing with fiscal policy, effects (2), (3) and (4) are operative only in the case of money financed budget deficits and effects (5) and (6) only in the case of tax financing. In the case of bond financing, there is no direct effect in the model. Changes in the stock of outstanding government bonds and treasury bills, do not exert a direct impact, neither on real expenditures or the demand for money (wealth impact), nor on the rate of interest (portfolio impact).

As regards the feedback responses of the model, we can distinguish the following:

(a) A negative feedback response on fixed business investment and housing investment, due to the fiscal impact via the increase in the rate of interest and also a positive feedback response, associated with expansions in the money supply and thus, reductions of the rate of interest.

(b) A negative feedback response on consumption expenditure and on the rate of interest, and a positive response on stckbuilding, associated with increases in the inflation rate, due to increases in the rate of change of money supply.

(c) A negative feedback response on all real

endogenous variables in the system, due to decreases in the multipliers, associated with increases in the marginal tax rates.

(d) A positive feedback response on the demand for money function, tax functions, income responsive expenditure functions (and consequently a negative feedback response on the balance of payments), due to increases in income, associated with the initial fiscal impact of government expenditure.

4.4 Policy Multipliers

In what follows, we provide the dynamic multipliers of the model for the Greek economy, which give the effects of certain key policy instruments on the most important endogenous variables. When dealing with linear models of the form:

$$B_0Y_t + B_1Y_{t-1} + \ldots + B_nY_{t-n} + CX_t = u_t$$

the dynamic multiplier can be obtained from the final form of the dynamic econometric model, given by:

$$Y_t = -B(L)^{-1}CX_t + B(L)^{-1}U_t$$

derived from the reduced form of the model, given by:

$$Y_t = -B_0^{-1}(B_1Y_{t-1} + \ldots + B_nY_{t-n} + CX_t) + B_0^{-1}U_t$$

on the assumption that

$$B(L) = B_0 + B_1L + \ldots + B_nL^n$$

is stable[78], where the B_1 matrices are all GxG in the case of G endogenous variables, n representing the maximal lag that appears in the system, X being a vector of the truly exogenous variables, and Y_{t-j} $(j>0)$ being a vector of lagged endogenous variables, L denoting the lag operator.

However, dealing with non-linear models, the multipliers derived above no longer apply, for there is no longer an explicit reduced form of the model. In general, multipliers depend on the levels of the variables at which they are calculated and are not simple functions of the parameters of the system. They are different at different states of the economy and, therefore, depend on initial conditions.

In the case of non-linear systems, multiplier analysis proceeds by the method of simulation, as follows. The solution for the endogenous variables are obtained using actual values

of the exogenous variables as done previously in section 4.2, which is labeled 'control solution'. The effect of a change in an exogenous variable on the system, is obtained by recomputing the solution running the simulation for the endogenous variables, with different values of the exogenous variables and comparing the 'control solution' with the new 'disturbed solution'. The 'disturbed solution' is thus, based on the different values of the exogenous variables.

The multiplier effects for a number of periods of dynamic simulation, are derived using the ratio of the difference between the two solutions, 'control' and 'disturbed', and the two sets of exogenous variables, actual and 'disturbed'. These are the 'dynamic' multipliers of the system, although derived in a different manner, describing the dhanges of endogenous variables over time, in response to a change in the exogenous variables[79]. The multipliers may vary with the size of the perturbation of the exogenous variables, if the model is highly non-linear, but experiments indicated that this is not the case with our model.

The dynamic multipliers of government expenditure (NG), and of the monetary base, for some key endogenous variables, are presented in Tables 4.4.a and 4.4.b below. The disturbed solutions result from a unit (not sustained) shock of 1 b. drs in nominal government spending and monetary base, and measure the current and delayed effects on the time path of the endogenous variables. Changes in sign occur for the system oscillates as it returns to equilibrium.

As can be seen from the impact multipliers (first period), a 1 b. drs increase in NG, ceteris paribus, tends in the current period to result in an increase of 0.747 b. drs

in nominal income, and in an increase of 1.02 b. drs in real income[80]. The unit increase in NG, increases the rate of interest in the first period by 0.2%, which in turn, depresses fixed business investment by 0.13 b. drs and housing investment by 0.273 b. drs, the latter being more responsive to interest rate changes. Fixed business investment is mostly affected in the second and third peiods, due to the lag structure of the investment function. Private consumption is increased by 0.15 b. drs in the first period.

As shown in Table 4.4.a, a positive change in government expenditure has its greatest impact on real income during the year in which the outlays are made. The GNP fiscal multiplier remains positive for the next two years, then becoming negative. As the number of periods increase, the multiplier converges asymptotically to zero. The movement to a new equilibrium position appears to be relatively slow, since the cumulative GNP multiplier (measuring the effect of a sustained increase of one unit of each of the exogenous on endogenous variables over time) is within a range of $\pm$ 10% of the equilibrium multiplier after 10 to 12 years. The negative effect after three years of an increase in NG, reflects the, already mentioned, crowding-out effect. The higher levels of consumption and investment, induced by changes in public spending, cause interest rates to rise. The higher interest rates will eventually lead to a reduction of investment, which depresses income and consumption.

The cumulative GNP multiplier of government expenditure, after 16 years is 0.97 (or 0.891 on nominal GNP), which is less than one. Thus, the results reject the hypothesis of full crowding-out of private demand. However, partial

crowding-out exists with respect to housing investment only. Total investment is increase after 16 years, being affected by the increase in real income.

An increase of 1 b. drs in the monetary base increases nominal income by 3.324 b. drs and real income by 2.17 b. drs, since some of its effect is diverted to prices. Hence, the monetary base impact multipliers are higher than the govrnment expenditure ones. However, the exogeneity assumption of the monetary base, results in an upward bias of the multipliers, since only a proportion of NBA exerts a direct influence on the model. A rise in base money leads to a decline of the rate of interest, which induces an increase in business and housing investment. The level of private consumption is depressed in the first period, being affected by the accelerated pace of inflation. The inflation rate is increased in the first period by 2% and after a fall of about 1% in the second period, retains its simulated values in the subsequent years.

A sustained increase in the monetary base by 1 b. drs, results into an increase in nominal income by 5.712 b. drs and a drop in real income by 7.39 b. drs (Table 4.4.b). Given the specification of the model and especially the price adjustment equation, an increase in money supply induces increase in nominal income and prices, lowering interest rates, which results into a fall in real incomes.

The evolution of the dynamic multipliers of the monetary base over time, does not indicate a positive convergence within the sixteen periods, although there is a converging trend in the first five to seven years.

Other investigators have reported similar multiplier values for models of the Greek economy. Kasmas (1972), for a

similar model with the one presented in 4.1 above, but estimated over an earlier time period (1956-66), finds an impact government expenditure multiplier of around 2, but he does not report dynamic multipliers. Tsoris (1976), for a 91 equation model over the period 1962-70, finds an impact income multiplier of the monetary base of 4.92. The GNP multiplier for government investment (constituting about half of total government spending), is 0.35, which is close to the value we reported above. Zobanakis (1978), does not report any multipliers for his model estimated over the period 1958-75. Finally, Pavlopoulos (1966), finds larger government expenditure multipliers than ours, for his 1949-59 model, which does not incorporate a monetary sector and, therefore, higher multipliers are expected.

TABLE 4.4.a

GOVERNMENT EXPENDITURE MULTIPLIERS* (NG)

Period	Y		NY		R x 100	
1	1.02	1.02	.747	.747	20.47	20.47
2	.23	1.25	.169	.916	4.63	25.10
3	.03	1.28	.03	.919	.64	25.74
4	-.03	1.25	-.01	.918	-.41	25.33
5	-.04	1.21	-.03	.915	-.66	24.67
6	-.04	1.17	-.03	.912	-.71	23.96
7	-.03	1.14	-.03	.909	-.31	23.65
8	-.03	1.11	-.03	.906	-.64	23.01
9	-.03	1.08	-.03	.903	-.56	22.45
10	-.02	1.06	-.02	.901	-.50	21.95
11	-.02	1.04	-.02	.899	-.34	21.61
12	-.02	1.02	-.02	.897	-.30	21.31
13	-.02	1.00	-.02	.895	-.29	21.02
14	-.01	.99	-.02	.893	-.20	20.82
15	-.01	.98	-.01	.892	-.20	20.62
16	-.01	.97	-.01	.891	-.06	20.56
		0.97		0.891		20.56

Period	I		H		C	
1	-.130	-.130	-.273	-.273	.15	.15
2	.273	.143	-.060	-.279	-.14	.01
3	.394	.537	-.010	-.280	.11	.12
4	-.014	.523	.005	-.275	.09	.21
5	-.024	.499	.009	-.266	.06	.27
6	-.024	.475	.009	-.257	.04	.31
7	-.021	.454	.009	-.248	.03	.34
8	-.017	.437	.008	-.240	.01	.35
9	-.015	.422	.007	-.233	.01	.36
10	-.011	.411	.007	-.226	-	.36
11	-.009	.402	.004	-.222	-	.36
12	-.008	.394	.003	-.219	-	.36
13	-.005	.389	.004	-.215	-	.36
14	-.004	.385	.003	-.212	-	.36
15	-.003	.382	.002	-.210	-	.36
16	-.003	.379	.001	-.209	-	.36
		0.379		-0.209		0.36

(*) The dynamic multipliers are shown in the first columns of each variable and the cummulative multipliers in the second.

TABLE 4.4.b

MONETARY BASE MULTIPLIERS* (NBA)

Period	Y		NY		R x 100	
1	2.17	2.17	3.324	3.324	-120.59	-120.59
2	-1.42	.75	.705	2.619	62.98	-57.61
3	-.42	.33	.070	2.689	-1.73	-59.34
4	-.26	.07	.220	2.909	2.53	-56.81
5	-.28	-.21	.253	3.162	2.95	-53.86
6	-.35	-.56	.24	3.40	-.65	-54.51
7	-.41	-.97	.22	3.62	1.81	-52.70
8	-.47	-1.44	.23	3.85	2.34	-50.36
9	-.51	-1.92	.18	4.03	2.35	-48.01
10	-.57	-2.52	.20	4.23	2.33	-45.68
11	-.63	-3.15	.20	4.43	1.44	-44.24
12	-.69	-3.84	.19	4.62	.38	-43.86
13	-.78	-4.62	.21	4.83	1.61	-42.25
14	-.86	-5.48	.24	5.07	1.26	-40.99
15	-.97	-6.45	.27	5.34	-.04	-41.03
16	-.94	-7.39	.37	5.71	-1.23	-42.26
		-7.39		5.71		-42.26

Period	I		H		C		P x 100	
1	.789	.719	1.59	1.59	-.29	-.29	1.351	1.351
2	.077	.866	-.83	.76	.43	.14	.257	1.608
3	-.510	.356	.01	.76	.24	.38	.263	1.871
4	-.189	.167	-.05	.71	.12	.50	.272	2.143
5	-.122	.045	-.06	.65	.02	.52	.280	2.423
6	-.109	-.064	-.06	.59	-.08	.44	.294	2.717
7	-.114	-.178	-.05	.54	-.16	.28	.302	3.019
8	-.119	-.297	-.06	.48	-.23	.05	.315	3.334
9	-.115	-.412	-.06	.42	-.20	-.15	.321	3.655
10	-.115	-.527	-.08	.34	-.37	-.52	.329	3.984
11	-.116	-.643	-.07	.27	-.43	-.95	.332	4.316
12	-.130	-.773	-.06	.21	-.48	-1.43	.343	4.659
13	-.132	-.905	-.09	.12	-.55	-1.98	.360	5.020
14	-.144	-1.049	-1.02	-.09	-.61	-2.59	.391	5.381
15	-.149	-1.198	-.09	-.18	-.68	-3.27	.451	5.831
16	-.100	-1.298	-.04	-.22	-.73	-4.00	.549	6.380
		-1.298		-0.22		-4.00		6.38

(*) The dynamic multipliers are shown in the first columns of each variable, and the cummulative multipliers in the second.

Notes to Chapter 4

1. Fromm and Schink (1973) have shown that large-scale models perform more accurately.
2. Figures in parentheses are the t-ratios; S is the standard error of estimate; S/M is the ratio of the standard error of estimate over the mean of the dependent variable; p is the autocorrelation coefficient, reported only when it is significant; Δ denotes the backwards first-difference operator; Equations (a) are estimated by the OLS method and (b) by the Instrumental Variables (I.V.) technique; the R^2 statistic is reported only in the OLS estimates, and only when there is no autocorrelation in the residuals. The x_1^2-statistic tests for the 'correctness' of the dynamic specification in the OLS estimates. The x_2^2-statistic tests for the independence of the instruments used with the error term in the I.V. estimates, see Hendry (1970, 1976).

   Note that in all equations presented below the x^2-statistic is insignificant, and therefore, their lag structure is 'correct' and the instruments used are independant of the error term.
3. An 'N' in front of the variable signifies that the variable is measured in nominal terms; otherwise the variable is measured in real terms.
4. Note that R_t is also an endogenous variable, being determined by the demand and supply of money.
5. Note that ΔPB_t is also a policy instrument, but is determined residually by the setting of N-1 (out of N) policy instruments.
6. See Chapter 2, Section 3 above.
7. See Chapter 2, Sections 5 and 6 above. However, a recent study by ZobanaKis (1978), treats the net inflow of foreign

capital a function of the rate of inerest, but the results are not satisfactory.

8. Keynes (1936), p. 96.
9. For a survey of recent studies, see Ferber (1973) and for the rationalization for the use of liquid essets, see Townend (1976), Davidson et al (1978) and Arestis and Hadjimatheou (1981).
10. For simplicity we used money stock (which includes private and public demand deposits) as the relevant 'liquid assets' variable, since public demand deposits constitute a small and non-erratic fraction of total demand deposits. Empirical evidence showed that this simplification is hardly damaging (see note 19 below).
11. See Turnovsky (1977), Chapter 3.
12. See Duesenberry (1949).
13. The same approach is followed by Klein and Goldberger (1955) and Ball and Drake (1964). Evans (1967) showed that the use of the GNP deflator instead that of the consumption deflator, lowers the estimates of the short-run mpc and raises the long-run mpc.
14. See Chapter 2, Section 4 above.
15. For a further discussion on these issues, see Townend (1976), Davidson et al. (1978) and especially Deaton (1977).
16. This fact is recognized by Friedman and Meiselman (1963), but is considered of minor importance. None of the existing studies on Greece have reported significant interest rates effects.
17. An early rationalization is provided by Brown (1952).
18. For instance, Zobanakis (1978) reports a short-run mpc of 0.438 and a long-run mpc of 0.86 for the period 1958-75, the Bank of Greece model (1975) a long-run mpc 0.267 and a long-run mpc of 0.86 for the period 1954-72, Kasmas (1972)

finds a short-run mpc of 0.626 and a long-run one of 1.21 for the period 1956-66, and Tsoris (1976) finds a short-run mpc of 0.403 and a long-run mpc of 0.95 for the period 1957-73 and for the re-estimated 1957-75 model 0.179 and 1.14 respectively.

19. If instead of money stock, private liquid assets is used, the following equation is obtained:

$$C_t = \underset{}{2938} + \underset{(4.27)}{0.161}Y^d_t + \underset{(15.4)}{0.775}C_{t-1} + \underset{(2.32)}{0.327}LA_{t-1} - \underset{(1.31)}{1.390}\dot{P}_t + u_{1t} \quad ; \quad \underset{(2.63)}{\rho=-0.913}$$

$S=2139$, $x^2_1=1.82$. Comparing this equation with 1a above, it can be seen that the use of the money stock, which provides a better link with the monetary sector of the model, is hardly damaging for the behaviour of the model.

20. See Eisner and Strotz (1963), Lund (1971), Bridge (1971, Ch. 4.) and Greenberg(1976) for a survey on the subject.

21. A rationalization is provided by Tinbergen and Polack (1950) and Junankar (1970).

22. Distributed lag structures are used by Koyck (1954), De Leeuw (1962), Almon (1965) and others.

23. We refer to the discussion in Chapter 2, Section 5 above. The role of liquidity factors is recognized by Duesenberry (1958), as well as by Jorgenson (1963).

24. Depending on circumstances, the Bank of Greece makes direct loans to high priority industries.

25. When certain priority industries are not willing to undertake investment projects, existing ceilings might cause the creation of idle funds. On the other hand, if non-priority industries are willing to invest, imposed credit rationing might not allow for it. It therefore becomes possible, that a slow down in general investment activity might be the result of a miscalculated strategy by the

authorities.

26. The interest rate variable is long ago recognized as an important determinant of investment (Keynes, 1936; Jorgenson, 1963). It seems to be operating when firms' self financing is low.

27. Although the foreign capital inflow facilitated any bottlenecks, due to shortage of financing, it cannot be assumed, on a priori grounds, that it financed high priority industries rather than the high profitability ones.

28. The depreciation rate δ used, is obtained as a weighted average of the depreciation rates of various sectors of the economy, as given by Skountzos and Matheos (1974).

29. See Chapter 2, Section 5 above.

30. Various alternative lag structures for the private investment equation were tried, but failed to aquire significance.

32. See Guttentag (1961).

33. We used the rate of interest that enters the business investment equation, instead of the mortgage rate, to keep the number of exogenous variables as small as possible. The latter has also been tried, but the results do not differ significantly.

34. The countercyclical availability of credit has been recognized by the majority of investigators, e.g. Suits (1962), Alberts (1962), Maisel (1963).

35. This is the case in other empirical studies, e.g. Maisel (1963). Alberts (1962) reaches much the same conclusions with us, while Klein (1966) uses the term as a 'modification' varible (p. 223).

36. An example of specifying an explicit cost function is

Mills (1962).

37. If expected sales are made a function of actual and lagged sales, i.e. $Sl_t^e = (1-p)Sl_t + pSl_{t-1}$; p is the coefficient of anticipations, and if for simplicity we assume unbiased expectations, i.e. p=0, we obtain : $Sl_t^e = Sl_t$; (Lovell, 1964, p. 182).

38. Evans (1969), p. 202, classifies the motives for holding inventories as follows: (a) transactions, (b) speculative, (c) buffer stock and (d) backlog of demand.

39. Klein (1964), reports significant results snd a positive correlation of price variables in his stockbuilding equation. Others, like Lovell (1961) and Trivedi (1970), found no role for price variables.

40. Only a few studies have reported a significant link between stockbuilding and the rate of interest, e.g. Ando et al. (1963), Courchene (1967), Trivedi (1970).

41. The majority of investigator have used the partial adjustment model developed by Lovell (1961).

42. Much the same conclusion is reached by Pavlopoulos (1966). He arrived at this by estimating both aggregate and disaggregated import functions (pp. 110-128).
Other import functions for Greece are also estimated by Suits (1964), Ch 3; Adelman and Chenery (1966), pp. 1-19.

43. Orcutt (1950), apart from statistical inconsistencies, also raised methological problems in the estimation of import function: imports are determined as a residual from the demand and supply of importables, and actual empirical work involves data on imports.

44. See Houthakker and Magee (1969), Barker (1970) and for the case of Greece, the empirical evidence provided by Prodromides (1976), p.140.

45. See, for example, Ball and Marwah (1962).

46. Such variables have been used successfully by Pavlopoulos (1966), estimating import functions for Greece, but for a different period, where strict controls applied to imports.

47. See Junz and Rhomberg (1973).

48. See Friedman (1956), Tobin (1952), Baumol (1956).

49. Lee (1967) and Feige (1967), for instance, found an adjustment coefficient close to unity.

50. See for instance Laidler and Parkin (1972); In the case of Greece, Kasmas (1972) arrives at similar results with us.

51. For an analytical derivation see Cagan (1965).

52. Kasmas (1972), pp. 168-204, analyzed the period 1956-66, along the lines of analysis of Meigs (1962), Cagan (1965) and Morrison (1966). Tsoris (1976), pp. 77-82, analyzing the period 1958-73, arrived at similar conclusions.

53. Kasmas (1972), p. 204.

54. See Weintraub (1960), and for a comprehensive review of these issues, Bronfenbrenner and Holzam (1963).

55. For a detailed survey, see Laidler and Parkin (1975) and also Trevithick and Mulvey (1975).

56. A trade-off between the rate of change of prices and unemployment is established, if the price of output is defined by a mark-up factor on unit labour cost, in its turn defined as a ratio of total employment of labour to total output. The fact that other variables are also relevant determinants of money wage changes, such as price changes and profits, gave rise to the so-called 'extended Phillips curve', (see Eckstein and Wilson, 1962 and also Perry, 1964).

56a. The 'expectations' hypothesis is the most dominant explanation of the breakdown of the Phillips curve. It

assumes that the Phillips curve shifts due to changes in the price and wage expectations (Friedman, 1968 and Phelps, 1968).

57. This issue is raised by Modigliani and Tarantelli (1973).

58. By the term 'hoarding' we mean labour fully utilized only at peaks in the production cycle, (Dow, 1964).

59. In a recent study, Vliamos (1979), employes the ratio of actual to trend GNP as a proxy for excess demand. The trend GNP is obtained by the equation Y=a+bt, where t is the time trend.

60. The equation is estimated in percentage changes and not in levels. We think that inflation can be more usefully analyzed within a dynamic framework, rather than in purely static terms, since it is defined in general as a situation of rising prices, concerned with percentage increases rather than price levels.

61. A similar model has been adopted by Cross and Laidler (1976).

62. The consequences (in quantitative terms) are discussed in Chapter 5, Sectin 3 below.

63. See Griliches (1968).

64. Sahota (1975), discusses the issue of tax functions in the countries at similar stages of development as Greece.

65. We refer to the approach employed by Balopoulos (1967).

66. See Chapter 2, Section 6, and also the discussion undertaken by Tatsos (1977).

67. To account for structural changes, a dummy variable was introduced in both equations, taken the value of one in the years 1966-75 and the value of zero elsewhere. Tatsos (1977), provides a detailed elaboration on the structural changes and development of the Greek tax system.

68. This issue is related to modern-day monetarist argument, that the impact of fiscal action crucially depends upon the method of finance.

69. The importance of including a government budget constraint in macroeconomic analysis, is emphasized by Ott and Ott (1965), Crist (1967, 1968, 1969), Silber (1970), Steindl (1971, 1974), Spencer and Yohe (1970). Monissen (1972/73), Blinder and Solow (1973) and in the review papers by Choudhry (1976) and Currie (1978), just to mention a few.

70. The pricise specification of the constraint is determined by the insitutional set-up of the economy. Hansen (1973), and Hart and Meyer (1975), for instance, distinguish between the European and the American budget constraint.

71. The model employes static behaviour equations and is built along the lines of Hansen (1973) theoretical model, aiming at evaluating year-to-year income effects of fiscal and monetary policies.

72. We refer to the models by Pavlopoulos (1966), Kasmas (1972), Avramides (1972), Vernardakis (1975), Tsoris (1976), Tatsos (1977) and Zobanakis (1978).

73. See Zobanakis (1978), p. 138

74. Other studies for the Greek economy report no important differences between the OLS and what they call '2SLS' (in fact I.V.) estimates, but they employ only a limited number of instruments out of a large number of exogenous variables of the model, in the second stage of the estimation, e.g. Tsoris (1976), Avramides (1972) etc.

75. In the previous section (4.1) we estimated an equation for the demand for money and a second one for the supply of money, which together with the equilibrium condition constitute the monetary sector of the model. Since the variables of demand and supply of money are numerically the same, it is not not possible to curry out the simulation

run, because the monetary aggregate is defined twice in the model. This problem is overcome by obtaining the reduced form of the monetary sector and introducing it in the model.

76. The same approach is followed by Meyer (1975) and Arestis (1979). A similar, though somewhat different classification, is followed by Friedman (1972), where the 'first-round' effects arise immediately upon adoption of policy not dependant on the passage of time, while 'subsequent-round' effects are due to an increase in the rate of growth of government debt, leading to a larger stock of debt and a higher interest rate.

77. By 'wealth impact' we really mean a cash balance effect, because a proxy for wealth is used in the consumption function.

78. See Wallis (1973), pp. 121-127.

79. See Klein (1974).

80. Note that the difference in the two multipliers is due to the fact that a 1 b. drs increase in nominal government spending is equivalent to a 1.376 b. drs increase in real government spending. In view of the formulation of the price adjustment equation, no effect is transmitted to prices.

CHAPTER 5

OPTIMIZATION AND RESULTS

We have already discussed the formal way the optimization problem is stated. We also elaborated on the estimated econometric model for the Greek economy. In this chapter we present the formulation of the optimization problem for the case of Greece; the choice of the optimization period, the specification of the objective function and the way the experiments were conducted. Given the macroeconomic objectives, we evaluate the effectiveness of alternative modes of financing fiscal policy.

Although in actual policy making budget deficits are covered by more than one mode, we analyse only polar cases, i.e. bond financing, money financing and tax financing, which are useful in bringing out hidden properties of the model (economy). A combination of the various modes of financing will result in intermediate cases and will answer practical policy problems, not of our concern in this study.

5.1 Choice of Optimization Period

Although the model is estimated over the period 1957-1975, the optimal policy experiments were run over the ten year period 1966-1975. There are two reasons for choosing this time span. First, the period 1957-1975 is rather long to base any short-term policy analysis and supply constraints are more likely to arise in the developing economy of Greece. Second, as argued in Chapter 2 Section 1, up to the mid-sixties the primary production sector of the economy was quite dominant in participating in the national product and

consequently, the fluctuation of output was very much dependent on exogenous factors, such as weather conditions etc. From the point of view of stabilization policy, therefore, there was an additional difficulty in the hands of the authorities in coping with exogenous elements which cannot be costed in the objective function.

It can also be argued that a ten year period is rather long for short term policy analysis, but a choice of a substantially shorter period would run into problem of inadequacy of data points, given that only annual observations exist.

5.2 Choice of Objective Function

The choice of the objective function involves decision upon the targets and instruments to be included in its arguments and also the relative weighting associated with them. The difficulties related to their decision are already discussed in Chapter 3, Section 2. We now proceed with the exact specification of the objective function.

The economic policy targets are taken to be the rate of change of National Income ($\dot{Y}$) and the inflation rate ($\dot{P}$). The authorities are aiming at achieving high and steady rates of growth of output to keep the economy at near full-capacity levels, associated with low levels of unemployment. Also a low and steady level of inflation rate is related to keeping up the purchasing power of the public and reducing uncertainty about the future. In addition, the authorities besides their effort to achieve these objectives must ensure stability in the money market. This is made possible by a steady level in the interest rate (R), while low levels of it ensure low cost of borrowing[1].

In principle we could have included other (or all) endogenous variables in the objective function, such as investment and consumption[2]. Rather than complicating the experiments it was thought it would be better to keep the examples straight forward especially in view of the recursive ("compact") character of the model.

Finally, the objective of reducing the share of the public sector in the economy, defined as the ratio of government expenditure to total income (G/Y), is added in some of the experiments. This is rationalized on the assumption that the authorities have decided that increased government spending is for some reason - undesirable allocation of resources between private and public sector - unacceptable and harmful to the economy[3]. In the light of this added objective we examine the consequences on the achievement of the previously mentioned objectives ($\dot{Y}$,$\dot{P}$,R).

The policy controls in the hands of the authorities are fiscal and monetary instruments. We make the assumption that the authorities do not have adequate hold over the instruments, implying that there are inherent difficulties in steering the economy towards some desired targets[4]. Also, the inclusion of only certain instruments in the objective function implies that the possible excluded instruments take their historical values, which may inject into the results a bias in favour of what actually happened[5]. However, this kind of bias is substantially reduced in comparing various alternative policies, since it is present in all cases.

According to the specification of the model, the fiscal instruments are the following: current government

expenditure on goods and services (NG), based tax levels of direct and indirect taxes (d_0 and t_0) and the marginal direct and indirect tax rates (d_1 and t_1). The monetary instruments include the monetary base (NBA) and the stock of outstanding Government bonds and Treasury bills (ΔPB). Note that the potential instrument variables CRI and CRH - changes in bank long term credit to industry - although they are included in the investment functions, to account for their correct specification, are excluded from the possible set of instruments in the objective function. The reason is that these variables are part of the wider definition of money which is not accounted for by the specification of the model. If they were arguments in the objective function, allowed to vary accordingly, we would have introduced an asymmetry in the achievement of targets. This would be so, since their direct influence on investment activity would be felt, while their repercussions on the rate of interest and the money market would not have been allowed for.

As regards to the values assigned to the desired trajectories for the targets and instruments, the quantification is based on various publications related to the long (and short) term prospect and planning of the Greek economy[6].

It is very difficult to trace the actual targets of official policy makers and the relative weights attached to each one. This kind of inside information is not readily available, because Government choices are not always disclosed. Precise information would be necessary if we were to evaluate specific policies followed, that is, if we were to see the extent to which the target values as given by the planning authorities were consistent with the actual achievement

of the economy. The aim of our investigation, however, is to compare various alternative policies and evaluate their consequences on the economy. In carrying out comparisons, therefore, precise information about the authories' macro-economic targets and their ranking does not invalidate any of our results, as long as they are kept unchanged in all selected policies.

We have made the following choices for the targets: A 10% annual growth of GNP is considered to be ensuring full-employment steady growth of the economy, assuming there is no supply constraint. A 2% annual rate of inflation is also considered to be acceptable[7]. As regards the rate of interest, its average value of 5% over the period is thought to provide low cost of borrowing and at the same time ensuring stability in the money market. Finally, the value of the share of the public sector in the economy (G/Y) - when included in the objective function - is set at the level of 20%, which is less than the average 22.6% over the 10 year period. Although there is an element of arbitrariness in the choice of the latter value, it does not alter the results qualitatively. The desired values of the target variables are kept the same throughout the optimization period which makes the experiments simpler without any loss of analytical exposition.

The desired trajectories for the instrument variables are a smoothing out of actual developments. Their desired values are set equal to their mean growth rates and in this way we have extracted the effect of deterministic disturbances on the instruments. All exogenous uncontrollable inputs, contrary to the instruments variables, are set equal to their

historical paths, hence exposed to deterministic disturbances. Under these circumstances, the resulting optimal trajectories are less volatile than if the exogenous inputs were smoothed out[8]. Thus, we make the following choices for the instruments: The desired annual growth rate of government expenditure (NG) is 16%. Desired nominal monetary base (NBA) grows at 16% per annum, while the annual growth rate of the stock of government borrowing(ΔPB) is 30%. Marginal tax rates and base tax levels of direct and indirect taxes (d_1, t_1, d_0, t_0) follow their historical values[9].

Finally, as regards the numerical weights attached to the arguments of the objective function, we must point out that it is not the actual numerical weight that matters but the effective weight, which depends on the numerical weight and the desired value of each variable. For example, for equal weighting among the variables, the numerical weight attached to each variable must be inversely proportional to the square of the desired value of the variable, since we penalize for square deviations in the cost functional. Thus, the weighting coefficient that corresponds to the rate of growth of GNP ($\dot{Y}$) with desired value of 10 (expressed in percentages), will be considerably greater than that of, say, government expenditure (NG) whose desired value is about 80 billion drs (expressed in levels) on average.

The weights attached to the target variables are the following:

target	$\dot{Y}$	$\dot{P}$	R
weight	10^7	10^7	10^3

Equal importance is placed on the rate of growth of GNP and the inflation rate. The rate of interest is not a 'final'

objective of macroeconomic policy and is weighted less than half as heavily than the other targets. In all experiments that follow absolute and relative weighting remains the same in all periods and, therefore, the ranking of objectives is unaltered[10]. The weights attached to the instruments differ from one experiment to the other and are discussed along with the presentation of the various objective functions below.

5.3 Trade-off between $\dot{P}$ and $\dot{Y}$

Some preliminary runs were carried out in order to obtain a feeling for the behaviour of the model with the aim of investigating the possible existence of a trade-off between the inflation rate and the rate of growth of real income. At first the objective function included $\dot{P}$ and $\dot{Y}$ as objectives and NG and NBA as instruments. The weights on $\dot{P}$ and $\dot{Y}$ were varied so as to place more or less emphasis on the control of $\dot{Y}$ as against the control of $\dot{P}$, which allows us to derive the trade-off between these two objectives (weights on NG and NBA remain unchanged). In all experiments, the resulting behaviour of the rate of interest was unacceptable for the stability in the money market. The indication is that an interest rate target is appropriate and thus, the experiments were repeated by including R in the objective function[11].

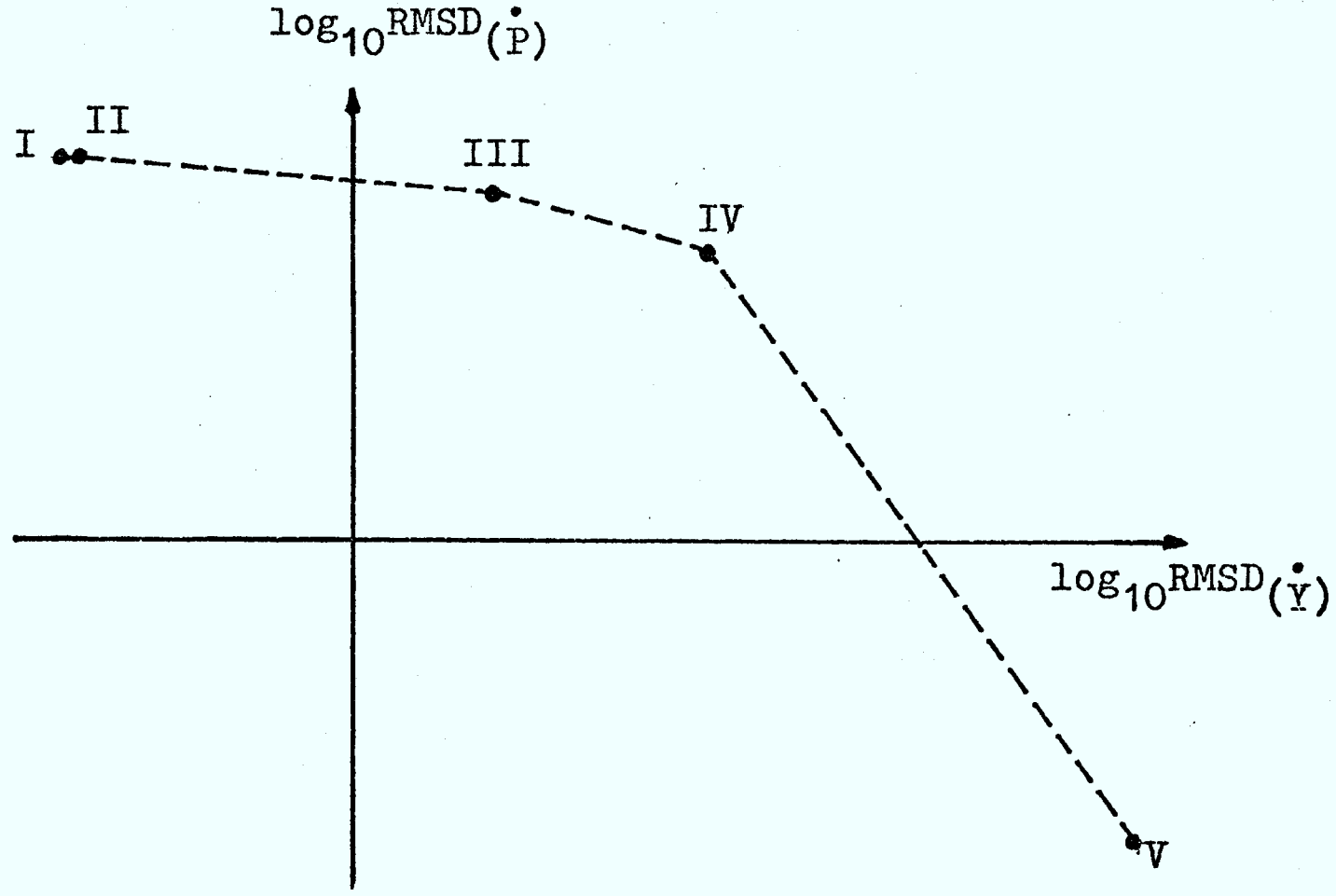
The extent to which each objective is satisfied is measured by the root-mean-square-deviation (RMSD) of its optimal path from some desired path, given by:

$$RMSD_y = \left[\frac{1}{N} \sum_{t=1}^{N} \left(y_t^{opt} - y_t^{des} \right) \right]^{\frac{1}{2}}$$

The RMSD tends to zero with the closer achievement of each objective. The results of the optimisation experiments are shown below[12]:

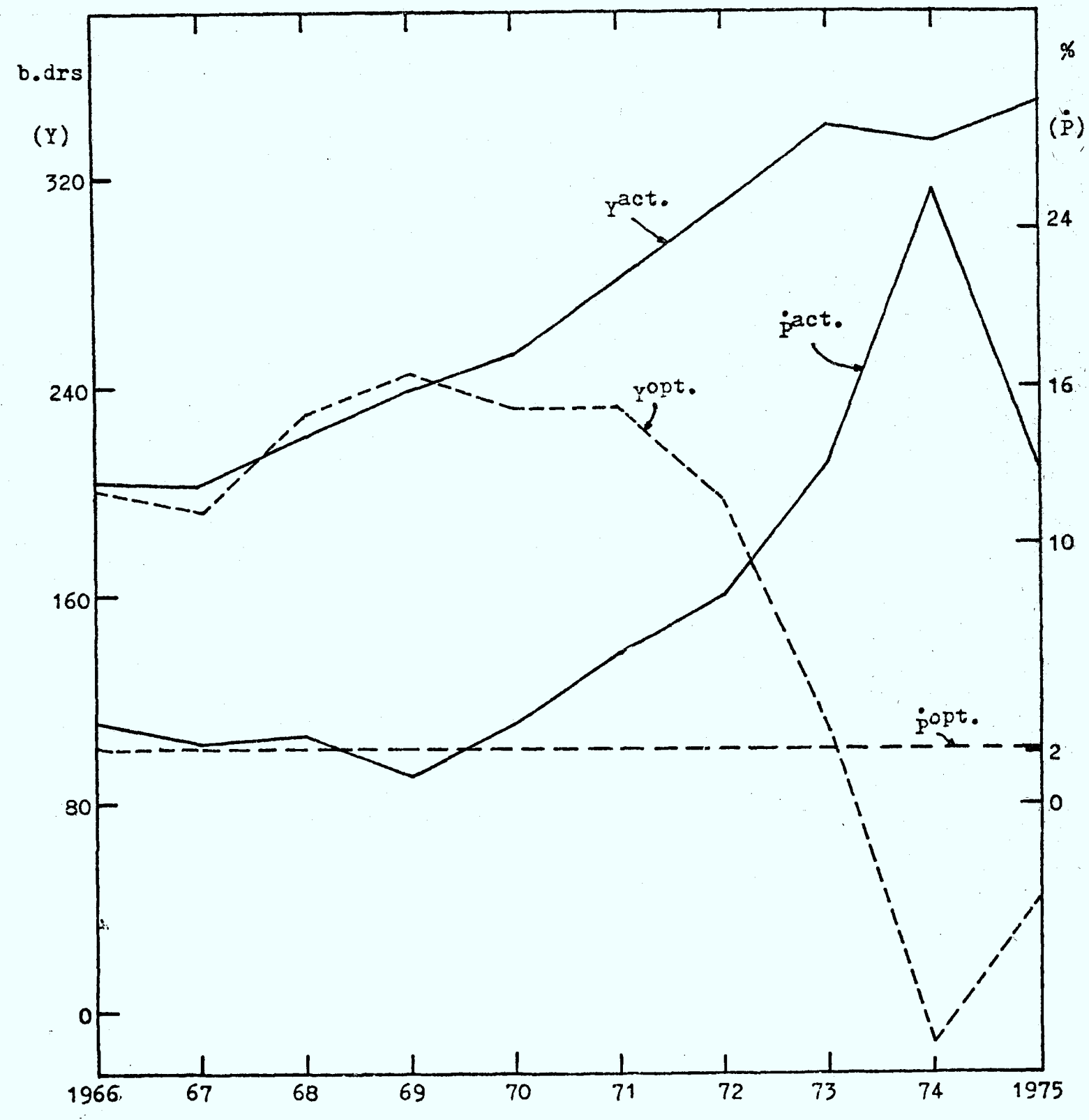
	weights		RMSD	
	$\dot{P}$	$\dot{Y}$	$\dot{P}$	$\dot{Y}$
Run I	0	10^7	10.00	0.163
Run II	10^4	10^7	10.00	0.162
Run III	10^7	10^7	8.70	2.17
Run IV	10^8	10^7	5.87	8.86
Run V	10^8	0	0.16	120.00

The existence of a $\dot{P}$ & $\dot{Y}$ trade-off is established. For each combination of costs on $\dot{P}$ and $\dot{Y}$ we can obtain a point on the underlying trade-off curve as shown in the figure below:



Trade-off curve between $(\dot{P})$ and $(\dot{Y})$.

It can be seen from the trade-off curve, that the fulfilment of the $\dot{Y}$ target is relatively easy while the reduction of the inflation rate to near acceptable levels is quite difficult. Moreover, judging from the figure shown below, it becomes obvious that a reduction in $\dot{P}$ is only possible at the expense of an unacceptable reduction in economic activity.



Simulated and Optimal Trajectories of Real Income (Y) and Inflation Rate ($\dot{P}$): Run V.

Having discussed the specification of the objective function and also some basic properties of the model, we proceed with the description of the various optimization runs and the discussion of the resulting outcomes.

5.4 Attainment of $\dot{P}$, $\dot{Y}$ and R targets

In the first set of experiments we assess the possibility of attaining simultaneously the three policy objectives ($\dot{P}$, $\dot{Y}$, R) under the following modes of financing the budget deficits.

5.4.1 Money Financed Case

In this run the objective function to be minimized is defined as follows:

		$\dot{Y}$	$\dot{P}$	R
a)	targets			
	weights	10^7	10^7	10^3
b)	instruments	NG	NBA	ΔPB
	weights	10^{-2}	10^{-9}	10^{-4}

The coefficients of the tax equations are fixed to their actual values. The weight attached to (ΔPB) is large, such that the variable is restricted to its desired trajectory, while the weight attached to NBA is relatively small so that it becomes free to move away from the desired trajectory. The weights on NG as well as on target variables remain the same as defined previously.

Any budget imbalance due to changes in fiscal policy (NG) is accounted for by changes in the level of the monetary base only to the extent that the created budget deficits

or surpluses are not covered by induced tax revenues and changes in foreign reserves.

5.4.2 Bond Financed Case

The specification of the objective function is as follows:

a)	targets	$\dot{Y}$	$\dot{P}$	R
	weights	10^7	10^7	10^3
b)	instruments	NG	NBA	ΔPB
	weights	10^{-2}	10^2	0

All tax instruments are fixed to their actual values. The weight attached to the monetary base is large and thus the variable is restricted to track its desired path. The stock of government debt is assigned zero weight, thus allowed to move irrespectively of its desired trajectory. The weights on the rest of the variables remain unchanged.

In the bond financed case, therefore, any imbalance in the budget due to changes in fiscal instruments (NG), is matched by changes in the stock of government debt. Of course, the created budget imbalance will be also financed by induced tax yield (fiscal drag) and foreign reserves, due to initial income changes as a result of fiscal policy.

5.4.3 Tax Financed Case

The financing of the budget through changes in tax instruments is dealt with in two separate runs. In the first one, only changes in the base tax levels are considered. In the second run, only the marginal tax rates are allowed to

vary. The specification of the two objective functions is the following:

A) Budget Financing via the Base Tax Levels

a)	targets	$\dot{Y}$	$\dot{P}$	R		
	weights	10^7	10^7	10^3		
b)	instruments	NG	NBA	ΔPB	t_0	d_0
	weights	10^{-2}	10^2	10^4	10^8	10^8

B) Budget Financing via the Marginal Tax Rates

a)	targets	$\dot{Y}$	$\dot{P}$	R		
	weights	10^7	10^7	10^3		
b)	instruments	NG	NBA	ΔPB	t_1	d_1
	weights	10^{-2}	10^2	10^4	10^9	10^9

We have attached large weights to the monetary base and the stock of government borrowing from the public in order to force them to trace their desired paths. The weighting on t_0, d_0 and on t_1, d_1 is such that they are allowed to deviate from their actual values. The weights on NG and all targets is as before.

In the tax financing case it is guaranteed that fiscal policy does not necessitate additional deficit financing. Any budget disequilibrium, due to changes of government spending, is covered by an equivalent amount of tax revenue aquired through changes in either the based tax levels or the marginal tax rates of direct and indirect taxes.

Before we carry out the discussion of the optimization results a few comments are in order with respect to the weighting of tax instruments. Period-to-period changes in the optimal values of tax instruments must not be large.

In reality, the authorities can hardly impose changes in tax rates or in base tax levels by more than about 5% on average. Frequent changes in tax legislation are mostly avoided involving increasing administrative costs and also enhanced uncertainty about future tax policies, thus introducing destabilizing factors into the economy. Besides this fact, since the tax rates determine the multipliers of the system, any excessive discretionary action destabilizes the whole system. In the extreme case the system becomes either unstable or the iterative process for the numerical solution is so slow that can be easily handled by the program. To overcome this kind of problem we imposed relatively heavy weights on tax coefficients so that their optimal values do not diverge from the desired ones (taken to be the ones obtained from the estimation of the tax equations) by unacceptable margins. In this way we obtained feasible solutions for the tax rates and the base tax levels.

Finally the weighting of the direct and indirect tax coefficients has been equal. In view of the fact that direct taxes affect the system via disposable income and therefore consumption, while indirect taxes have a more direct effect as a component of gross expenditure, the effective weighting is unequal. On the assumption that the marginal propensity to consume is less than one, deviations from desired values of indirect taxation are thus penalized more severely than those of the direct taxes. In addition, in comparing the optimization results of the two runs (financing through changes in base tax levels and through changes in marginal tax rates), it must be noted that not only are the weights on the two sets (t_0, d_0) and (t_1, d_1) different, but also

their values are different, therefore the effective weights differ. Consequently, comparisons can only be made to the extent that we are not prepared to obtain 'better' or 'worse' results at the expense of a wider fluctuation in our instruments.

5.4.4 Results[13]

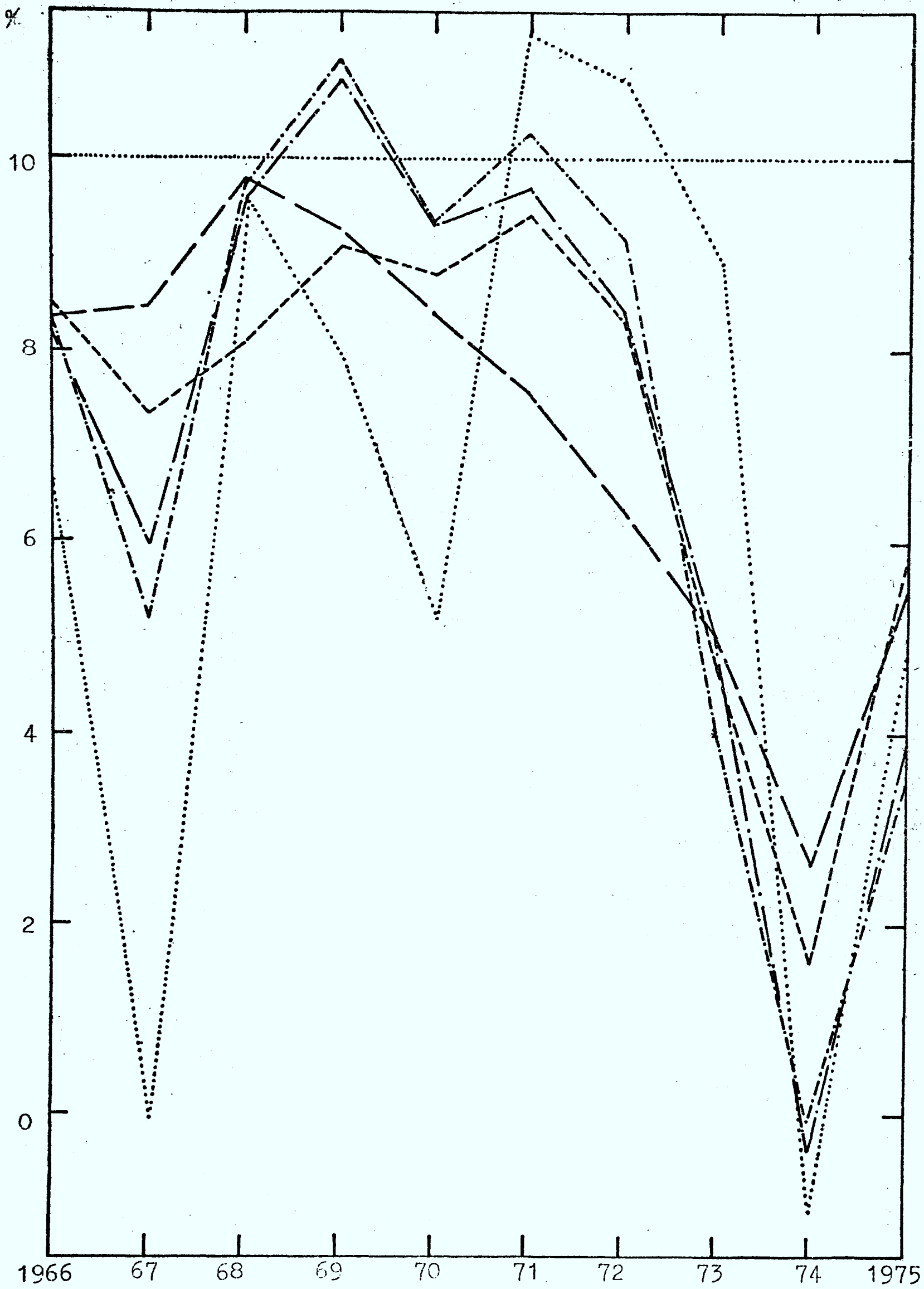
The optimal rate of growth of GNP under the three modes of financing is shown in figure (5.I.1). All policies result in a substantial reduction of the fluctuation of aggregate economic activity , with varying degree of successfulness. This is manifested by the diminution of the 1967 recession and also by the reduction in severity of the 1974 economic slump.

Under money financing the rate of growth of GNP is close to around 9% over the period 1966-1972 declining steeply thereafter. In contrast, under bond financing ($\dot{Y}$), after increasing slightly in the first two periods, reaching near full capacity, starts declining gradually to a minimum of around 3% in 1974.

In comparison, the optimal $\dot{Y}$ resulting from the bond financing case is more effective in minimizing short term fluctuations in economic activity, in the sense that it produces a smoother path between troughs and slumps. The specification of the model makes it easier for adjustments in the budget to be facilitated by changes in the stock of public borrowing, which appear exogenous in the model, rather than by changes in the stock of money, which affects directly the expenditure and the demand for money function.

Growth Rate of Real Income (Ŷ)

Fig. 5.I.1



Simulated values
Desired values (constant 10%)
Money Financing
Bond Financing
Tax Financing (t_0, d_0)
Tax Financing (t_1, d_1)

As a result bond financing reduces the unemployment strains on aggregate economic activity by producing gradual reductions in income preceeding the slumps, on the assumption that unemployment is more sensitive to output changes rather than levels.

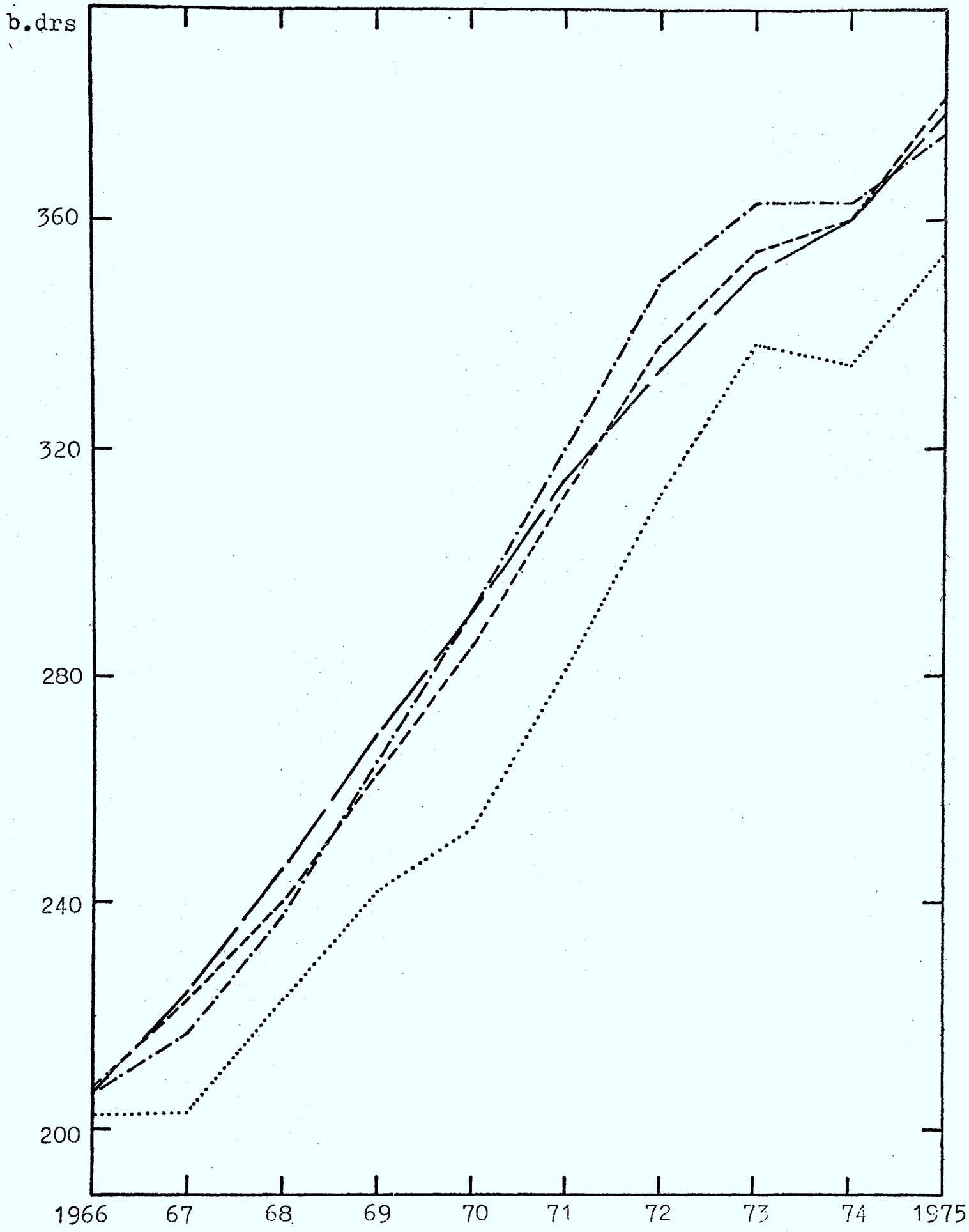
The optimization results also indicate that a fair reduction in the fluctuation of the economy is possible in the case of tax financing. The effectiveness of tax financed deficits is shown to be inferior to the previous modes of financing, given the low tax coefficients of the economy of the order of less than 10%, which reduce the built-in flexibility of taxation. Also, the imposed inflexibility on tax parameters depicting administrative etc. costs, reduces the effectiveness of stabilisation policies in these cases even further. Note that at this level of modelling the economy, there is no apparent gain in persuing tax policies by altering either the base tax level or the marginal tax rate.

As a consequence of the developments of the optimal growth of GNP, the level of aggregate economic activity is set on an expanding path superior to actual developments (fig. 5.I.2). Also, the general unemployment situation in the country improves at higher levels of economic activity, to the extent that there is a slack in the supply side of the economy. Compared to money financing, a bond financing policy is more expansive over most of the planning period (except 1972-74). These differences will be explained by the development of the individual components of national expenditure below.

Contrary to the satisfactory achievement of the rate of growth of GNP target, the objective of reducing the

Real level of Income (Y)

Fig. 5.I.2



inflation rate to desired levels especially in the second half of the planning period, is almost unattainable (fig. 5.I.3).

Under bond financing, the optimal inflation rate is above the actual in the period up to 1970, by about 2%, which can be considered as an acceptable state of affairs, given the relatively fast and smooth growth of the economy. The improvement of the inflation rate in 1971-72 is followed by a steep increase in import prices in 1973, which renders all instruments of controlling prices ineffective. This owes much to the specification of the price adjustment equation. Recalling the low coefficient (0.20) of the proxy for demand pressures ($\dot{NM}$) included in the equation, it makes it very difficult to reduce $\dot{P}$ unless we are prepared to reduce $\dot{NM}$ substantially. As we have shown in section 5.3 above, this is an unacceptable state of affairs driving the economy into a deep recession. It suffices to say that for a different specification of the price adjustment equation, with the inclusion of other variables and instruments of policy, it would have been easier to control the rate of inflation more effectively. Finally, we should stress the heavy dependance of domestic inflation on import prices (coefficient of $\dot{P}^m$ 0.47) which adds to endogenous inflationary pressures.

Under money financing the optimal inflation rate is overall lower than under bond financing, with the exception of periods of recession (1967 and 1974). This is again to be expected given the specification of the price adjustment equation. Since $\dot{P}$ is determined to some extent by demand factors, it worsens during slump periods, because the

Inflation Rate ($\dot{P}$)

Fig. 5.I.3

..... Simulated values
..... (constant 2%) Desired values
---------- Money financing
— — — — — Bond & Tax financing

authorities in their effort to boost the economy increase liquidity, and fuel inflation[14].

With the stock of government borrowing and the stock of money tracing their desired paths, we do not expect any differences to occur in the optimal path of the inflation rate between the tax and bond financed cases. All effects due to alteration of tax instruments are transmitted to the real variables and any inflation impact is absent.

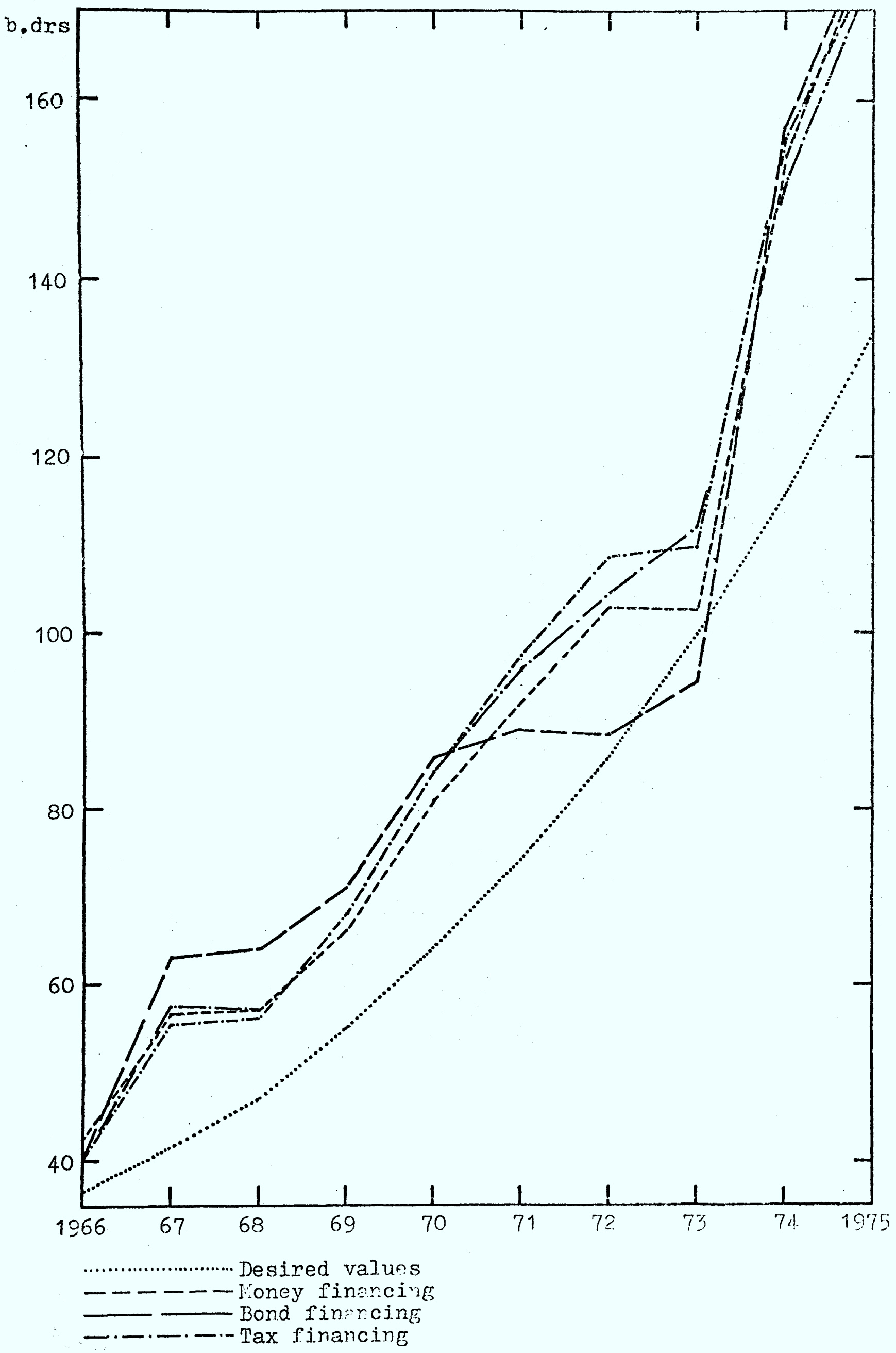
Government expenditure exerts a direct fiscal impact on the level of income, which in its turn affects the expenditure and money functions in the model. The associated feedback responses affect the rate of interest influencing the money market and the investement demand functions. The optimal developments of government expenditure is shown in figure 5.I.4.

Under money financing, the optimal policy calls for the predominant use of fiscal instruments. NG develops at a higher level than its desired path throughout the planning period. It follows clearly a countercyclical pattern, with fast increases during ressesions as in 1967 and even faster increases in 1974, slowing down when the economy overheats in 1968 and more importantly during the boom prior to 1974.

Contrary to the previous case, a more active fiscal policy is necessary with regard to government spending, if the financing is undertaken by adjustments in the stock of government borrowing and not by adjustments in the stock of money. With a passive monetary policy more excessive increases in NG are necessitated in 1967 and 1974, and a substantial slow down in NG is needed in boom periods when deflationary measures

Government Expenditure (NG)

Fig. 5.I.4



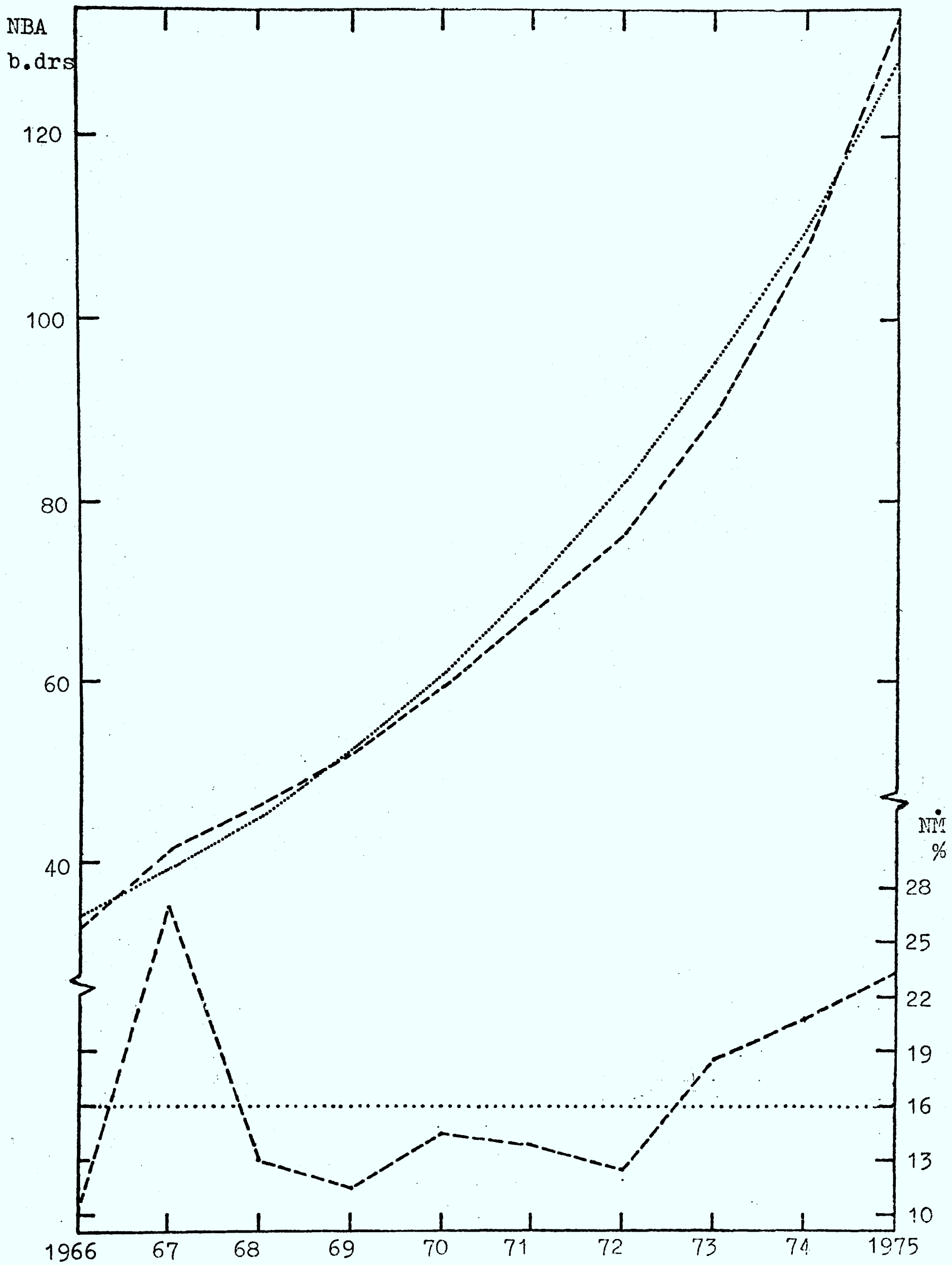
are in order.

With regards to the monetary base (fig. 5.I.5), the optimal policy calls for its reduction in the period 1970-74, below its desired trajectory. In 1967 and 1975 NBA has to be increased above its desired level to facilitate the economic recovery. The optimal annual rate of change of NBA is accordingly fast in 1967, falling subsequently to around 12-14%, accelerating after 1972. Changes in the level of monetary base will produce equivalent changes in the money supply, the rate of change of which affects directly the inflation rate and hence the price level. Feedback responses, arising as a result of the initial change in the inflation rate, are expected to affect negatively the level of private consumption expenditure and the rate of interest, through the demand for money and positively the level of stockbuilding. Feedback responses of the price level affect all nominal variables in the model, although these effects are not expected to be substantial, due to the fact that optimal policies are ineffective in influencing the price level.

The optimal path of the stock of government debt, required to finance the created budget deficits or surpluses associated with changes in government expenditure policy, is shown in figure 5.I.7. As expected, ΔPB follows a similar path to that of public spending, with upswings in 1967 and 1973-75 and downswings in 1971-72. Recalling that Treasury bills and Government bonds are exchanged for cash on an obligatory basis, mainly with the commercial banks[15], the problem of adequate demand for their aquisition does not arise. As a consequence, the outstanding stock of government debt

Monetary Base (NBA) &
Growth Rate of Money Supply ($\dot{NM}$)

Fig. 5.I.5



only exerts an indirect effect on the rate of interest associated with the financing of fiscal policy. Thus, not only any portfolio impact of the increase of government bonds is absent but also any wealth impact on private consumption or the demand for money.

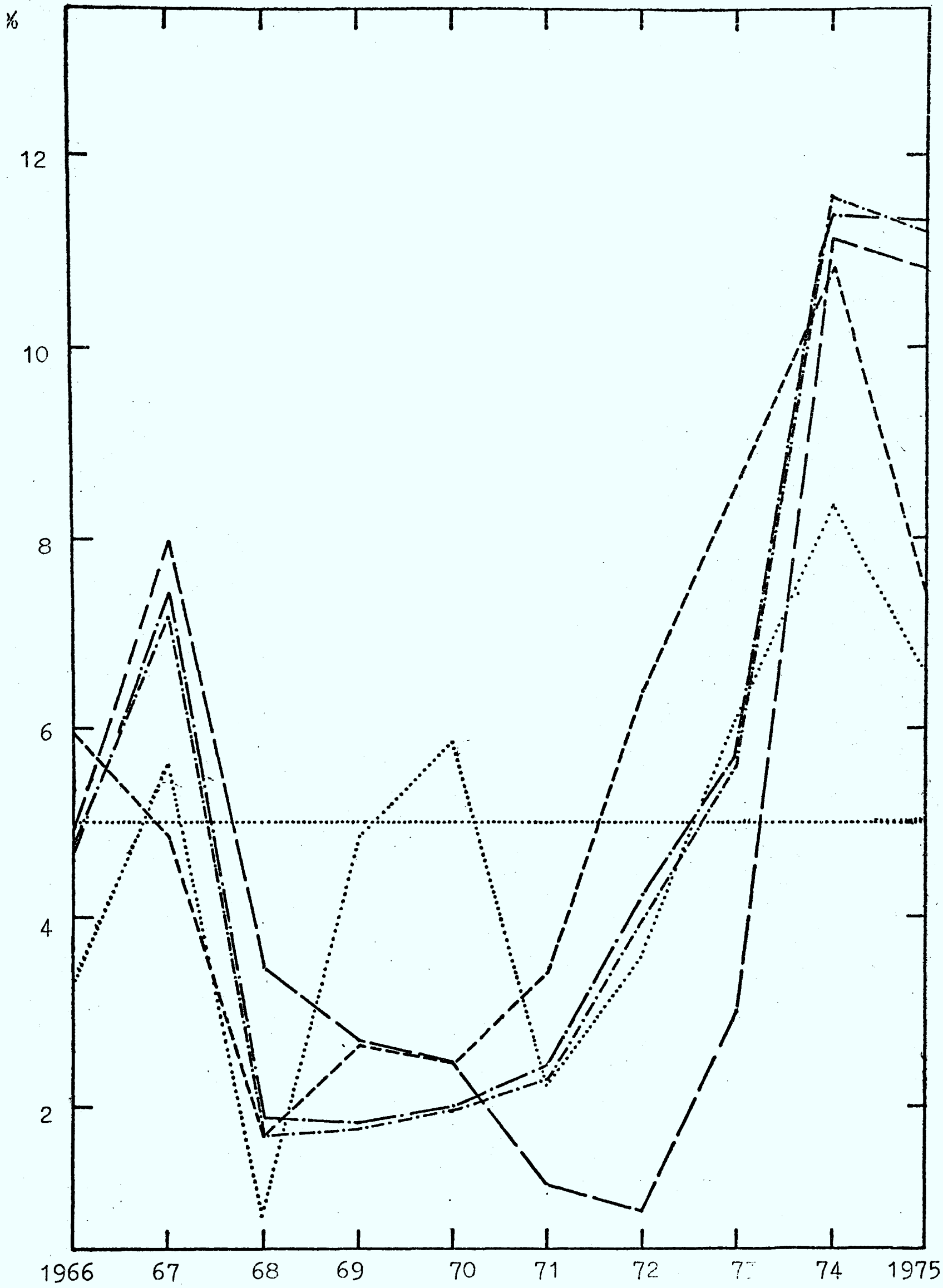
The rate of interest is directly affected by the availability of money and also by the feedback responses due to the fiscal impact of government expenditure on the level of income. The inflation rate also influences R through the demand for money, although this effect is rather weak. The optimal trajectory of the rate of interest is depicted in figure 5.I.6.

In the case of money financing, the steep increase in liquidity in 1967 forces the rate of interest down, while the call for a stricter monetary policy thereafter puts it on an ascending trend. After 1972, R starts increasing even faster facilitated by the induced fiscal feedback responses of the higher level of income, and after 1974 it starts falling again as a result of an expansionary monetary policy outweighing the relatively moderate increase in the level of income.

When the budget is covered by government borrowing, the rate of interest rises as a result of the substantial increase in government spending in 1967, falling thereafter reaching low levels in the early 70's. These low levels of R can be explained by the lower levels of liquidity supplied to the economy compared to the previous run and also by the fact that in the period 1970-73 the increase in NG was very mild if any at all. In 1974, the active fiscal policy pushes the rate of interest up, declining thereafter in view of a stricter monetary policy and a less active fiscal policy.

Interest Rate (R)

Fig. 5.I.6



Simulated values

(constant at 5%) Desired values

Money financing

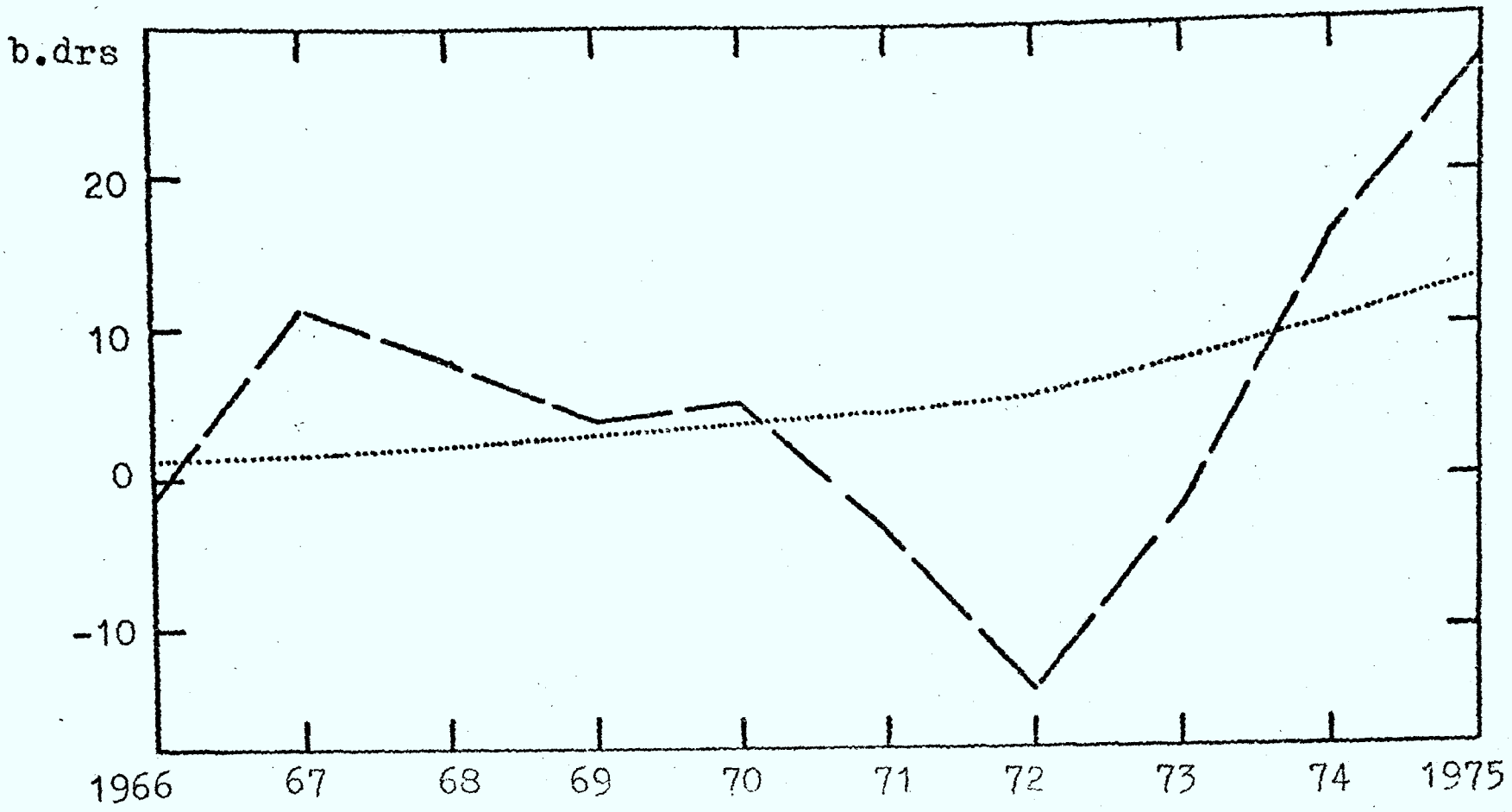
Bond financing

Tax financing (t_0, d_0)

Tax financing (t_1, d_1)

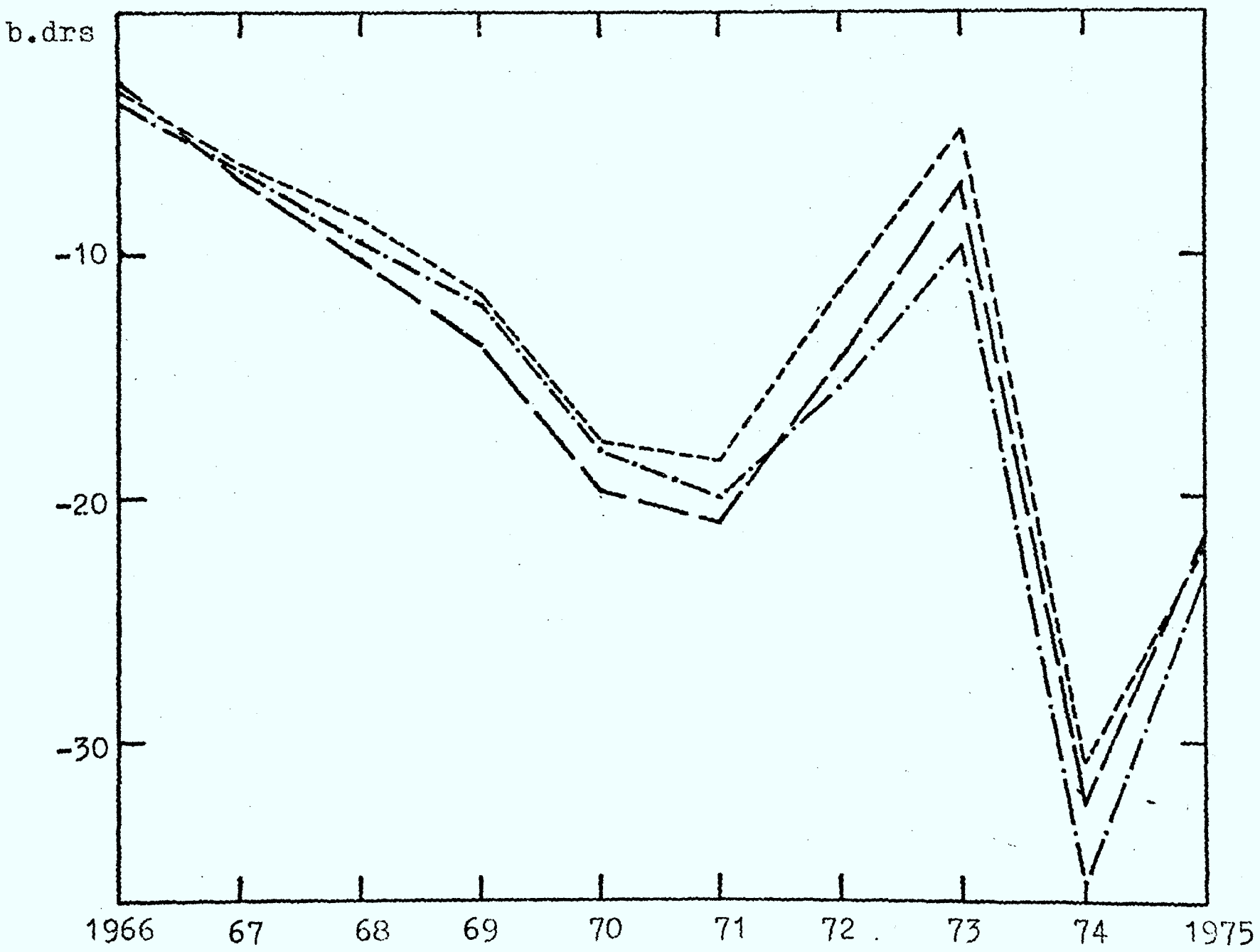
Stock of Government Debt D(PB)

Fig. 5.I.7



Balance of Payments (DNF)

Fig. 5.I.8

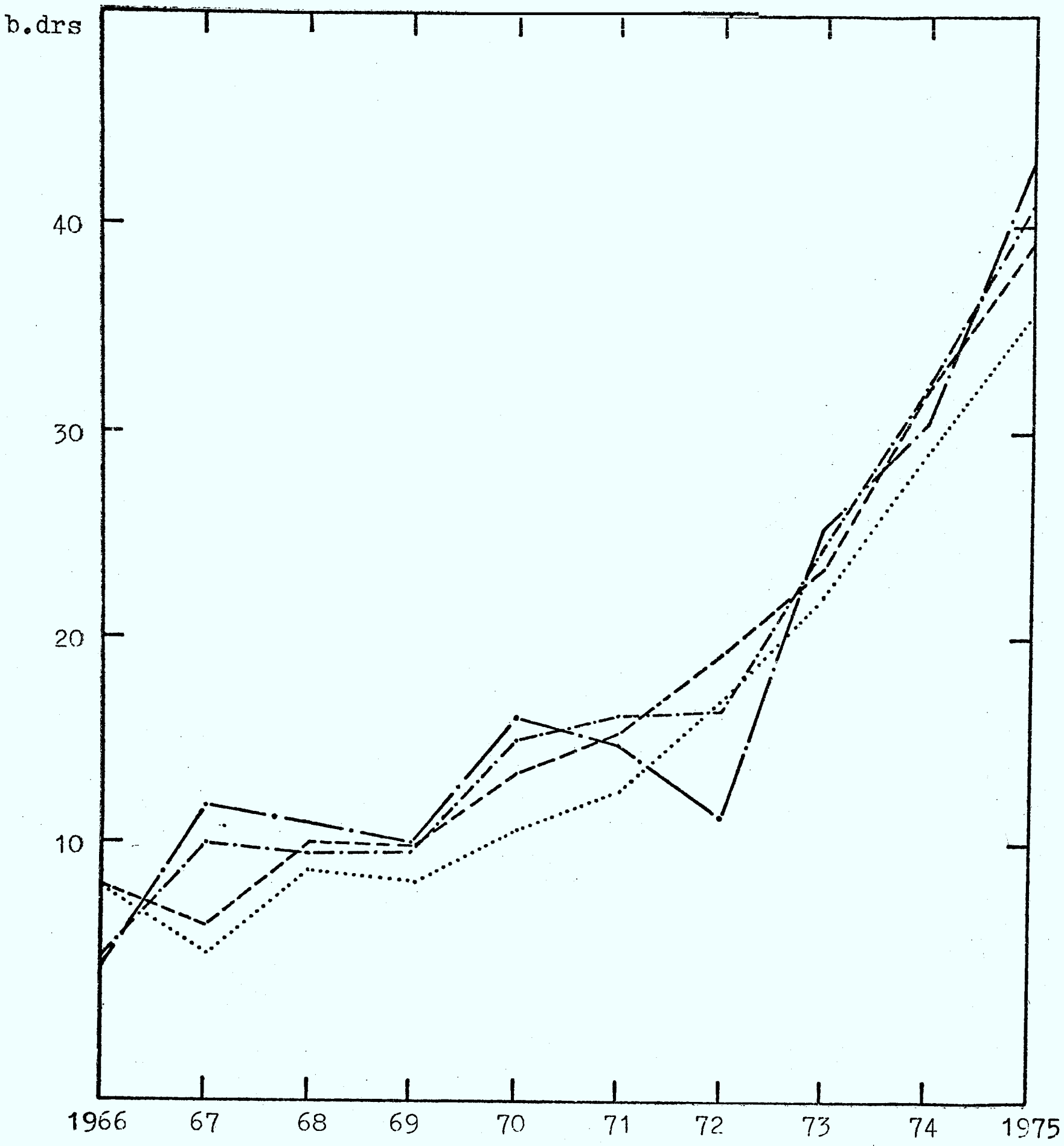


Under tax financing, R follows a similar pattern to the previous run. Given the desired path of the monetary base, the level of the rate of interest is determined by the extent of the direct fiscal impact due to changes in government expenditure, not offset by changes in based tax levels or changes in the multipliers associated with alteration in the marginal tax rates. Thus, after an initial peak in 1967 and a sharp drop in the following year, the rate of interest is constantly rising, mainly due to active fiscal policy reaching a peak in 1974.

Recalling that under money and bond financing there is no change in the stock of government long and short debt instruments, beyond the needs necessitating from the expansion of the economy and with unchanged tax parameters, the direct and indirect tax yields (fig. 5.I.9 and 5.I.10) are set on an expanding trend above the actual trajectory, as a result of higher optimal levels of income. The contribution of direct taxation (fiscal drag) to the financing of the deficit is smaller compared to that of direct taxation, due to its indirect effect on the level of income, through private consumption. Moreover, while increases in the price level inflate nominal tax revenues,real tax revenues are reduced. This is so, since higher prices increase the progressiveness of direct taxation by reducing the real base tax levels. Likewise, higher prices reduce the regressiveness of indirect taxation, thus reducing the real tax intake in both cases. The similarity of tax yields is due to the low marginal tax rates which diminish the difference in fiscal drag between the two ways of covering the budget. In addition, the similarity of the optimal inflation rate in both cases reduces the difference in

Direct Tax Revenue (NT^d)

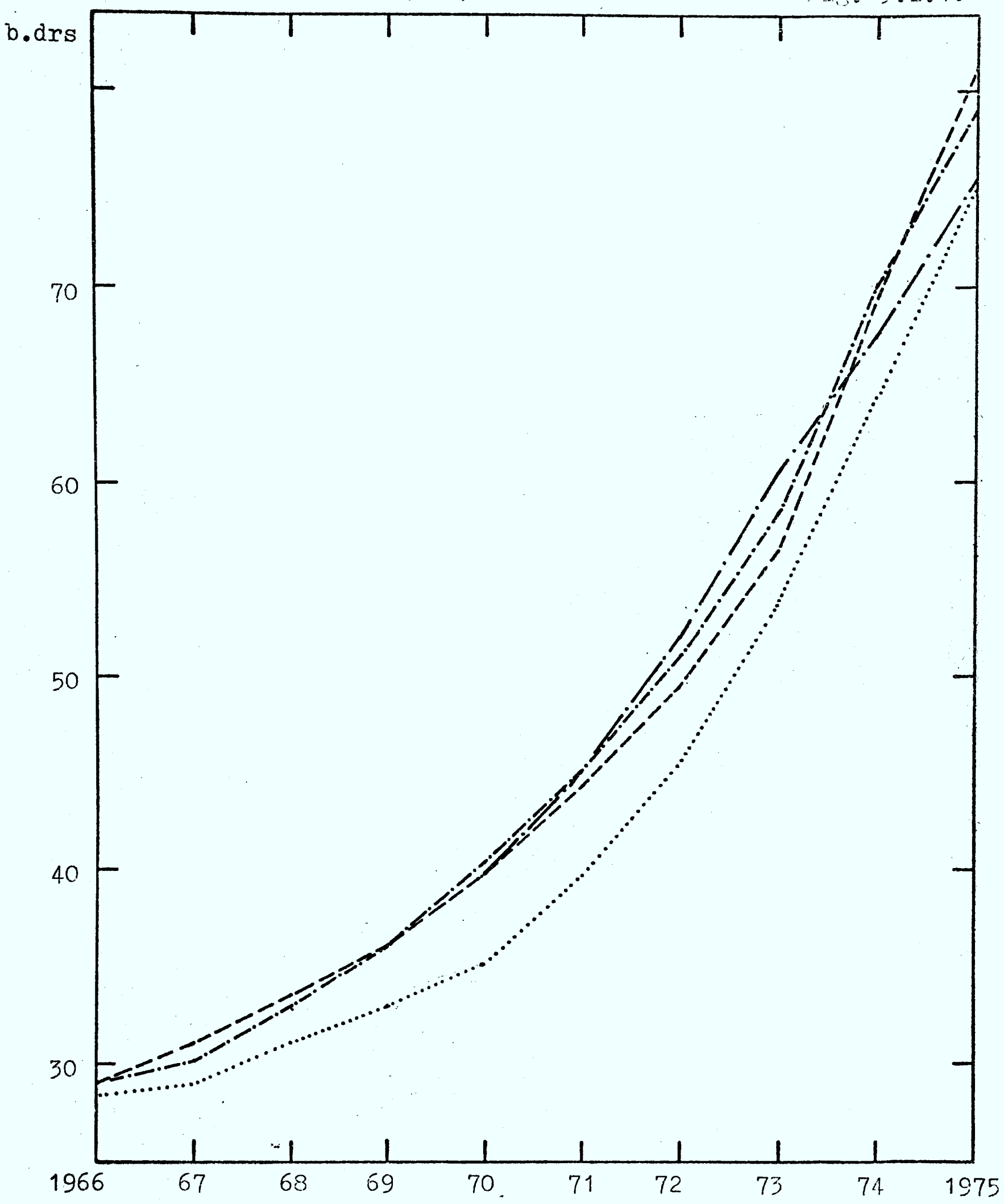
Fig. 5.I.9



..... Simulated values
— — — — — Money & Bond financing
—·—·—·—·— Tax financing (t_0, d_0)
———·——— Tax financing (t_1, d_1)

Indirect Tax Revenue (NT^i)

Fig. 5.I.10



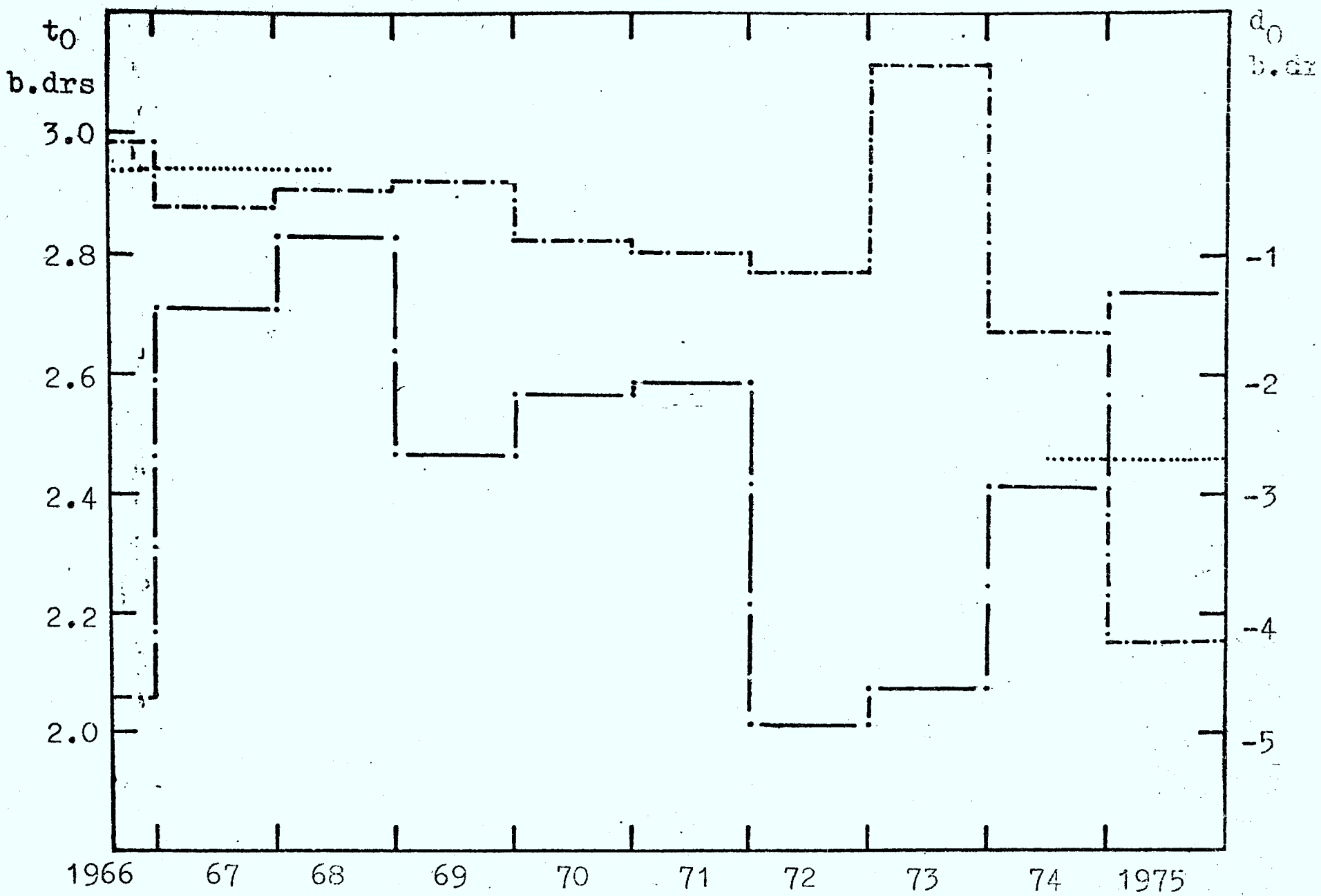
excess inflation tax.

When discretionary action is undertaken on the marginal tax rates, besides the direct effects on income through the financing of the budget deficits, there occurs an indirect discretionary effect via the multipliers of the system. For this reason, excessive discretion on tax rates is undesirable, besides other reasons (incurring costs etc.), because it tends to destabilise the system.

The optimal values of the base tax levels (when objective function 5.4.3.A was employed) and the optimal values of the marginal tax rates (objective function 5.4.3.B) are shown in figures 5.I.11 and 5.I.12, oscilating around their desired values. The behaviour of tax instruments is such that they tend to increase tax yields during recessions (1967-68 and 1974) and decrease them during booms, to provide for the financing of government expenditure.

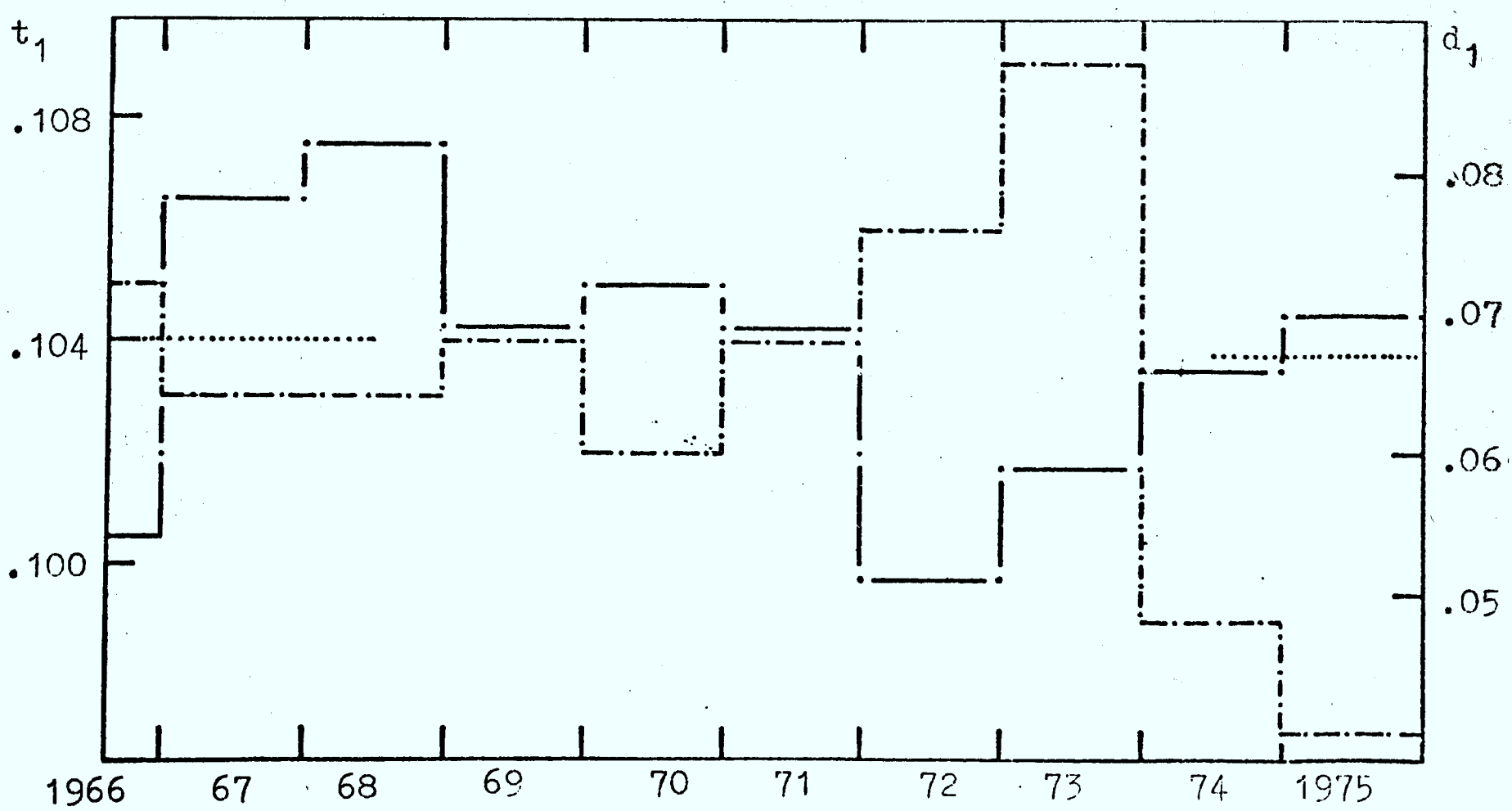
The balance of payments, shown in figure 5.I.8, is in deficit in all cases as expected by the structure of the model. Changes in the level of foreign reserves is represented in a simplified manner of a fixed exchange rate regime, exogenously determined exports and capital flows invariant of domestic economic variables, justified on the grounds of the specific character of the Greek economy[16]. The only endogenously determined component, imports on goods and services, is related to the level of disposable income. Enhanced economic activity, therefore, necessitates additional imports resulting in a deterioration of the balance of trade and hence the balance of payments. Differences in inflation rates (and price level) and discretionary tax actions between the various runs, are expected to induce differences in real

Developments of Base Tax Levels (t_0,d_0) Fig. 5.I.11



——·——·—— t_0 (left scale)
——·——·—— d_0 (right scale)

Developments of Marginal Tax Rates (t_1, d_1) Fig. 5.I.12



——·——·—— t_1 (left scale)
——·——·—— d_1 (right scale)

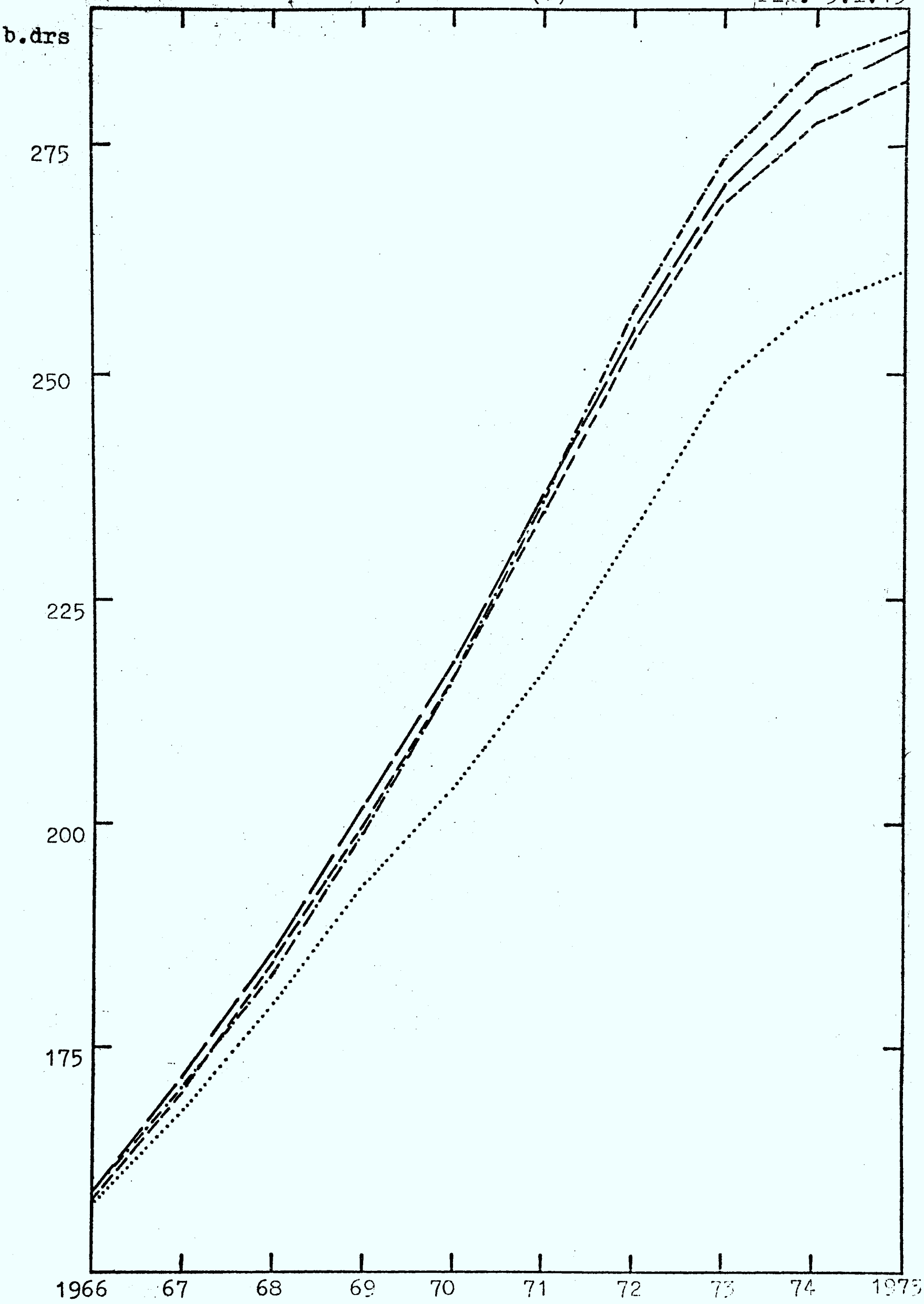
direct tax yields and hence, differences in the levels of real disposable income. The overall effect on the balance of payments is of similar magnitude in all cases.

Private consumption expenditure is affected by the fiscal impact of an increase in government spending through the level of income and, therefore, disposable income. It is also directly influenced in a positive manner by the wealth impact of monetary expansion (proxy for liquid assets) of the previous period. A third direct impact, but in opposite direction, is via the rate of inflation through changes in the stock of money. The fact that the coefficient of M in the consumption function of 0.35 is relatively large, compared to the coefficient of real disposable income of 0.153, explains the difference in the development of optimal consumption expenditure in the cases of money and bond financing (fig. 5.I.13).

Bond financed budget deficits result in higher levels of private consumption (compared to money financing) not only due to induced higher levels of income, but also due to enhanced liquidity in the economy, as depicted in figure 5.I.6 above. The direct effect of inflation on consumption between various modes of financing, is not expected to be substantially different due to its small coefficient of 3.11 and also the minimal differences in the optimal inflation rates between runs.

Under tax financing, optimal consumption follows a similar pattern to bond financing because M and $\dot{P}$ trace the same desired trajectory. The only differences arise from deviations of real disposable income.

Private Consumption Expenditure (C) Fig. 5.I.13

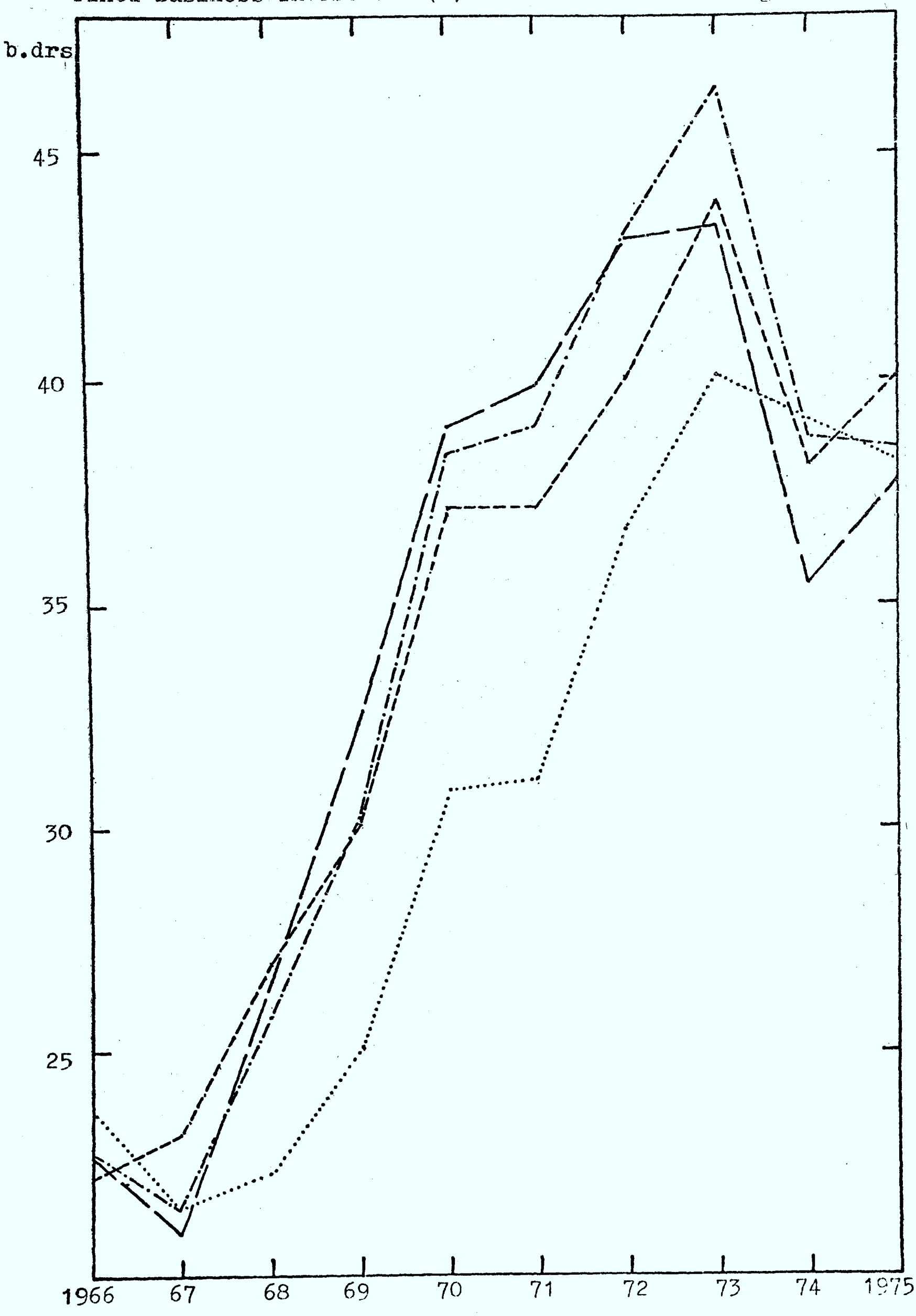


Fixed business investment is affected directly (in a positive manner) by a fiscal expansion through the previous period level of aggregate demand (profits), which in turn, induces an increase in the rate of interest through the demand for money, thus depressing investment (financial crowding out).

The optimal trajectory of fixed business investment (fig. 5.I.14) is higher than the actual path over most of the planning period. This is mainly explained by increased levels of optimal income and therefore profits, given the high income elasticity of business investment of 2.516 on average. Business investment follows an expanding path throughout the period reaching a peak in 1973, as a result of higher levels of income, outweighing the contractionary effects of rapidly increasing interest rates. The fall in investment activity in 1974 is mainly due to outstanding high cost of borrowing. Note that in 1974, the optimal level of the interest rate is about 11%, which is 3 points above the actual level and the interest elasticities of money demand and business investment are -0.105 and -0.160 respectively.

Under bond financing, private business investment is higher than money financing except in 1967 and 1973-75. This is explained by enhanced economic activity and also lower interest rates for the period 1968-73. The downswing in 1974-75 is mainly the result of reduced levels of income, the levels of interest rates are about the same to those of money financing. The fall in 1967 is attributed to higher interest rates as a result of a stricter monetary policy. When the budget deficit is covered by increased tax yield, the optimal levels of business investment reach their peaks

Fixed Business Investment (I) Fig. 5.I.14



in 1972-74 when income levels are greater to deficit financing.

Housing investment is mainly affected by developments in the level of the rate of interest, which in turn is determined by a fiscal and monetary policy. Its optimal path is shown in figure 5.I.15 below.

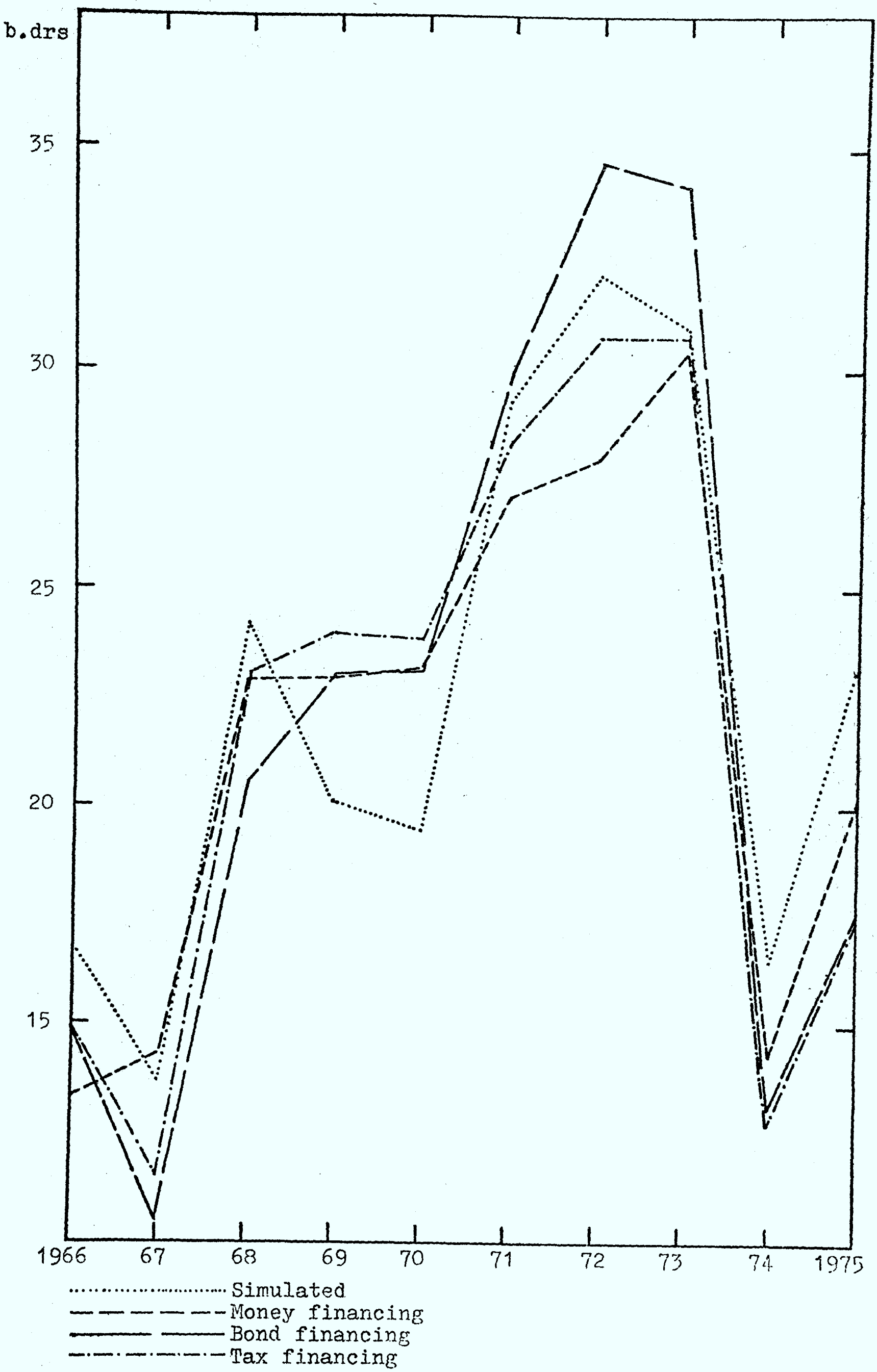
Under money financing, housing investment follows a smoother pattern compared to actual developments. In particular the 1967 and 1969-70 recessions in housing activity are minimised, while the 1973 boom is substantially curtailed. In view of the fact that a significant proportion of the work force is employed in construction[17], minimisation of short term fluctuation in housing investment has an important effect in reducing the unemployment situation in the economy. Conditions of relatively excessive unemployment in this particular sector cannot be prevented resulting from high interest rates. In the case of bond financing, housing investment is boosted in 1971-73 and curtailed in 1966-68 and 1974-75, being far more responsive to the cost of borrowing than fixed business investment (the interest elasticity of H is -0.466 compared to -0.105). Thus, contrary to the previous case, optimal housing investment does not exibit a countercyclical behaviour.

The optimal share of government expenditure in the economy is depicted in figure 5.1.16, and it is generally well above the actual share over the planning period.

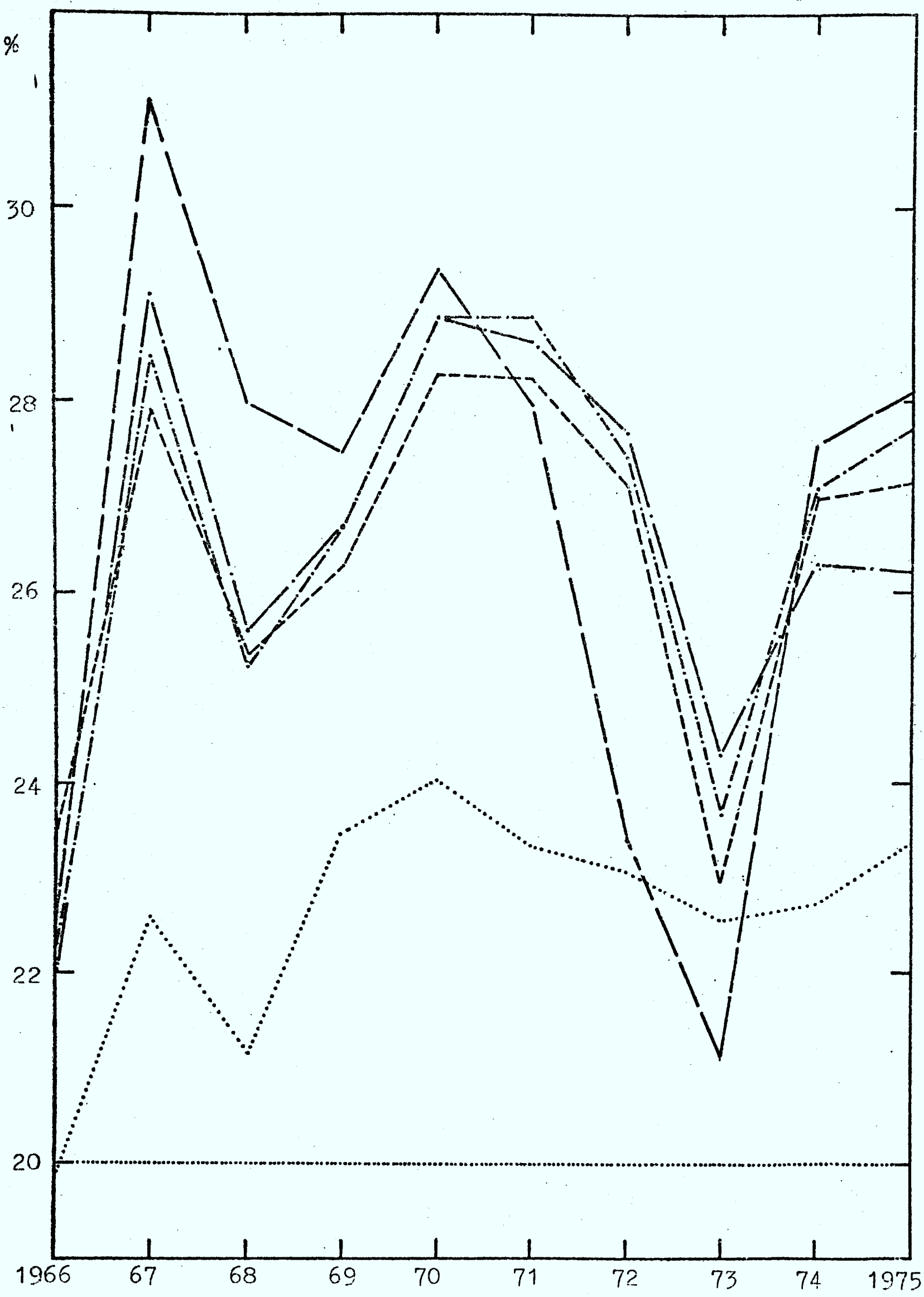
With respect to the predetermined objectives, bond financed deficits result in higher shares of the public sector in the economy (measured in terms of G/Y) compared to

Housing Investment (H)

Fig. 5.I.15



Share of Public Sector in Economy (G/Y) Fig. 5.I.16



.....Simulated values
.....(constant 20%) Desired values
– – – – – – –Money financing
——— ———Bond financing
—·—·—·—·—·—Tax financing (t_0, d_0)
———·———Tax financing (t_1, d_1)

money financing over the whole planning horizon, except in the period between the years 1970-71 and 1973-74. For tax financing, G/Y follows a path similar to but above that of money financing. The average values of optimal G/Y for the various modes of financing are as follows:

money	26.4%
bonds	26.6%
tax	26.7%
actual (simulated)	22.6%

5.4.5 Summary

The main findings can be summarized as follows:

Under all forms of financing the budget, it is possible to reduce substantially fluctuations in aggregate economic activity and also increase its level. Money financing achieves high rates of growth of income up to 1972 falling rapidly thereafter, with a possibility of creating difficulties in the labour market. In contrast, bond financing allows for a smooth reduction in the pace of growth of income towards the 1974 recession. Under tax financing and without excessive swings in tax legislation it becomes possible to smooth out some of the irregularities of $\dot{Y}$, but deficit financing is necessary.

Regarding the expansion of the level of income, bond financing is more expansive up to 1971, compared to money financing. After 1971, money financing is more expansive due to the necessitating impact of the higher increase in government expenditure. Fixed business investment seems to be following overall a more expansive path, under bond financing. The evidence for housing investment, which is not

directly dependant on aggregate economic activity, suggests that bond financing policy is preferable inducing a counter-cyclical behaviour in housing activity.

A reduction in the inflation rate in the seventies is almost impossible, unless we are prepared to stagnate aggregate economic activity. This is mainly due to the influence of imported inflation on domestic inflation and the low responsiveness of $\dot{P}$ on demand factors. The introduction, therefore, of more instruments for the control of inflation is suggested.

The heavy dependance of the development of the economy to imported goods, creates balance of payments difficulties if we are seeking for a rapid expansion of domestic output. The introduction of selective import quotas seems most appropriate to allow for the expansion of the import substitution industries and disentangle the dependance of exports on imported goods.

All policies call for an increase of the share of the public sector in the economy by about 4% on average, being the prerequisitive for the achievement, as far as possible, of the predefined macroeconomic objectives. As shown in the set of experiments that follow, the added objective of reducing the share of the public sector is incompatible with the aforementioned macroeconomic objectives, and results into a reduction in economic activity without improving inflation.

In what follows the optimisation experiments are performed again with the introduction of the objective $G/Y = 20\%$ to be satisfied in all cases.

5.5 Attainment of $\dot{P}$, $\dot{Y}$, R and G/Y targets

In this second set of runs the possibility of attaining all four policy objectives ($\dot{P}$, $\dot{Y}$, R and G/Y) will be examined, under the three modes of financing the deficits of the budget.

5.5.1 Money Financed Case

In the money financed case the arguments of the objective function and their respective weights are the following:

a)	targets	$\dot{Y}$	$\dot{P}$	G/Y	R
	weights	10^7	10^7	10^{10}	10^3
b)	instruments	NG	NBA	ΔPB	
	weights	10^{-2}	10^{-9}	10^4	

The rationale for the specification of the objective function is similar to the 'money financed case' without any restrictions on the share of the public sector (5.4.1 above). With fixed coefficients of the tax equations, any remaining budget disequilibrium associated with changes in government spending, is accomodated by changes in the level of the monetary base.

5.5.2 Bond Financed Case

The specification of the objective function with the inclusion of the G/Y objective is shown below:

a)	targets	$\dot{Y}$	$\dot{P}$	G/Y	R
	weights	10^7	10^7	10^{10}	10^5
b)	instruments	NG	NBA	ΔPB	
	weights	10^{-2}	10^2	0	

The imposed weights on targets and instruments and also the desired values are the same as in run 5.4.2 above, with the exception of the weight imposed on the interest rate, which has been increased from 10^3 to 10^5. When, at first the optimization was carried out (with $w_R = 10^3$), it was found that the rate of interest took unacceptable and in some periods negative values. As will be shown for run 5.5.1 below, the imposed restriction of G/Y requires the reduction of aggregate economic activity and consequently the liquidity of the system. In this run, however, NBA is restricted to follow a desired path higher than the optimal and therefore the optimal values of the rate of interest forced to take low numerical values, sometimes less than zero. By increasing the penalty on the deviation of optimal R from its desired path we have corrected for this imbalance. The implication of increased weight on R, is that the authorities, although they do not rank their objectives differently, pay increased attention to the achievement of the stability of the money market relative to the other objectives. This is so in this particular run in relation to the other runs, and has to be taken into account in comparing the bond financed case to the other policies.

Thus, according to the specification of the objective function, the stock of public borrowing is allowed to match any remaining imbalances induced by fiscal action, the monetary base being restricted to its desired path.

5.5.3 Tax Financed Case

In the tax financed budget deficits the objective function takes the following two forms:

A) Budget Financing via the Base Tax Levels

a) targets	$\dot{Y}$	$\dot{P}$	G/Y	R	
weights	10^7	10^7	10^{10}	10^3	
b) instruments	NG	NBA	ΔPB	t_0	d_0
weights	10^{-2}	10^2	10^6	10^9	10^9

B) Budget Financing via the Marginal Tax Rates

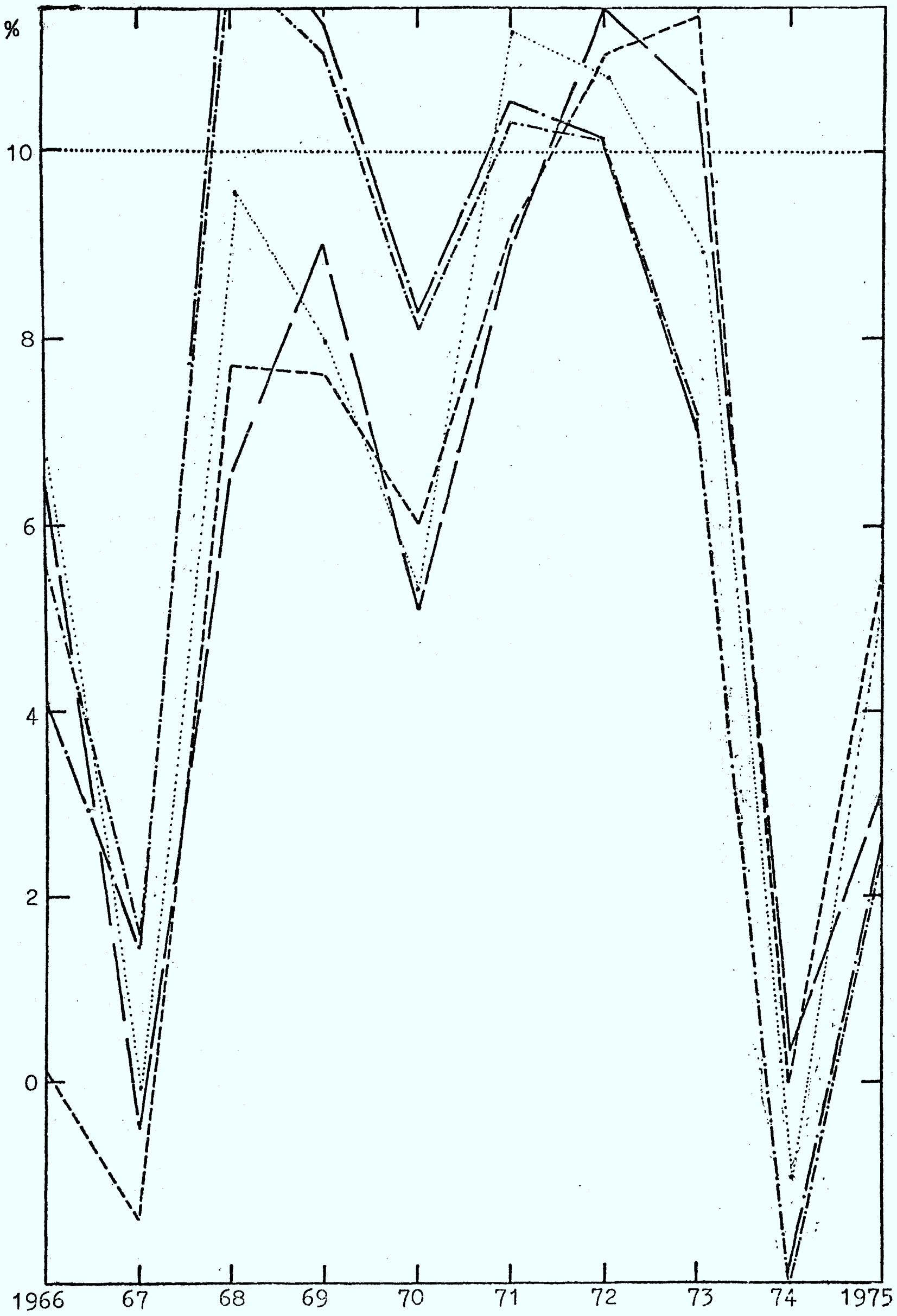
a) targets	$\dot{Y}$	$\dot{P}$	G/Y	R	
weights	10^7	10^7	10^{10}	10^3	
b) instruments	NG	NBA	ΔPB	t_1	d_1
weights	10^{-2}	10^2	10^6	10^{11}	10^{11}

Recalling the discussion in 5.4.3 above, the weights attached to tax instruments must be such that their optimal values must not diverge from the desired value by 'large' margins. In both objective functions equal weighting is placed on direct and indirect tax instruments. Given the objective of reducing G/Y to 20%, the stock of public borrowing and the level of monetary base tracking their desired paths, any budget disequilibrium due to fiscal action, is accounted for by adjustments in the tax coefficient.

5.5.4 Results

When the objective of reducing the share of the public sector among the macroeconomic targets, the effectiveness of optimal policies in reducing fluctuations in aggregate economic activity, judged by the rate of growth of GNP, is very much reduced as shown in figure 5.II.1. The effect of macroeconomic policies under money or bond financing is sometimes destabilizing in terms of accentuating recessions and enhancing

Growth Rate of Real Income ($\dot{Y}$) Fig. 5.II.1



..... Simulated values
..... (constant 10%) Desired values
– – – – → Money financing
——— Bond financing
—·—·—·— Tax financing (t_0, d_0)
—·—·—·— Tax financing (t_1, d_1)

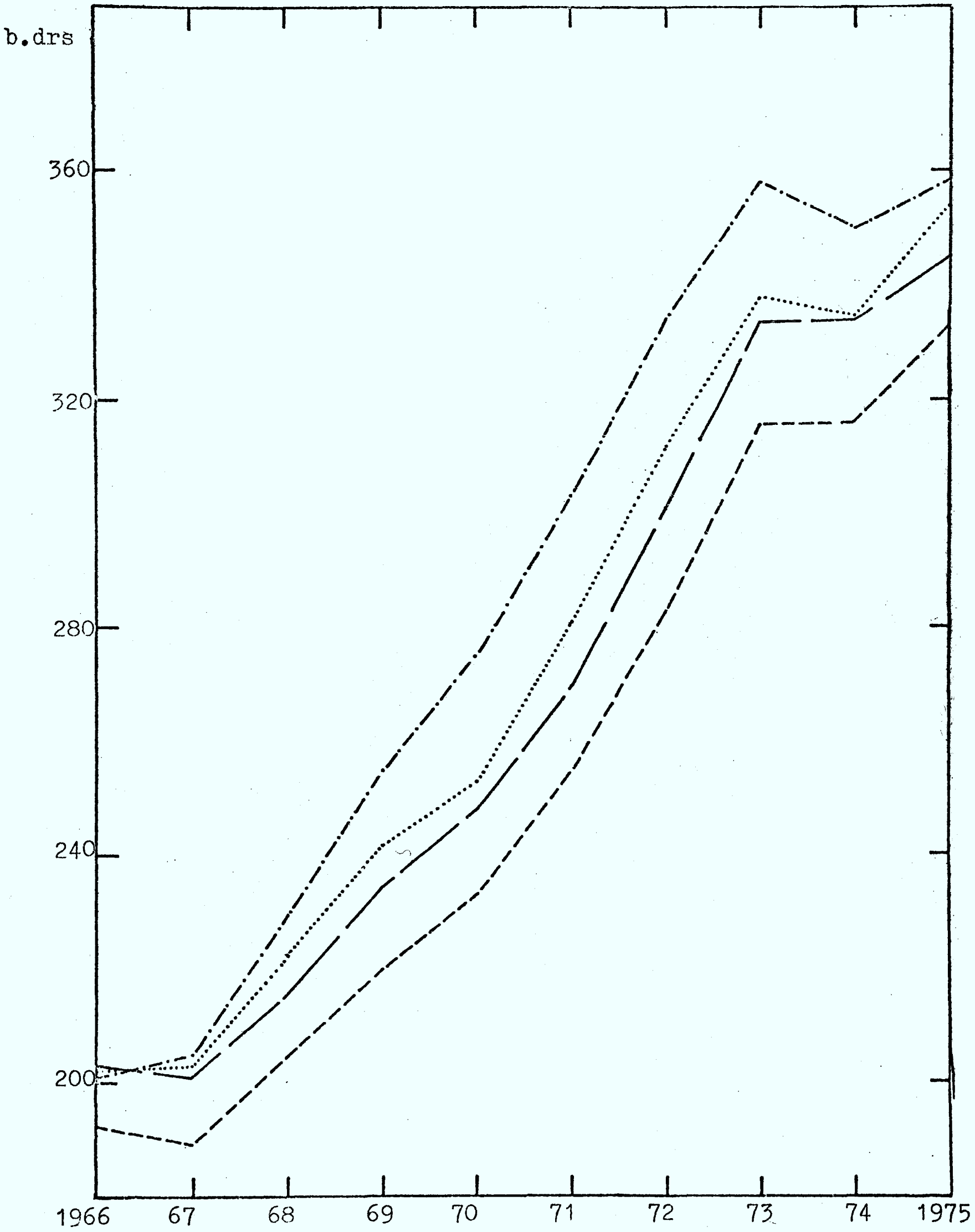
booms. As regards to the tax financed budgetary policies, the indication is that overall they do not perform any worse than in the other two cases. They do not do any better either.

The optimal level of economic activity under money and bond financing, although on an increasing path, is lower compared to its actual trajectory (fig. 5.II.2) and also to the optimal paths of runs 5.4. Making comparisons, however, between modes of financing, bond financing results in a less contractionary level of economic activity. In this respect the objective of reducing the share of the public sector is better accomodated when the budget deficits are covered by the creation of debt. If, on the other hand, a discretionary tax policy is pursued to balance the deficit, the level of income follows a more expansive path, not only with respect to deficit financing but also with respect to its actual level.

The objective of reducing the rate of inflation, in the case of money financing, is achieved for the period of up to 1972 (fig. 5.II.3), but the actual inflation rate as well as the target is exceeded subsequently. Recalling the specification of the price adjustment equation, where $\dot{P}$ depends on $\dot{NM}$ and imported inflation, the optimal inflation rate is explained in part by the development of the monetary base and $\dot{NM}$ (fig. 5.II.5). The optimal policy calls for the reduction of the level of monetary base below desired levels, which is the outcome of reduced liquidity needs of the economy due to lower levels of aggregate expenditure. The rate of growth of money supply, although at lower than desired levels up to the early seventies, starts picking up thereafter exceeding its target values, generating higher inflation rates in this period.

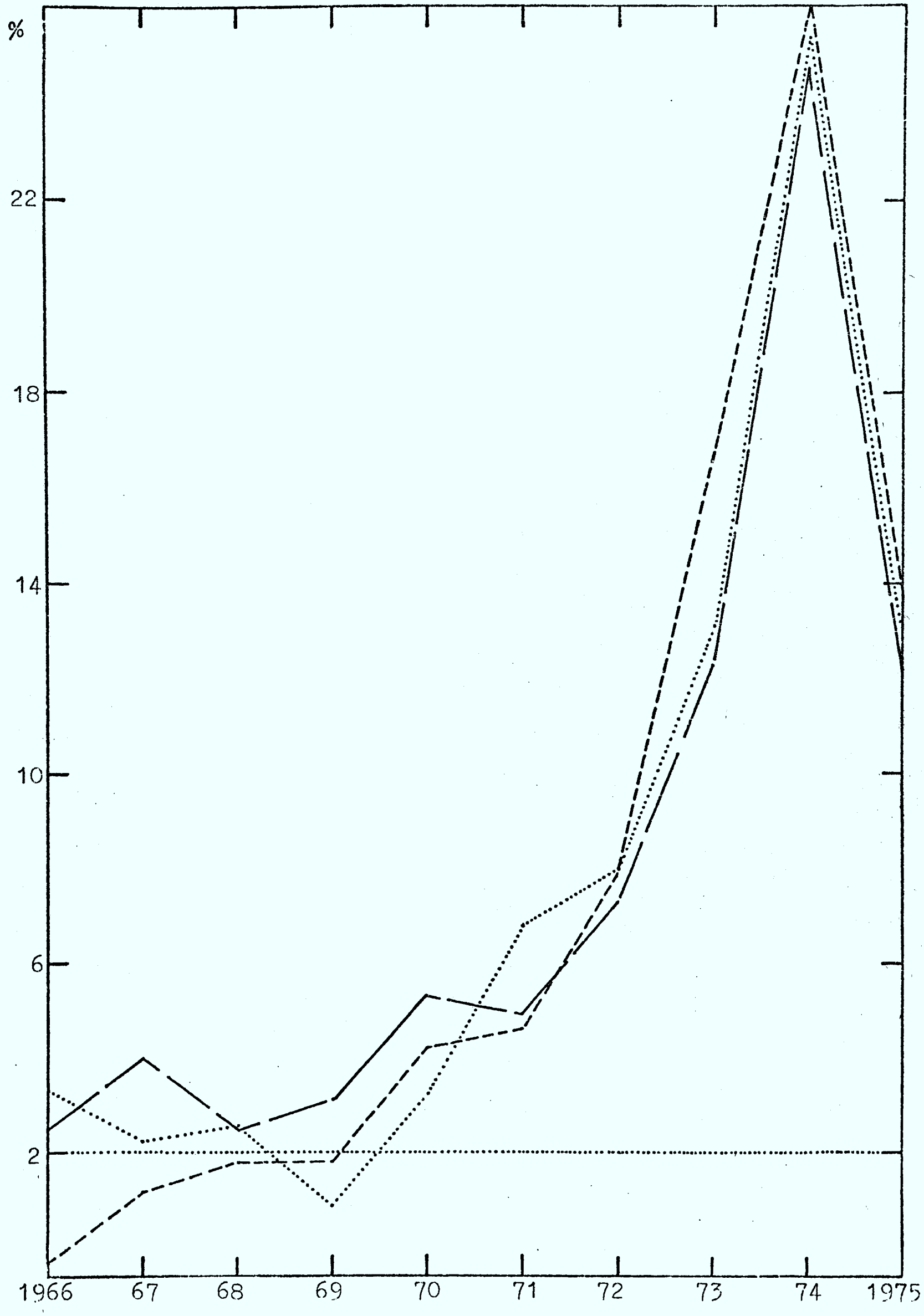
Real level of Income (Y)

Fig. 5.II.2



Inflation Rate ($\dot{P}$)

Fig. 5.II.3



Thus, the domestic component of inflation together with the impact of higher import prices makes the objective of reducing the pace of inflation unattainable after 1972.

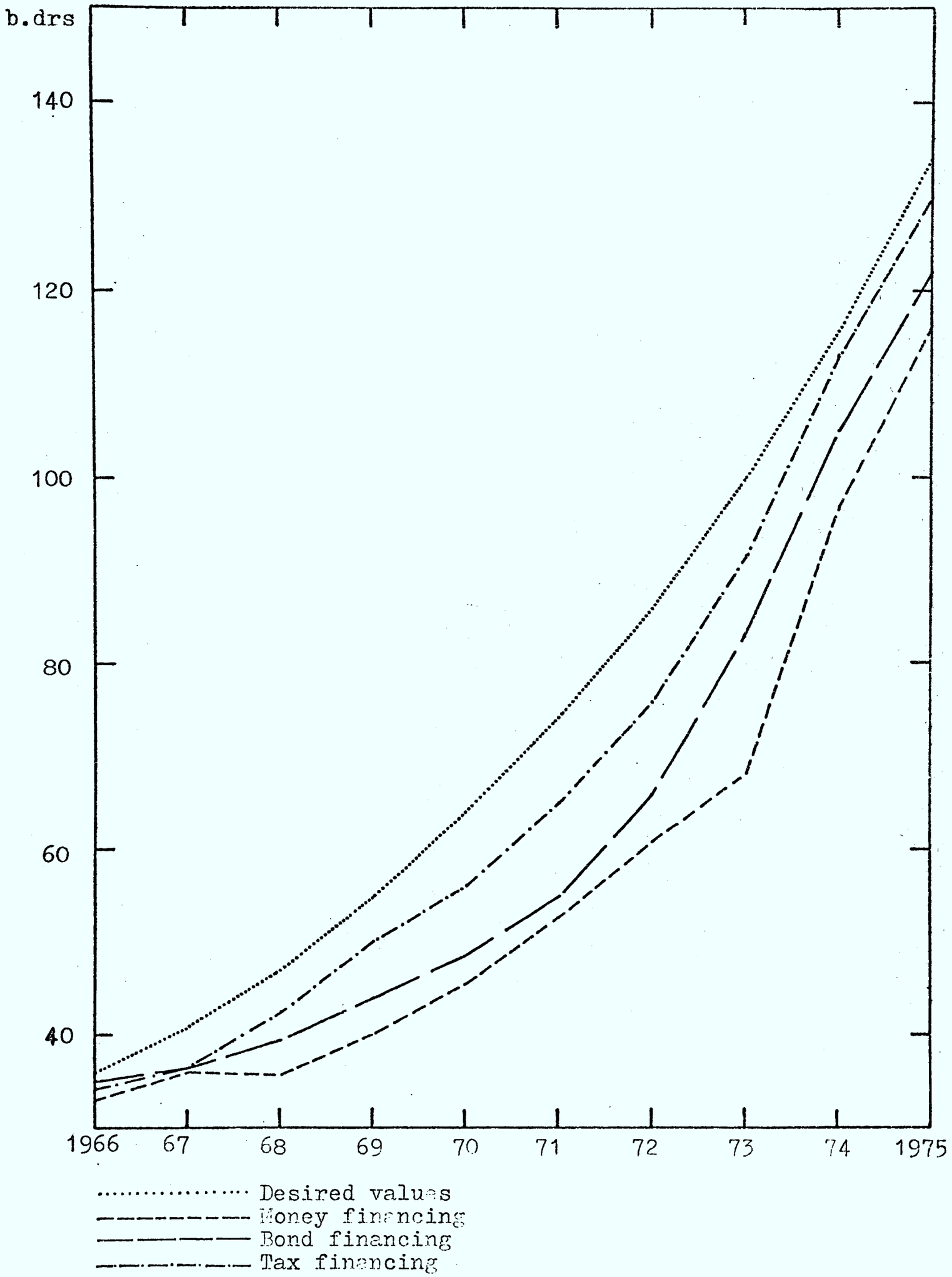
By the same rationale and as a result of the specification of the objective function, the rate of inflation in the bond and tax financing cases, is worse than actual developments in the first half of the planning period improving in the seventies due to resulting slower growth rates of the money supply.

Optimal government expenditure (fig. 5.II.4) follows lower than desired trajectories, recording faster rises in the years 1973-75 to counterbalance the dropping economic activity. Irrespectively of the mode of budget financing, the patterns of development of government spending, do not register any abrupt changes in policy, indicating the need for a rather passive discretionary fiscal action. As a result, optimal policies render discretionary government expenditure policy ineffective in controlling fluctuations in the economy.

The reduction in NG will reduce gross expenditure, being a part of it, but will induce rises in economic activity through the effect of the rate of interest on private investment. Nevertheless, as we see below, the high income responsiveness of fixed business investment and relatively low interest responsiveness, together with a high income responsiveness and relatively high interest rate responsiveness of the demand for money function, cannot increase investment (and therefore income) substantially to counterbalance the drop in government spending. Housing investment is in some periods increased, being highly responsive to interest rate developments.

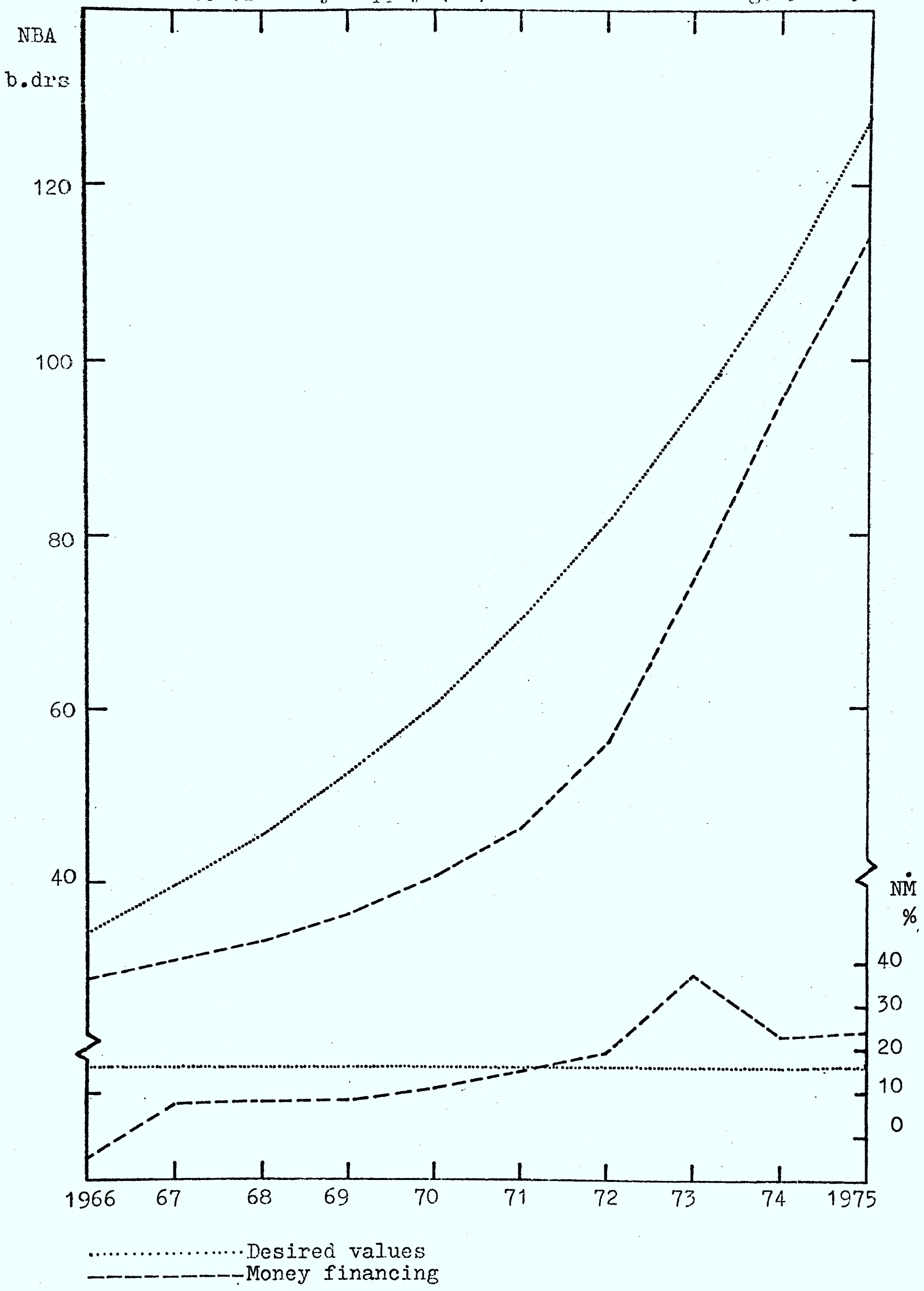
Government Expenditure (NG)

Fig. 5.II.4



Monetary Base (NBA) &
Growth Rate of Money Supply ($\dot{NM}$)

Fig. 5.II.5



The optimal path of the stock of government debt (fig. 5.II.7) is lower than desired, which is due to decreased needs of financing the already lower than desired levels of government spending. The recorded peaks in 1968 and 1973 are the result of a faster than desired increases in NG in these years and an inadequate increase of tax revenues due, to the already mentioned, low tax coefficients.

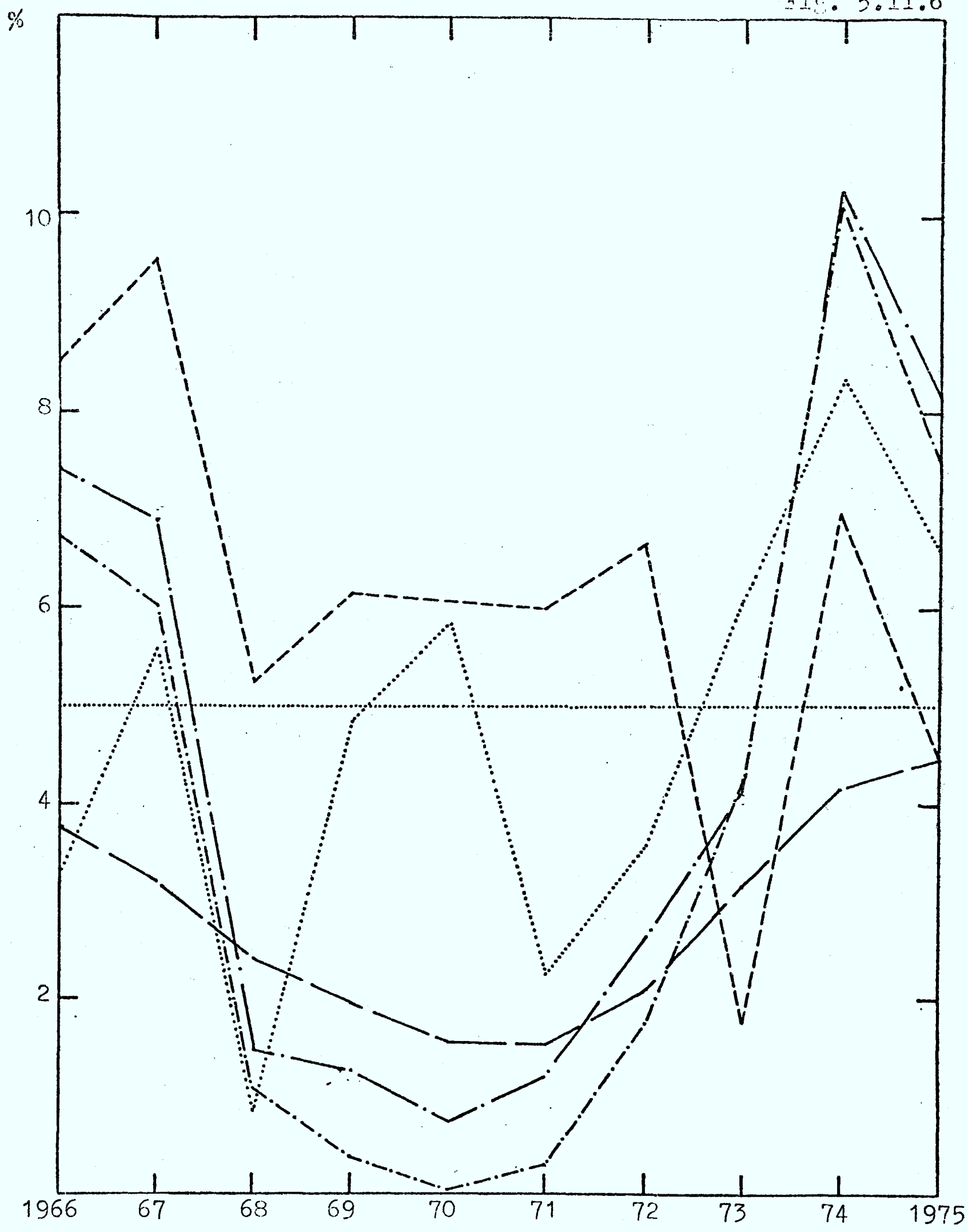
Under money financing the optimal rate of interest (fig. 5.II.6) takes higher than its actual values in the period 1966-72, mainly as a result of low (lower than desired) levels of the money supply requiring to finance reduced public spending. The relatively easier monetary policy in the years 1973-75 allows for the interest rate to adjust to lower levels. The steep rises in R in 1967 and in 1974 are explained by the slowing down in economic activity.

The smooth optimal values that the interest rate takes in the case of bond financing,is due to increased weight attached on R in the objective function as explained in section 5.5.2 above. The low (below desired) levels of the interest rate are due to the existence of ample liquidity in the economy throughout the planning period, since the desired path of NBA is to accomodate much higher levels of the income than indicated by the results. In the case of tax financing the pattern of the optimal interest rate is similar to case 5.4.3, but at lower levels due to weaker income effects of a lower level of government spending.

The direct effects of inflation on the interest rate through the demand for money are weak as in the previous case (section 5.4 above) due to the small deviation of optimal from actual inflation rates and the small coefficient of $\dot{P}$

Interest Rate (R)

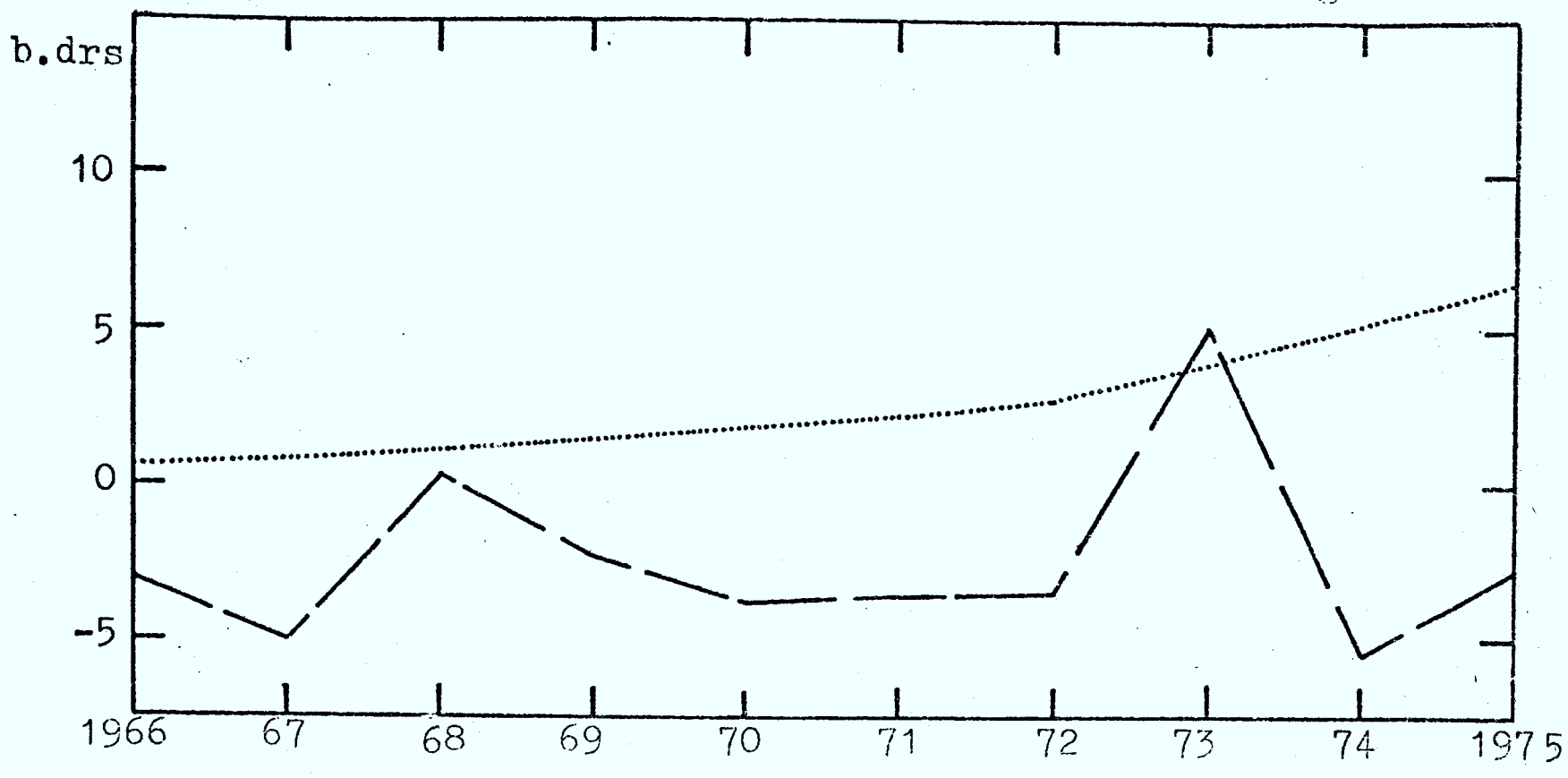
Fig. 5.II.6



..... Simulated values
..... (constant at 5%) Desired values
---------- Money financing
———————— Bond financing
—·—·—·—·— Tax financing (t_0, d_0)
—·——·——·— Tax financing (t_1, d_1)

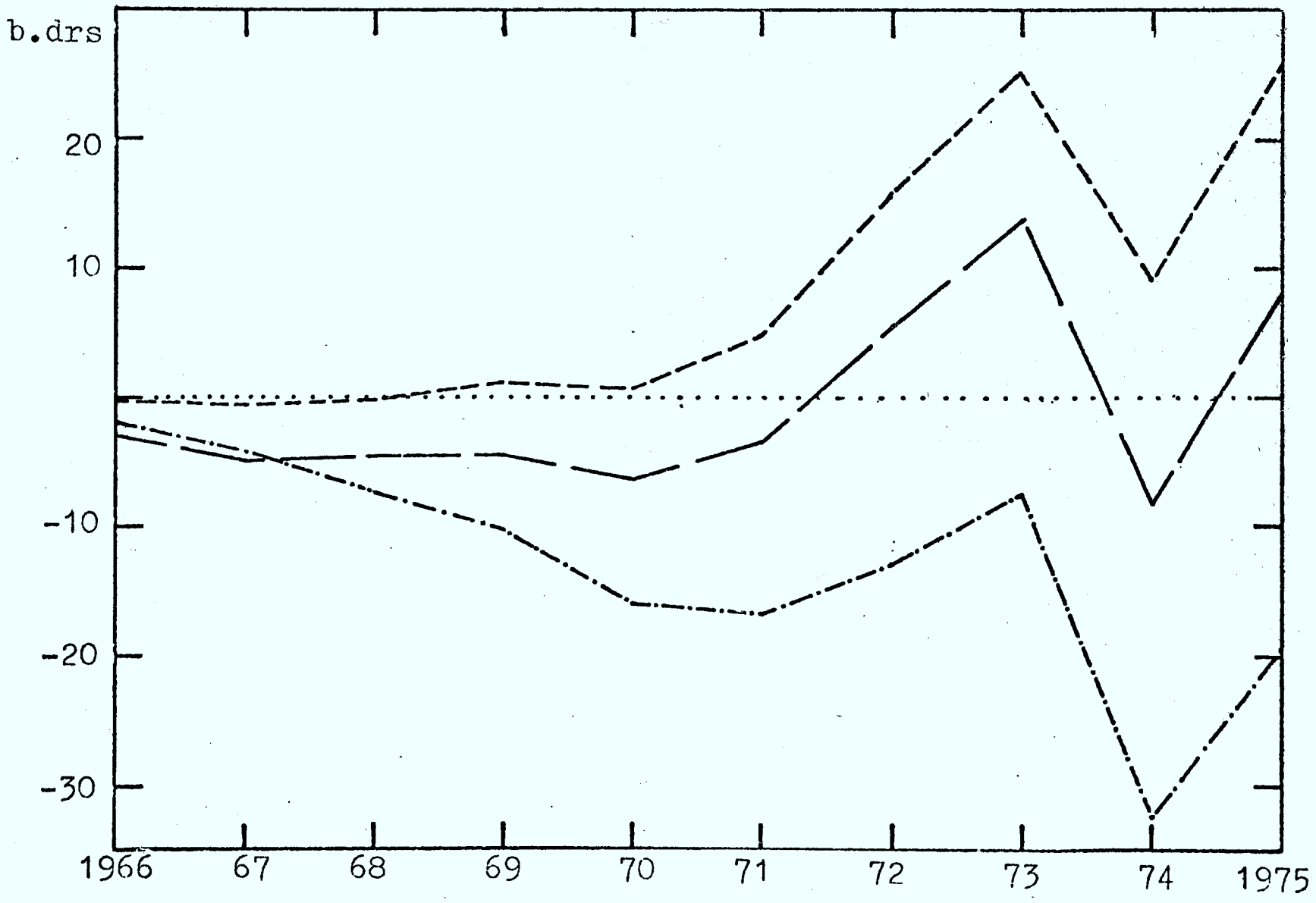
Stock of Government Debt D(PB)

Fig. 5.II.7



Balance of Payments (DNF)

Fig. 5.II.8



in the demand for money function.

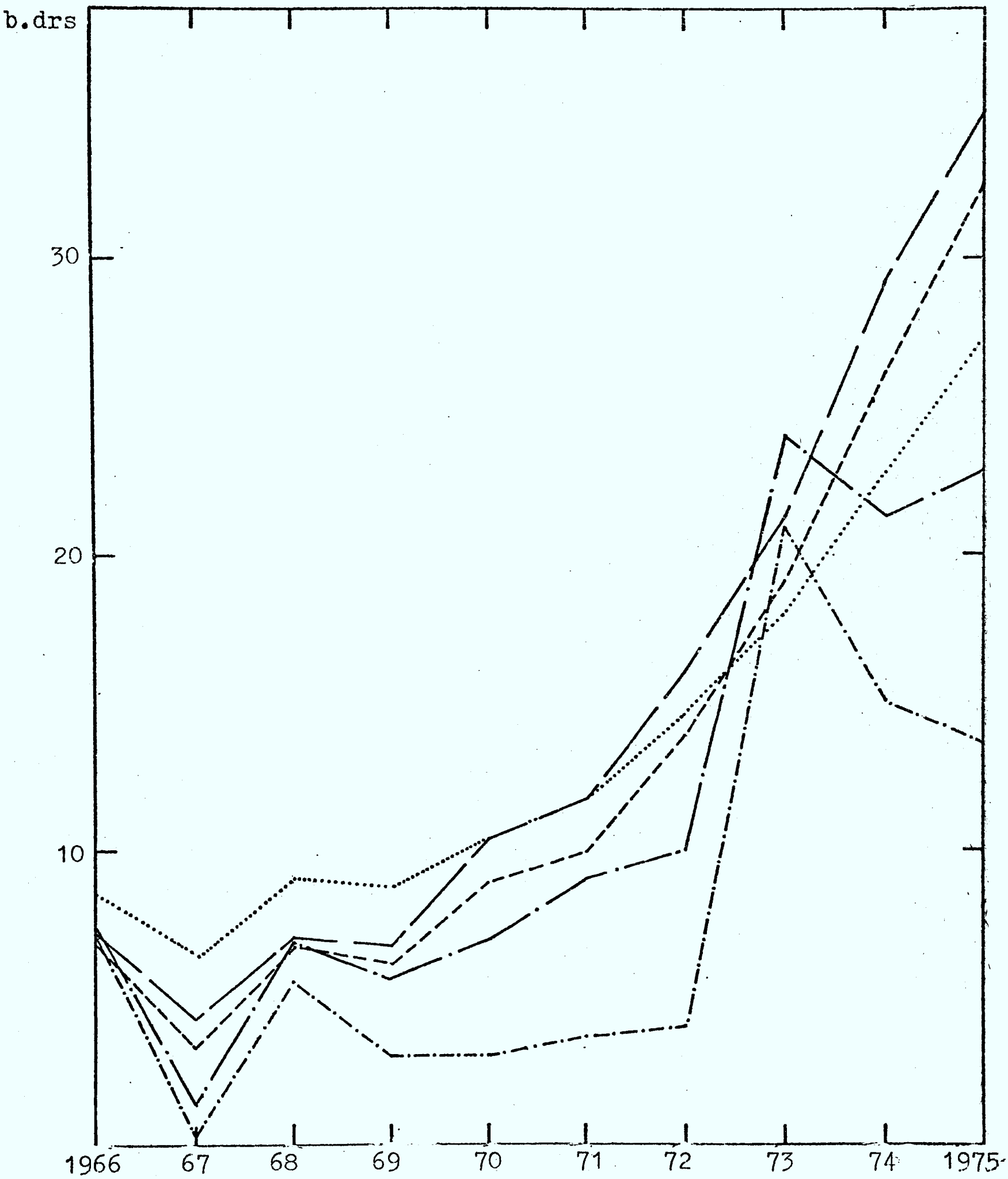
Assuming deficit financing, the reduction of the level of government expenditure results in lower levels of total expenditure and therefore to a smaller yield taxation (fig. 5.II.9 and 5.II.10), compared to the previous run of section 5.4. In the case of tax financing and discretionary tax policy, the optimal indirect tax revenue is smooth compared to that of direct tax revenue, given the greater effective weight imposed on indirect tax parameters.

The optimal developments of tax instruments are depicted in figures 5.II.11 and 5.II.12. The base tax level of indirect taxation increases over time, thus increasing the regressiveness of indirect taxation, while the continually descending trend of direct based tax levels increases the progressiveness of direct taxation. The same results are obtained when stabilization policy is carried out through changes in the marginal tax rates (fig. 5.II.12). Hence, if the amount of deficit financing is kept to what is described as 'normal' by the objective function, it is possible to reduce the share of the public sector and expand the economy if we are prepared to lower the revenue from taxation. This will become clearer when we discuss the optimal developments of the various demand components.

Under deficit financing, optimal disposable income appears to be curtailed due to the reduction in general economic activity outbalancing the increase related to the decrease in direct taxation. In the case of tax financing, optimal disposable income increases but not as much due to the above mentioned effect. The positive effect of inflation on real disposable income is quite small being associated with

Direct Tax Revenue (NT^d)

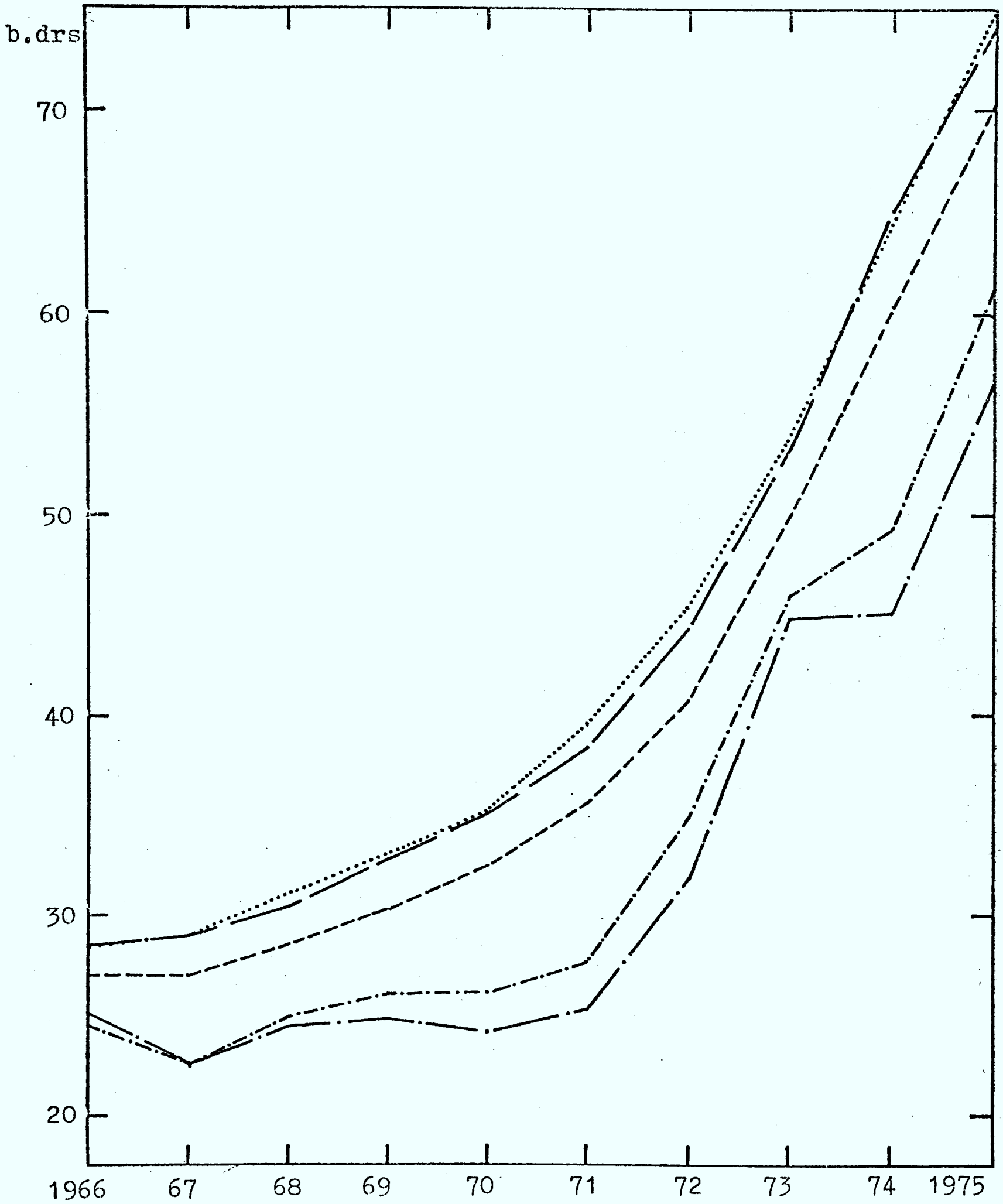
Fig. 5.II.9



..... Simulated values
– – – – – – – – – – Money financing
———————— Bond financig
—·—·—·—·—·— Tax financing (t_0, d_0)
—·——·——·— Tax financing (t_1, d_1)

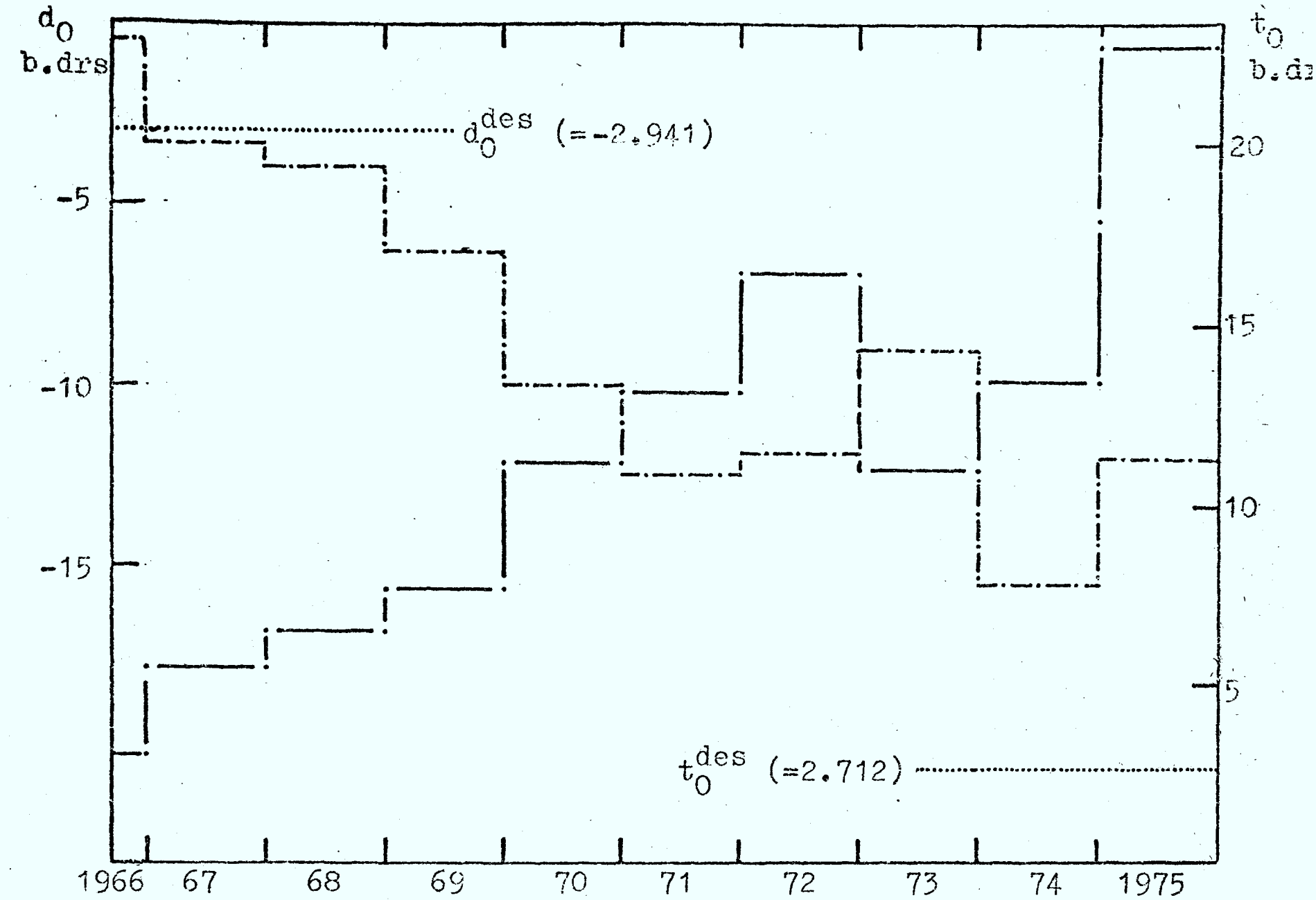
Indirect Tax Revenue (NT^i)

Fig. 5.II.10



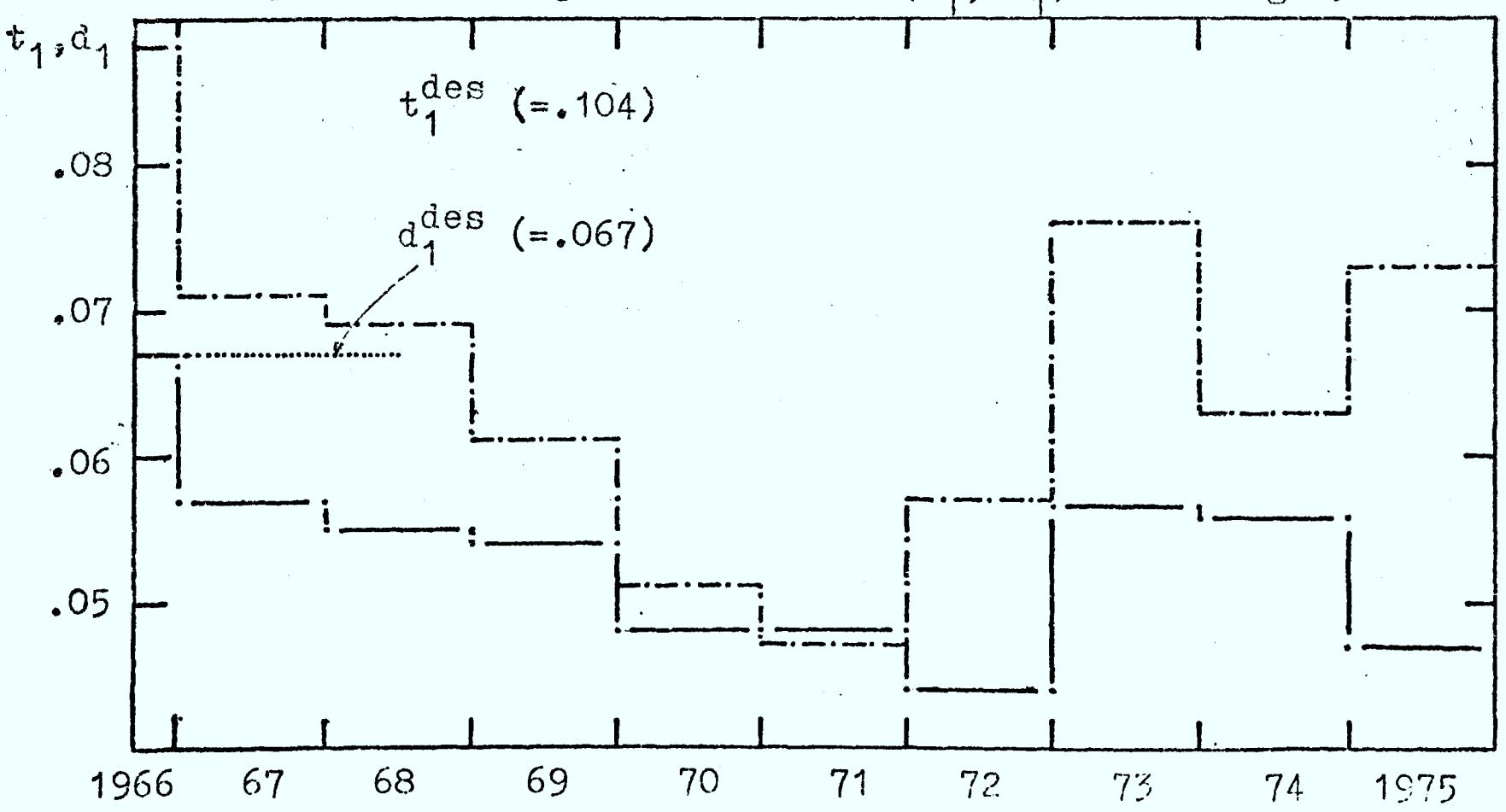
..... Simulated values
———— Money financing
— — — — Bond financing
—·—·—·— Tax financing (t_0, d_0)
——·——·—— Tax financing (t_1, d_1)

Developments of Base Tax Levels (t_0, d_0) Fig. 5.II.11



——·——·—— d_0 (left scale)
——·——·—— t_0 (right scale)

Developments of Marginal Tax Rates (t_1, d_1) Fig. 5.II.12



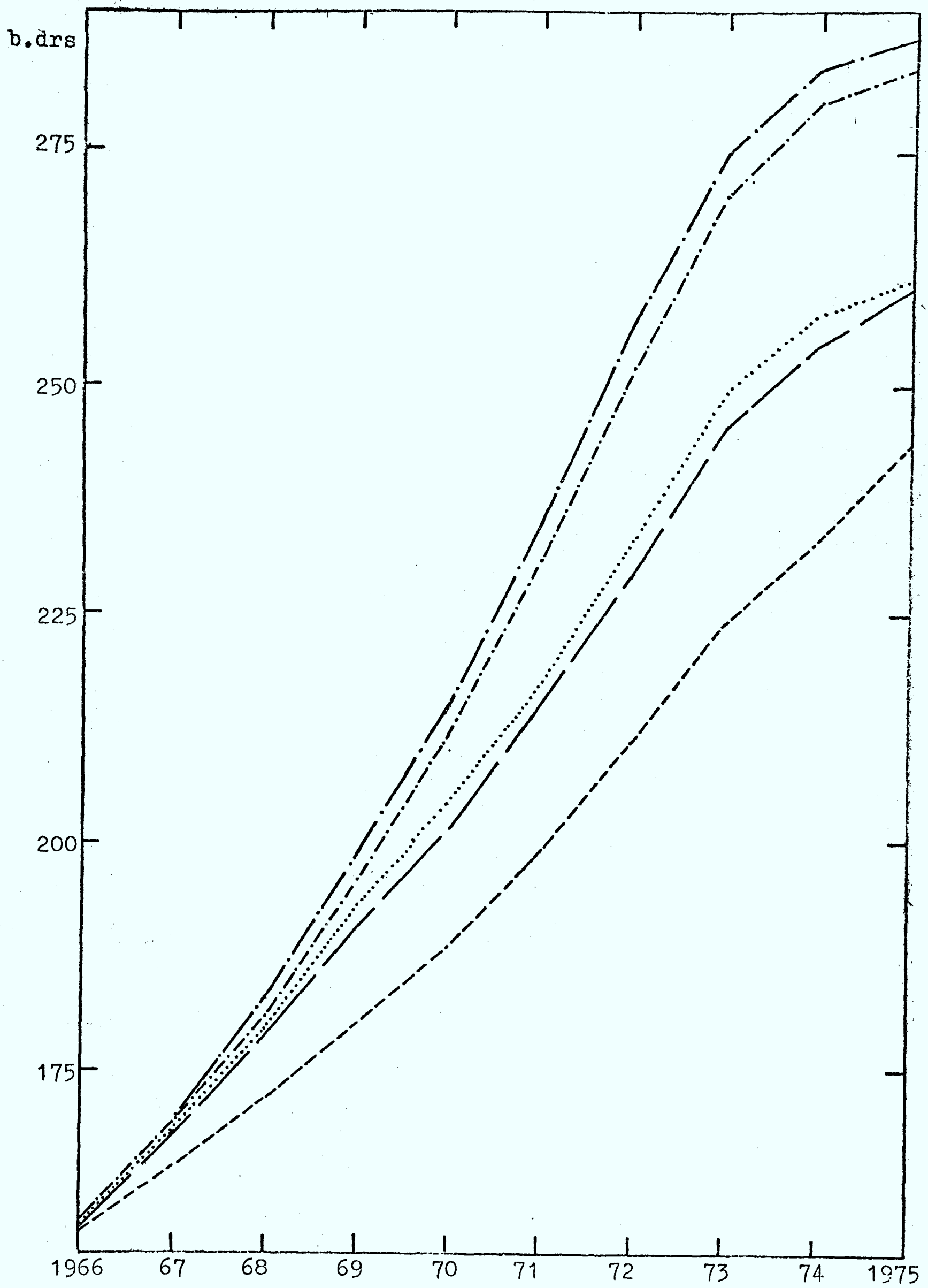
——·——·—— d_1
-·-·-·-·-·- t_1

the increase in the progressiveness of direct taxation due to a fall in inflation and consequently the general price level.

According to the model structure, disposable income developments are reflected in the optimal pattern of imports and private consumption expenditure. The depression of domestic economic activity is depicted on the balance of payments, given the exogeneity of the balance of invisibles and the capital account (fig. 5.II.8). In the case of debt financing the external balance of the country is improved substantially and compares favourably with the tax financed budget deficits. Under the latter policy the balance of payments problems are enhanced associated with increased needs for imports of machinery and capital equipment on which so much the domestic activity depends. Finally, as it appears from these experiments, the resulting balance of payments difficulties are smaller in severity to those encountered in the policies described in section 5.4.

Optimal private consumption expenditure is shown in figure 5.II.13. Recalling the specification of the consumption function and the related coefficients, private consumption is mostly reduced under money financing mainly due to low levels of liquidity to which it is very much responsive (coefficient of M_{t-1} = 0.35). In the case of bond financing, when 'liquid assets' resume their desired levels, the drop in consumption expenditure below actual levels is explained by the lower, below actual, levels of disposable income. Private consumption would have been even lower if it were more responssive to disposable income effects, a fact that would have increased consumption even more in the case of tax

Private Consumption Expenditure (C) Fig. 5.II.13



..... Simulated values
——————— Money financing
— — — — — Bond financing
—·—·—·— Tax financing (t_0, d_0)
——·——·—— Tax financing (t_1, d_1)

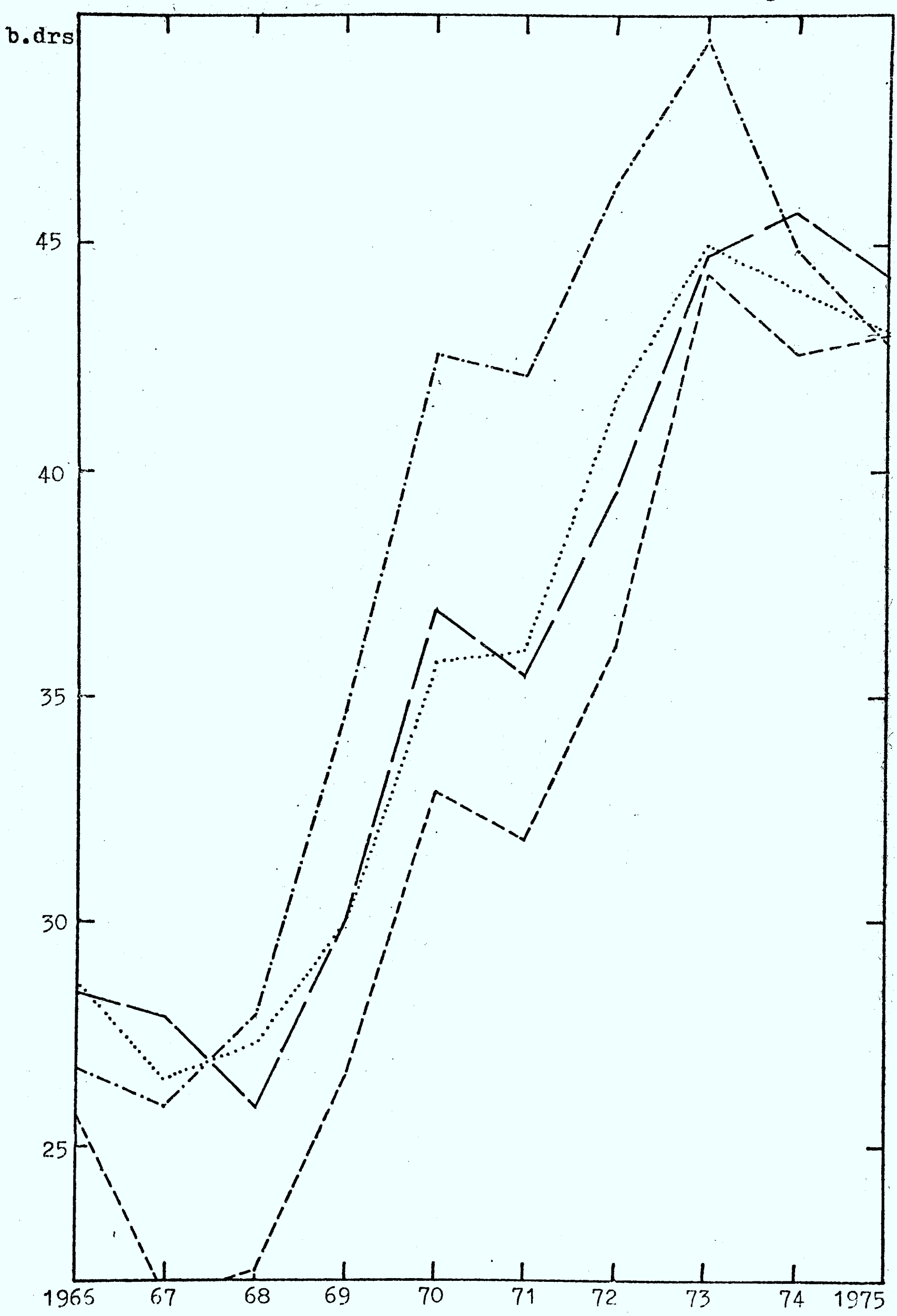
financing. This is due to increased real disposable income as a result of lower levels of real direct tax yield. As in the previous experiments (5.4) the direct negative effect of a higher inflation rate is rather unimportant.

Money financing depresses fixed business investment (fig. 5.II.14),given the reduced level of profits associated with reduced economic activity and to a lesser extent to relatively high interest rates induced by the restrictive monetary policy. The adverse interest rate effect is felt particularly in 1968, when business investment reaches an unprecedented low level of 16 b.drs. In contrast, bond financing does not affect it adversely since the drop due to decreased economic activity is balanced by the inducement of investment associated with the fall in interest rates. Enhanced economic activity, under tax financing, gives rise to high levels of business investment over the planning period, with the exception of the years 1966-67 and 1975 due to respective high cost of borrowing.

The pattern of housing investment is mainly determined by developments in the rate of interest, since direct credit to housing is not considered as a policy instrument in the model. Under money fincing housing investment is depressed for most of the period due to high interest rates (fig. 5.II.15). In addition, had a credit variable being used as a policy instrument, the strict monetary policy would have reduced housing investment, on the assumption that the availability of credit is positively related to the monetary squeeze or ease. This is not the case for bond financing, however, where the fairly high (higher than actual) levels of housing investment are not expected to be affected by changes in credit, the money supply

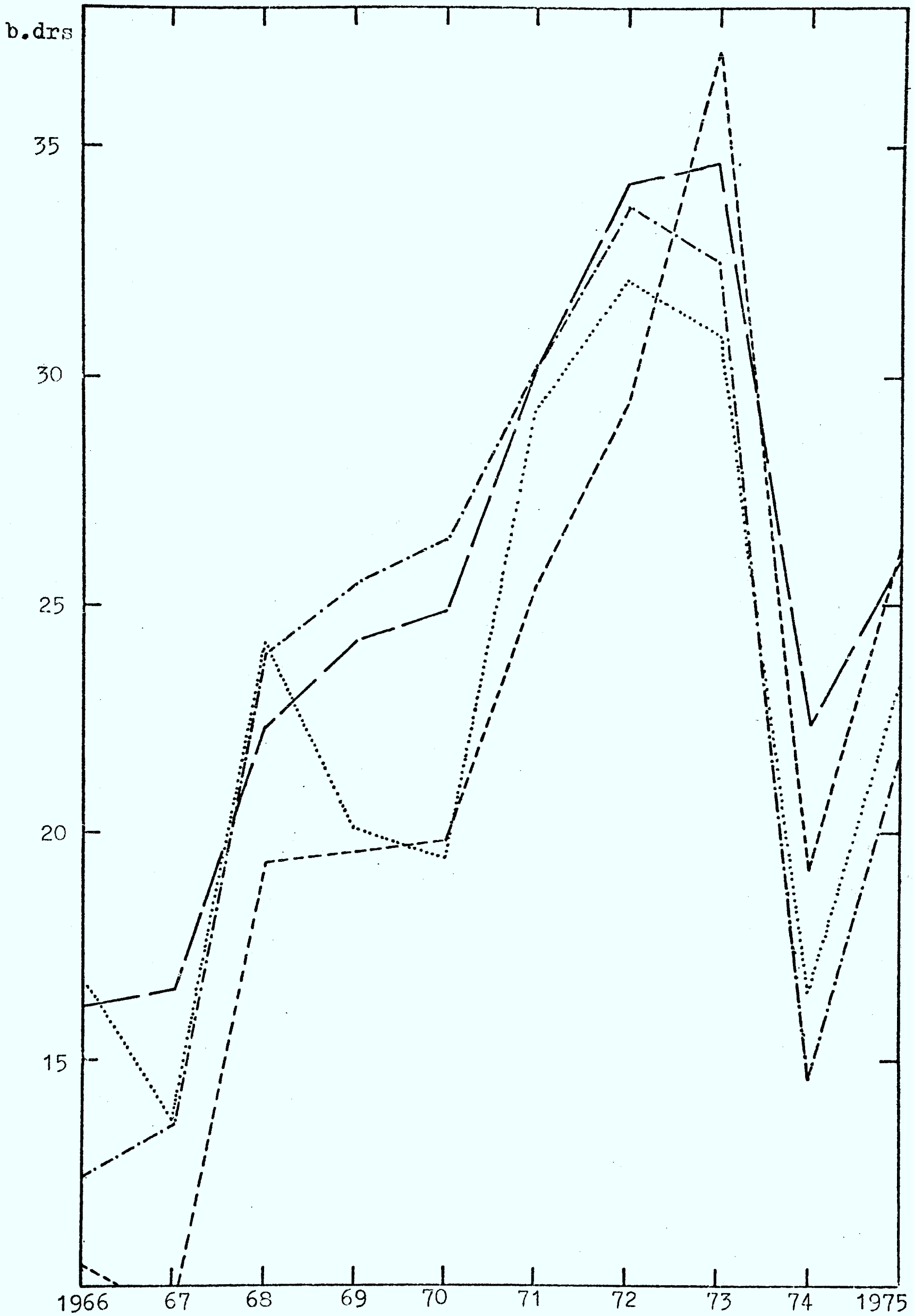
Fixed Business Investment (I)

Fig. 5.II.14



Housing Investment (H)

Fig. 5.II.15



tracing its desired value. As far as tax financing is concerned, it is not clear if it expands housing investment overall. Unlike fixed business investment, the absence of direct income effect on housing investment deprives it from being related to contemporaneous economic activity, although it is highly responsive to the rate of interest.

5.5.5 Summary

The major results of the second set of optimization experiments are the following:

Optimal policies require less discretionary action in Government expenditure policy which results in an inefficient control of the cyclical movement in aggregate expenditure. Thus under all forms of financing the budget deficits, it becomes very difficult to reduce fluctuations in general economic activity. A reduction of the share of the public sector in the economy and therefor reduced levels of income, in the case of bond and money financing, result in an optimal trajectory of government expenditure below its actual path. As expected, reduced levels of economic activity create fewer problems in the balance of payments, and in the cases of money and bond finance, the balance of payments difficulties are absent. Bond financed deficits are clearly more expansive with respect to real income, compared to money financing, throughout the optimization period and they are, therefore, preferable.

In contrast to the above, tax financed budget deficits require a smaller drop in government expenditure, compared to money and bond financing, and they result in higher than actual levels of real income. As regards the

optimal trajectories of fixed business investment and housing investment, they are similar to that of real income. Overall, bond financed deficits give rise to higher levels of investment activity compared to money financing. Under tax financing the optimal paths of investment activity are higher to actual.

Optimal policies are incapable of reducing the rate of inflation to acceptable levels. Although money financing achieves a certain reduction in inflation in the first half of the period, it becomes ineffective in reducing it in the subsequent years due to the necessitaing increase in the rate of growth of money supply.

Notes to Chapter 5

1. For a similar approach see Cambell (1979).
2. For instance, Pindyck (1973), in his study of the US economy, included over a dozen target variables in the objective function. Zobanakis (1978), in the case of Greece, includes fifteen targets in the cost function.
3. A recent study by Bacon and Karayiannis-Bacon (1980) provides arguments for the inclusion of such a variable among the targets. See also Chapter 1 above.
4. See Holly et al.(1979).
5. See Arestis et al.(1979).
6. See The Draft of the Five Year Economic Development Plan for Greece, 1966-1970 (1965), The Long-Run Prospects of the Greek Economy (1967), and various issues of the Annual Reports of the Bank of Greece.
7. According to the sources of the previous footnote, the authorities in Greece did not have a target for the inflation rate up to the early seventies, since it was low anyway. We postulated a 2% target inflation rate over the planning period. In the seventies, the authorities' target inflation rate was set at 10% per annum. In view of the fact that we have not managed to control the pace of inflation adequately in the optimization experiments, it makes no difference if the $\dot{P}$ objective is set at 2% or 10% in the period 1970-75.
8. It is shown by Holly et al.(1979), with an example of the UK economy, that even on the assumption of Certainty Equivalence, deterministic disturbances in the form of exogenous variables will produce oscillations in the optimal

trajectories. Some of these consequences were further investigated by Zarrop et al. (1979).

9. We reiterate that, although the desired paths of the instruments are important regarding the optimization results, their choice does not produce any qualitative differences in carrying out comparative experiments, as far as the desired paths remain the same in all runs.

10. Note that the constancy of weights over the optimization period does not allow for the possibility that policy-makers discount the future. In addition, in the case of the existence of a trend in the desired paths, a constant numerical weight over time would have a smaller impact at the begining of the period than in the end (Arestis et al. 1979, p.11).

11. For a discussion on the inclusion of the rate of interest in the objective function see Cambell (1979). See also Pindyck and Roberts (1974) and Karakitsos et al. (1980) for a discussion on the way the trade-off curves are obtained.

12. Throughout this chapter the words 'actual' and 'simulated' are interchanged. The simulated values for the endogenous variables are considered the datum for comparisons and are taken to represent actual values, on the assumption that the model depicts real developments adequately. Note also that simulation results for the period 1966-75 differ marginally from those for the period 1959-75, due to the non-linear character of the model and the difference in initial conditions. Full numerical results are presented in Appendix A below.

13. The effects of increasing the liquidity of the economy on inflation can be also revealed by looking at figure 5.I.5 depicting the optimal $\dot{NM}$ under money financing.

14. See Chapter 2, Section 8 above.

15. See Chapter 2, Section 2 above.

CHAPTER 6

CONCLUDING REMARKS

After the end of World War II and the subsequent Civil War, the Greek economy was left completely disorganized and its productive capacity was brought to a minimum. The period after the 1953 devaluation, is characterized by an internal and external monetary stability, when the previously prevailing uncertainty ceased to exist. The public regained its confidence in the domestic currency and the mobilization of savings facilitated the financing of government projects. Favourable developments in the invisible receipts and foreign capital inflows provided for an additional source of growth for the economy, which enabled the authorities to remove the restrictions on imports (1958). Thus, the real national income and its components expanded at fast rates and, although declining somewhat in the seventies, were quite respectable compared to those of other countries.

In the process of industrialization, the agricultural sector contracted and, by the mid-sixties, the developments of the economy were substantially disentangled from exogenous factors. In these circumstances, the problem of cyclical fluctuations in income together with the inflationary pressures, which started to build up, gains renewed importance and becomes more meaningful to tackle. Thus, given that there were no apparent supply constraints to growth, the problem becomes one of demand management. Our aim, therefore, was to evaluate alternative policies for internal balance of the economy and see the extent to which they conform with certain macroeconomic objectives, such as the reduction in inflation and fluctuations in economic activity, and sufficient growth in income.

This is achieved by the employment of a fairly aggregate macroeconomic short-term model, depicting the functioning of the Greek economy and estimated over the period 1957-75. The model comprises of a real and a monetary sector and allows for the endogenous determination of taxation. Its structure recognizes the specific features of the economy, such as the narrowness of the capital market and the importance of the Currency Committee over the issues of macroeconomic policy. Particular emphasis is placed upon the interconnection of fiscal and monetary policies, through the introduction into the model of a government budget constraint identity, which allows for the financial implications of the budget and provides a framework for the explicit analysis of the various modes under which the budget deficits (or surpluses) are financed. Thus, the incorporation of the government budget constraint identity in our model, which has been the 'missing identity' of almost all empirical studies of the Geek economy, serves for a'better understanding of macroeconomic policies.

The evaluation of alternative policies (budget financing through bonds, money and taxation), was undertaken through an optimal control theory framework, which employs, besides the aforementioned model, an objective function depicting the desires of policy-makers. This method, as we have argued, is a general method for generating optimal policies, since the objective function reflects the preferences of the policy-makers in the policy variables and the target variables also. This is in contrast to the 'simulation techniques', which seek to determine the outcomes of selected policy actions on policy targets, and arrive at feasible, but generally non-optimal policies. An optimal policy is only obtained, when

a sufficient large number of simulations are carried out. Also, the resulting computational efficiency of the optimization approach, largely facilitates the comparison of various alternative policies.

The estimation of the equations of the model, revealed some of the structural characteristics of the economy and the policy channels were identified and quantified explicitly. The impact and dynamic multipliers brought out some further properties of the model and its behaviour to exogenous shocks on the policy instruments. The analysis indicated that, although there exists a certain degree of crowding out, private expenditure is not crowded out completely by fiscal actions.

Further features of the economy were highligheted by the application of the optimization method, where additional properties of the model were revealed. The optimization results indicate that there exists a trade-off between inflation and the rate of change of income (and consequently unemployment). However, the attainment of the reduction of the rate of inflation target, can be only made possible at the expense of an unacceptable reduction in aggregate economic activity, especially in the seventies. Thus, given the available policy instruments and the model specification, a reduction in the rate of inflation to acceptable levels, seems to be an enormous task on behalf of the authorities.

An investigation of the effectiveness of macroeconomic policies indicated that the level of economic activity can be expanded and its fluctuations reduced, provided we are willing to increase the government expenditure programs sufficiently and undertake discretionary fiscal policy. In support of

Keynesian thinking, the results do not establish a clear preference with regards to the mode of financing the budget on aggregate income, over the optimization period as a whole. Note that this preference becomes even more difficult to establish, especially when the judgment of optimal policies is made on a set of objectives and not just on a sole indicator of economic performance, such as national income. However, judging from the income trajectories, it seems that bond financing is more expansive compared to money financing in the first half of the planning period. In the second half of the period money financing is preferable. With respect to the stabilization of the rate of change of income, bond financing is clearly superior over the whole planning horizon, since it tends to smooth out more efficiently the major booms and troughs of economic activity. Discretionary tax policy on the other hand, is capable of substantial reductions in the cyclical movement of income, but deficit financing is necessary.

Regarding the reduction of the pace of inflation, we reiterate that all policies seem to be unsuccessful, necessitating unacceptable reductions in liquidity. This is due to the heavy dependence of economic activity on imported goods and, therefore, the high responsiveness of domestic inflation on imported inflation and also, due to the low responsiveness of domestic inflation on demand factors.

As regards the share of the public sector in the economy, optimal policies indicated that it has to increase by about 4% on average over the planning period, for the achievement, as much as possible, of the macroeconomic objectives. This is so, irrespectively of the method of financing the necessitating expansion in the budget. In

addition, the empirical evidence suggests that the objective of reducing the share of the public sector of the economy (by about 2% on average), is incompatible with the other macroeconomic objectives.

In the case of a reduction in the share of the public sector, it becomes very difficult to reduce fluctuations in aggregate economic activity, under all modes of financing, the optimal policies requiring less discretionary action in government expenditure policy. Bond financed deficits are clearly more expansive with respect to real income, compared to money financing, throughout the optimization period, although the optimal level of income is below its actual path in both cases. Discretionary tax policies, although they manage to expand the level of income above its actual level, they are totally ineffective in removing even the most severe of the fluctuations in economic activity. As regards the optimal inflation rate, it does not show any significant improvement especially in the second half of the period, when mostly matters.

In conclusion, we shall raise some points regarding the limitations of the study and the implications for policy issues as well as some directions for future work. Certain model deficiencies can be attributed partly to the non-availability of relevant information and partly to the model specification.

As mentioned in a number of instances, our effort has been directed towards incorporating into the model the major characteristics of the Greek economy. However, our effort has been curtailed to a certain extent due to the unavailability of the necessary information in general, and also the reliability of the existing

data. Unlike the cases of other countries (e.g. UK) where vast statistical information is readily available, the Greek State Statistical Services and the other semi-autonomous institutes are by no means efficient in compiling reliable and consistent information. Until this is achieved in the future we cannot but trade-off between what is required to be done and what it is practically feasible. In modelling the economy we should be particularly cautious about the reliability of information released during the seven-year military regime (1967-1974), since data distortions are quite likely to occur in this period in the effort of the dictatorship to cover up its failures and embezzlements.

A more detailed specification of the behavioural equations can always be accomplished within the limited context of the available information and is related to the question of disaggregation. Although in some cases disaggregation cannot go very far (e.g. stockbuilding) due to the unavailability of relevant information, some of the equations can be improved. In this way the impacts of a variety of policy instruments on the various objectives will be diversified and quantified more accurately.

Regarding the monetary sector, instead of an aggregate monetary policy instrument we shall have at our disposal the impacts of an array of more direct instruments, such as reserve requirements of the commercial banks, Central Bank advances to the economy, ceilings on loans, a set of differentiated interest rates, in addition to the already included compulsory sale of Treasury Bills to financial intermediaries. Their effects on investment activity and on the functioning of financial markets

can thus be modelled more realistically and quantified explicitly.

Disaggregated import functions will make it more meaningful to introduce policy instruments and price differentials, which do not work in the aggregate function (e.g. credit to importers). A more elaborate specification of tax functions will enable us to examine the effects of statutory tax instruments on real and monetary variables. These improvements together with a more detailed specification of differentiated price adjustment equations, will make it possible to reveal policy channels so as to affect and control the rate of inflation more efficiently.

The model can be further improved provided that relevant data will be at our disposal in the future. Information on money wages and unemployment will enable us to model adequately the wage-price sector and thus introduce elements of the supply side into the model. In addition, information on wealth will allow us to introduce wealth effects in the demand for money function and also model the securities markets. Sufficient information on capital movements and the sterilization coefficients of the economy will make it possible to model the external sector of the economy in more detail.

Finally, we should raise a point related to the deterministic character of the optimization approach persued in this study. The whole discussion throughout the study assumes a deterministic world, where the dynamic specification of the model and the coefficients of the behavioural equations are perfectly known. In practical

cases, however, our knowledge of the economy is incomplete and the coefficients of the model are in fact random variables. For this reason, we think that it is useful for the optimization policy problem to be treated within a stochastic framework, where disturbances should include all deviations that appear to be random. Therefore, further research should be directed towards this important aspect of optimal policies.

APPENDIX A

A.1 Data and Numerical Results

The tables that follow contain the results of the various optimization runs and the simulation results of the most important endogenous variables in the model. The data used for the estimation of the model is also included.

The definition of the symbols employed is given in Chapter 4, Section 1 (pp. 69-70).

All variables are denominated in billion drachmae, unless otherwise stated.

The sourses of the variables are shown in Section A.2 below.

REAL GROSS NATIONAL INCOME (factor cost) (Y)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	121.99						
1959	126.90	127.10					
1960	131.27	129.68		(Optimisation Results without a G/Y target)			
1961	146.20	144.96					
1962	147.47	154.46					
1963	162.49	169.14					
1964	174.83	179.68					
1965	190.87	190.98					
1966	201.19	204.34	203.61	207.09	206.85	206.82	206.57
1967	210.76	202.65	203.21	222.35	224.39	217.63	218.81
1968	223.17	221.63	222.69	240.34	246.33	238.81	239.85
1969	243.48	238.66	240.48	262.23	269.23	265.25	265.74
1970	263.50	250.67	253.02	285.40	291.89	290.09	290.67
1971	286.08	278.40	281.65	312.23	313.99	319.81	318.87
1972	312.23	308.09	312.10	338.29	333.99	349.10	345.63
1973	339.03	334.91	339.80	354.16	350.75	363.27	363.12
1974	332.03	331.24	336.06	359.83	359.99	362.94	361.89
1975	345.53	348.04	353.46	381.05	379.94	375.59	376.02

Year	Simul. 66-75	(Optimisation Results including G/Y target)			
1966	203.61	192.41	203.01	201.42	198.70
1967	203.21	189.52	201.95	204.64	201.60
1968	222.69	204.21	215.21	229.40	228.23
1969	240.48	219.74	234.66	254.67	254.41
1970	253.02	232.98	247.80	275.22	275.45
1971	281.65	254.40	270.17	303.57	304.37
1972	312.10	282.55	301.65	334.16	335.30
1973	339.80	314.88	333.86	358.23	358.95
1974	336.06	314.95	334.62	350.09	351.69
1975	353.46	332.13	345.23	358.61	360.70

REAL PRIVATE CONSUMPTION EXPENDITURE (C)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	101.54						
1959	104.45	104.79					
1960	107.81	109.40		(Optimisation Results without a G/Y target)			
1961	115.15	115.08					
1962	120.05	121.14					
1963	126.12	129.80					
1964	137.19	138.00					
1965	147.71	147.78					
1966	157.69	157.89	158.01	158.81	158.62	159.22	159.24
1967	167.53	167.83	168.69	170.67	171.59	170.40	170.32
1968	179.03	179.11	179.94	184.84	185.71	183.56	183.45
1969	190.09	191.90	193.40	200.94	201.88	199.77	199.73
1970	206.39	202.62	204.26	216.41	218.17	216.12	216.01
1971	218.06	214.93	217.18	234.91	236.80	236.07	236.05
1972	233.08	230.23	232.81	257.47	254.97	257.15	257.33
1973	250.46	245.67	248.90	268.83	271.25	274.77	274.74
1974	252.39	253.74	257.27	277.52	281.09	284.14	284.14
1975	264.31	257.90	261.75	282.77	286.02	287.67	287.55

(Optimisation Results including G/Y target)

Year	Simul. 66-75				
1966	158.01	157.55	158.01	158.40	158.09
1967	168.69	164.78	168.02	168.63	167.48
1968	179.94	171.89	179.36	180.57	178.62
1969	193.40	180.69	191.18	196.19	193.74
1970	204.26	188.43	201.71	212.34	209.50
1971	217.18	199.14	215.01	231.99	228.79
1972	232.81	211.29	229.73	252.87	249.40
1973	248.90	223.88	245.36	270.50	267.22
1974	257.27	233.05	254.46	280.60	277.58
1975	261.75	238.51	260.10	284.31	281.53

REAL FIXED BUSINESS INVESTMENT (I)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	10.00						
1959	9.64	10.48					
1960	11.01	9.90		(Optimisation Results without a G/Y target)			
1961	10.77	9.90					
1962	12.04	14.34					
1963	13.45	15.52					
1964	17.32	18.78					
1965	19.80	20.13					
1966	21.36	22.68	23.72	22.11	22.75	22.80	22.85
1967	20.70	20.73	21.55	23.07	20.98	21.51	21.29
1968	24.75	21.22	22.29	26.94	26.61	26.80	26.02
1969	28.25	24.18	25.18	30.50	32.44	30.90	31.13
1970	31.29	29.87	30.96	37.10	38.94	38.41	38.43
1971	32.17	30.49	31.54	37.08	39.89	39.01	39.24
1972	34.83	35.52	36.68	40.06	43.13	43.25	43.38
1973	41.96	39.24	40.38	43.98	43.47	46.42	45.41
1974	36.60	37.97	39.08	38.05	35.47	38.71	38.85
1975	33.39	37.13	38.17	40.43	37.74	38.51	38.19

Year	Simul. 66-75	(Optimisation Results including G/Y target)			
1966	23.72	20.67	23.46	21.67	21.29
1967	21.55	16.61	22.86	20.97	19.77
1968	22.29	17.21	20.86	22.93	22.07
1969	25.18	21.47	24.96	29.69	29.38
1970	30.96	27.91	31.99	37.61	37.46
1971	31.54	26.88	30.49	37.13	37.05
1972	36.68	31.13	34.56	41.34	41.43
1973	40.38	39.28	39.73	44.53	45.25
1974	39.08	37.61	40.72	39.92	40.22
1975	38.17	38.03	39.31	37.95	38.28

REAL PRIVATE HOUSING INVESTMENT (H)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	7.46						
1959	7.32	10.63					
1960	8.26	8.27		(Optimisation Results without a G/Y target)			
1961	8.93	9.42					
1962	10.17	11.31					
1963	11.11	10.65					
1964	13.50	12.05					
1965	15.28	11.18					
1966	15.26	14.63	16.68	13.36	14.69	14.79	14.89
1967	13.62	12.02	13.66	14.37	10.45	11.53	11.19
1968	19.11	22.78	24.19	22.88	20.67	22.96	22.70
1969	22.84	19.52	20.55	22.94	23.02	24.03	23.94
1970	19.44	18.70	19.57	23.25	23.18	23.83	23.66
1971	22.94	28.44	29.36	27.14	29.84	28.40	28.62
1972	29.29	31.24	32.17	27.99	34.67	30.77	31.69
1973	30.23	30.11	30.90	30.43	34.08	30.77	30.85
1974	15.68	16.16	16.59	14.31	13.06	12.67	12.92
1975	20.18	22.65	23.20	21.93	17.54	18.41	18.27

(Optimisation Results including G/Y target)

Year	Simul. 66-75				
1966	16.68	10.25	16.13	12.40	11.58
1967	13.66	8.86	16.59	13.08	12.03
1968	24.19	19.29	22.31	23.94	23.44
1969	20.55	19.58	24.23	25.54	24.87
1970	19.57	19.85	24.90	26.45	25.48
1971	29.36	25.52	30.28	31.04	30.00
1972	32.17	29.40	34.15	33.68	32.62
1973	30.90	37.07	34.63	32.52	32.61
1974	16.59	19.23	22.39	14.66	14.35
1975	23.20	26.20	25.92	21.59	20.95

REAL IMPORTS (Q)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	25.06						
1959	22.93	24.73					
1960	24.59	24.53		(Optimisation Results without a G/Y target)			
1961	27.08	25.82					
1962	28.21	27.74					
1963	33.17	30.81					
1964	38.04	34.31					
1965	43.98	38.35					
1966	43.38	43.39	47.94	48.26	48.24	48.64	48.66
1967	44.05	47.47	51.60	53.66	53.84	53.03	52.98
1968	47.87	52.68	56.21	59.64	60.34	58.97	58.89
1969	53.60	58.45	61.73	66.73	67.99	66.48	66.44
1970	57.27	64.27	67.24	74.60	76.30	74.63	74.63
1971	61.83	72.09	74.97	84.17	85.80	84.96	84.92
1972	72.80	81.45	84.27	94.65	95.65	96.70	96.80
1973	97.27	91.48	94.36	104.61	105.20	107.30	107.28
1974	94.94	99.27	102.15	113.24	113.75	115.83	115.82
1975	106.35	102.72	105.58	117.83	118.11	119.36	119.31

Year	Simul. 66-75	(Optimisation Results including a G/Y target)			
1966	47.94	46.89	47.88	47.80	47.47
1967	51.60	49.42	51.43	52.13	51.39
1968	56.21	52.59	55.36	57.67	56.74
1969	61.73	56.68	60.46	64.99	63.88
1970	67.24	60.70	65.68	73.15	71.80
1971	74.97	67.03	72.55	83.17	81.58
1972	84.27	74.65	81.21	94.79	93.00
1973	94.36	83.73	91.18	105.39	103.70
1974	102.15	91.06	99.30	114.02	112.29
1975	105.58	99.93	102.40	117.60	115.82

DIRECT TAX REVENUE (NT^d)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	3.41						
1959	3.67	3.11					
1960	4.15	3.80		(Optimisation Results without a G/Y target)			
1961	5.13	4.33					
1962	5.46	5.37					
1963	5.19	6.16					
1964	6.01	7.32					
1965	5.21	8.13					
1966	6.37	6.13	7.83	7.91	7.96	4.46	4.05
1967	6.59	6.22	4.56	5.93	5.90	10.09	11.81
1968	8.83	7.77	8.59	9.94	10.20	9.53	10.78
1969	9.62	8.93	7.99	9.87	10.34	9.68	9.86
1970	10.96	10.22	10.58	13.54	14.05	15.14	16.27
1971	12.43	13.06	12.50	15.39	15.62	16.28	14.91
1972	16.50	16.81	16.91	19.36	19.43	16.54	11.07
1973	21.97	22.09	21.72	23.41	23.49	24.11	25.31
1974	34.58	28.91	28.84	31.96	32.13	32.43	30.63
1975	29.55	35.54	35.22	39.38	38.90	40.80	42.42

Year	Simul. 66-75	(optimisation Results including G/Y target)			
1966	7.83	6.78	7.76	6.92	7.25
1967	4.57	3.24	4.59	.26	1.30
1968	8.59	6.80	8.02	5.56	7.09
1969	7.99	6.12	7.68	2.92	5.59
1970	10.58	8.78	10.46	2.94	7.07
1971	12.50	9.87	11.72	3.73	9.01
1972	16.92	13.79	16.10	3.71	9.72
1973	21.72	19.16	21.33	21.14	23.94
1974	28.84	26.15	29.14	14.59	21.35
1975	35.22	32.28	34.50	13.74	22.79

INDIRECT TAX REVENUE (NT^i)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	10.09						
1959	10.33	12.59					
1960	11.92	12.79		(Optimisation Results without a G/Y target)			
1961	13.72	14.26					
1962	15.10	15.43					
1963	17.25	17.01					
1964	19.33	18.58					
1965	21.81	20.03					
1966	25.18	29.13	28.65	28.79	28.86	28.90	29.02
1967	27.68	29.36	29.03	31.17	31.13	30.37	30.43
1968	31.88	31.73	31.38	33.51	33.91	33.15	33.14
1969	37.47	33.60	33.30	36.25	36.99	36.55	36.65
1970	40.92	35.59	35.30	39.96	40.76	40.46	40.18
1971	42.88	40.07	39.80	44.21	44.69	45.21	45.35
1972	47.75	45.94	45.66	49.50	49.60	51,23	51.93
1973	55.94	54.23	53.96	56.63	56.75	58.62	60.49
1974	56.88	64.27	64.59	69.48	69.75	70.00	67.44
1975	78.25	75.34	75.00	81.52	80.78	79.14	75.09

(Optimisation Results including G/Y target)

Year	Simul. 66-75				
1966	28.65	27.01	28.54	24.51	25.02
1967	29.03	26.95	29.07	22.75	22.60
1968	31.38	28.59	30.50	25.14	24.41
1969	33.30	30.36	32.81	26.08	24.82
1970	35.30	32.48	35.12	26.09	24.19
1971	39.80	35.67	38.58	27.74	25.22
1972	45.66	40.76	44.39	34.72	31.79
1973	53.96	49.95	53.36	45.81	44.89
1974	64.59	60.37	65.07	49.24	45.42
1975	75.00	70.38	73.87	61.62	56.56

CHANGE IN FOREING RESERVES (ΔNF)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	- .52						
1959	1.38	.21					
1960	.48	1.04		(Optimisation Results without a G/Y target)			
1961	.80	.54					
1962	.59	- .14					
1963	.24	-2.99					
1964	- .35	- .24					
1965	- .93	1.19					
1966	.37	-2.46	-3.01	- 2.90	- 3.08	- 3.45	- 3.47
1967	1.16	1.72	-4.69	- 7.36	- 6.99	- 6.16	- 6.11
1968	1.07	-4.16	-5.94	-10.12	-10.36	- 9.10	- 9.02
1969	- .15	- .77	-5.73	-12.42	-13.72	-12.27	-12.25
1970	- .21	-1.60	-7.20	-17.80	-19.81	-18.24	-18.16
1971	5.78	1.26	-6.24	-18.60	-21.07	-20.20	-20.25
1972	15.03	7.73	2.13	-11.49	-14.27	-15.46	-15.58
1973	.37	11.40	10.21	- 4.82	- 7.16	- 9.81	- 9.80
1974	-3.38	-9.31	-10.56	-30.93	-32.46	-35.88	-35.86
1975	.25	4.78	3.53	-22.35	-21.25	-23.39	-23.28

Year	Simul. 66-75	(Optimisation Results including G/Y target)			
1966	-3.01	- .64	-2.85	- 2.11	- 1.59
1967	-4.69	- .75	-4.92	- 4.79	- 3.72
1968	-5.94	- .92	-4.75	- 7.39	- 6.22
1969	-5.73	1.28	-4.74	-10.43	- 9.11
1970	-7.20	.84	-6.55	-16.27	-14.63
1971	-6.24	4.95	-3.76	-17.85	-15.88
1972	2.13	16.51	5.67	-12.87	-10.56
1973	10.21	25.38	13.72	- 7.31	- 5.10
1974	-10.56	8.95	-8.13	-32.56	-29.85
1975	3.53	25.94	8.04	-19.63	-16.47

REAL GROWTH RATE OF INCOME (%) ($\dot{Y}$)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	3.53						
1959	4.02	4.18					
1960	3.45	2.03		(Optimisation Results without a G/Y target)			
1961	11.37	11.78					
1962	.87	6.55					
1963	10.18	9.51					
1964	7.59	6.23					
1965	9.18	6.29					
1966	5.37	6.99	6.67	8.50	8.36	8.36	8.22
1967	4.79	- .82	- .20	7.37	8.49	5.23	5.93
1968	5.89	9.36	9.58	8.09	9.78	9.73	9.62
1969	9.10	7.68	7.99	9.11	9.29	11.07	10.79
1970	8.23	5.03	5.22	8.84	8.42	9.37	9.38
1971	8.57	11.06	11.32	9.40	7.57	10.25	9.70
1972	9.14	10.67	10.81	8.35	6.37	9.16	8.39
1973	8.58	8.70	8.87	4.69	5.02	4.06	5.06
1974	-2.06	-1.10	-1.10	1.60	2.63	- .09	- .34
1975	4.07	5.07	5.18	5.90	5.54	3.48	3.90

Year	Simul. 66-75	(Optimisation Results including G/Y target)			
1966	6.67	.81	6.36	5.53	4.11
1967	- .20	-1.50	- .52	1.60	1.46
1968	9.58	7.75	6.56	12.10	13.20
1969	7.99	7.63	9.04	11.01	11.47
1970	5. 22	5.10	5.60	8.07	8.27
1971	11.32	9.20	9.03	10.29	10.16
1972	10.81	11.06	11.65	10.08	10.16
1973	8.87	11.44	10.68	7.20	7.05
1974	-1.10	.02	.23	-2.27	-2.02
1975	5.18	5.45	3.45	2.43	2.56

INFLATION RATE (%) ($\dot{P}$)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	- .35						
1959	.07	4.12					
1960	3.78	.12		(Optimisation Results without a G/Y target)			
1961	1.23	2.75					
1962	4.87	3.62					
1963	1.07	2.81					
1964	4.42	4.66					
1965	4.21	2.80					
1966	4.96	4.30	3.31	2.33	2.84	2.87	2.89
1967	2.91	2.05	2.24	4.98	3.33	3.07	3.04
1968	1.76	2.69	2.59	2.77	3.11	3.36	3.36
1969	3.29	.87	.92	2.36	3.29	3.27	3.28
1970	4.04	3.26	3.23	4.89	5.16	5.21	5.20
1971	3.20	5.82	5.83	4.40	4.87	4.85	4.85
1972	5.38	8.04	8.03	6.60	7.33	7.31	7.32
1973	19.69	13.26	13.27	12.79	12.44	12.44	12.44
1974	22.65	25.58	25.58	25.58	24.56	24.65	24.64
1975	11.38	13.24	13.24	13.57	12.26	12.15	12.15

(Optimisation Results including G/Y target)

Year	Simul. 66-75				
1966	3.31	- .35	3.02	1.38	.78
1967	2.24	1.20	3.36	3.33	3.00
1968	2.59	1.80	.92	3.65	3.95
1969	.92	1.78	2.09	3.52	3.71
1970	3.23	4.24	4.27	5.35	5.40
1971	5.83	4.62	4.39	4.87	4.92
1972	8.03	7.93	7.83	7.46	7.53
1973	13.27	16.60	13.96	12.79	13.06
1974	25.58	26.09	26.72	24.41	24.48
1975	13.24	13.70	12.47	12.09	12.08

INTEREST RATE (%) ** (R)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	8.00						
1959	7.17	5.08					
1960	5.50	6.97		(Optimisation Results without G/Y target)			
1961	4.50	5.95					
1962	4.50	4.76					
1963	4.96	5.65					
1964	5.00	5.13					
1965	5.00	5.88					
1966	5.00	3.65	3.29	5.93	4.86	4.78	4.70
1967	5.00	6.13	5.52	4.86	7.97	7.15	7.41
1968	5.00	1.49	.87	1.69	3.49	1.71	1.91
1969	5.00	5.29	4.86	2.63	2.55	1.76	1.84
1970	5.00	6.22	5.85	2.43	2.44	1.93	2.07
1971	5.00	2.60	2.24	3.41	1.19	2.30	2.13
1972	5.00	3.87	3.57	6.39	.92	3.94	3.23
1973	6.08	6.29	6.12	6.11	3.03	5.60	5.54
1974	9.00	8.91	8.84	10.38	11.31	11.60	11.41
1975	8.50	6.77	6.67	7.33	10.86	10.19	10.30

(Optimisation Results including G/Y target)

Year	Simul. 66-75				
1966	3.29	8.50	3.73	6.28	7.40
1967	5.52	9.59	3.19	6.03	6.90
1968	.87	5.25	2.42	1.04	1.49
1969	4.87	6.16	1.96	.67	1.24
1970	5.85	6.08	1.56	.04	.76
1971	2.24	6.00	1.54	.29	1.19
1972	3.57	6.68	2.07	1.76	2.63
1973	6.12	1.74	3.14	4.25	4.19
1974	8.84	6.99	4.18	10.08	10.33
1975	6.67	4.52	4.46	7.76	8.26

** Desired value is 5.00% throughout the optimisation period.

STOCK OF GOVERNMENT BORROWING (ΔPB)

Year	Actual	Simul. 59-75	Desired	Bond Fin. excl. G/Y	Bond Fin. incl. G/Y
1966	1.47	-6.83	1.30	- 1.47	- 5.98
1967	2.01	-3.16	1.69	11.19	- 9.84
1968	3.13	-3.16	2.20	7.86	- 1.14
1969	3.98	4.19	2.86	3.28	- 4.67
1970	4.98	3.99	3.71	4.91	- 7.28
1971	5.67	-3.44	4.83	- 3.05	- 7.11
1972	10.08	-1.16	6.28	-13.81	- 6.97
1973	7.29	19.36	8.16	- 1.97	10.32
1974	14.32	5.16	10.61	15.90	-11.24
1975	12.10	12.96	13.79	27.12	- .54

MONEY SUPPLY (NM)

Year	Actual	Simul. 59-75	Simul. 66-75	Percentage Change in Money Supply** Actual	Simul. 66-75	Mon. Fin excl G/Y	Mon. Fin. incl G/Y
1958	11.23						
1959	13.05	14.27					
1960	15.53	14.94					
1961	17.83	17.80					
1962	20.50	21.31					
1963	23.62	24.51					
1964	28.18	28.29					
1965	32.34	31.46					
1966	35.86	37.16	37.16	10.90	14.93	10.01	-3.49
1967	43.42	41.84	41.84	21.08	12.60	26.42	7.36
1968	45.24	46.89	46.89	4.20	12.07	12.95	8.04
1969	48.97	48.83	48.83	8.25	4.14	11.43	8.51
1970	54.33	51.88	51.88	10.94	6.25	14.62	11.14
1971	61.80	62.80	62.80	13.75	21.03	13.81	14.89
1972	76.06	68.77	68.77	23.07	19.65	12.40	19.13
1973	93.14	73.12	73.12	22.46	20.44	18.07	37.23
1974	111.47	109.27	109.27	19.69	20.75	20.76	23.33
1975	128.89	132.89	132.89	15.62	21.61	23.31	23.93

(Optimisation Results)

** Desired rate of change in Money Supply is 16% per annum.

GOVERNMENT EXPENDITURE (NG)

Year	Actual	Desired	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
			(Optimisation Results without a G/Y target)			
1966	35.40	35.40	42.19	40.48	40.21	39.99
1967	41.11	41.06	56.48	62.96	55.63	57.18
1968	43.20	47.63	56.93	63.92	55.99	56.93
1969	52.21	55.25	65.93	70.80	67.80	68.23
1970	58.25	64.09	80.96	86.27	84.43	84.90
1971	66.40	74.35	92.37	89.40	97.54	96.34
1972	78.29	86.24	102.70	88.56	108.50	104.41
1973	94.66	100.04	102.48	94.54	109.63	112.52
1974	118.65	116.05	153.88	157.42	156.53	151.76
1975	145.23	134.62	186.21	190.36	178.92	176.28
			(Optimisation Results including G/Y target)			
1966			33.03	35.50	34.71	34.16
1967			36.43	36.58	36.55	35.99
1968			35.97	39.41	42.49	42.40
1969			40.08	43.93	48.95	49.21
1970			46.51	48.44	55.95	56.49
1971			52.60	55.13	64.95	65.72
1972			60.79	66.27	76.82	77.66
1973			68.01	83.37	92.68	93.36
1974			97.99	105.76	113.39	113.97
1975			116.61	122.72	129.96	130.89

MONETARY BASE (NBA)

Year	Actual	Desired	Money Fin. excl. G/Y	Money Fin. incl. G/Y
1966	34.29	33.73	32.83	28.85
1967	38.56	39.13	41.41	30.95
1968	43.17	45.39	46.73	33.43
1969	44.94	52.66	52.03	36.22
1970	47.73	61.08	59.58	40.21
1971	57.69	70.85	67.76	46.15
1972	68.95	82.19	76.14	54.90
1973	82.97	95.34	89.76	75.21
1974	100.11	110.59	108.32	92.66
1975	121.67	128.29	133.48	114.75

G/Y RATIO (%) (G/Y)

Year	Actual	Simul. 59-75	Simul. 66-75	Budget Deficits Financed by: Money	Bonds	Taxes t_0 d_0	Taxes t_1 d_1
1958	18.42						
1959	18.58	17.83					
1960	19.62	19.79		(Optimisation Results without a G/Y target)			
1961	19.96	19.76					
1962	20.91	19.83					
1963	18.39	17.25					
1964	21.64	20.52					
1965	20.46	20.20					
1966	19.81	19.38	19.88	23.52	22.48	22.32	22.23
1967	21.33	22.24	22.63	27.92	31.19	28.48	29.11
1968	20.82	20.81	21.15	25.34	27.94	25.27	25.58
1969	22.31	23.15	23.45	26.28	27.45	26.68	26.80
1970	22.11	23.82	24.09	28.27	29.34	28.88	28.98
1971	22.49	23.10	23.31	28.24	26.95	28.86	28.59
1972	23.06	22.78	22.96	27.18	23.38	27.40	26.64
1973	21.45	22.37	22.51	22.97	21.14	23.67	24.34
1974	22.38	22.58	22.72	27.04	27.53	27.14	26.39
1975	23.64	23.23	23.35	27.20	28.10	26.73	26.31

TAX PARAMETERS (t_0 d_0 , t_1 d_1)

Year	Budget Deficits Financed by Taxation:** (incl. G/Y target) t_0	d_0	t_1	d_1	(excl. G/Y target) t_0	d_0	t_1	d_1
1966	2.98	-4.75	.104	.054	- .65	3.04	.067	.088
1967	2.87	-1.49	.103	.078	-3.31	5.61	.057	.071
1968	2.90	- .90	.103	.082	-3.99	6.43	.055	.069
1969	2.91	-2.71	.104	.068	-6.33	7.88	.054	.061
1970	2.82	-2.18	.102	.071	-9.83	11.14	.048	.051
1971	2.80	-2.07	.104	.068	-12.69	13.29	.048	.047
1972	2.77	-4.95	.106	.051	-11.81	16.43	.044	.057
1973	3.10	-4.65	.109	.059	-8.96	10.98	.057	.076
1974	2.67	-2.91	.099	.066	-15.82	13.50	.056	.063
1975	1.31	-2.15	.097	.070	-12.03	22.66	.047	.073

** **Actual (estimated) values are:** t_0 = 2.94 b.drs ; t_1 = .104
d_0 =-2.71 b.drs ; d_1 = .057

NOMINAL NATIONAL INCOME (NY)

Year	Actual	Simul. 59-75	Simul. 66-75
1958	85.16		
1959	88.65	92.38	
1960	95.17	94.37	
1961	107.31	108.38	
1962	113.51	119.66	
1963	126.41	134.72	
1964	142.02	149.79	
1965	161.59	163.68	
1966	178.71	182.66	178.07
1967	192.73	184.87	181.69
1968	207.67	207.62	204.27
1969	234.03	225.51	222.61
1970	263.50	244.57	241.80
1971	295.30	287.44	284.86
1972	339.55	343.68	341.02
1973	441.30	423.14	420.54
1974	530.08	525.56	522.30
1975	614.38	625.31	622.07

NOMINAL DISPOS. INCOME (NY^d)

Actual	Simul. 59-75	Simul. 66-75
79.40		
82.38	86.67	
87.82	87.36	
98.82	100.70	
104.41	110.65	
117.63	124.96	
131.53	137.99	
151.56	150.72	
166.96	171.16	164.87
179.83	172.34	170.82
191.83	192.83	188.66
214.60	206.77	204.82
240.02	221.83	218.70
272.13	263.64	261.62
310.55	314.36	311.60
399.20	380.92	378.69
463.93	465.08	461.90
463.60	468.54	465.61

IMPLICIT GNP DEFLATOR (P)

Year	Actual	Simul. 59-75	Simul. 66-75
1958	.698		
1959	.698	.727	
1960	.725	.728	
1961	.734	.748	
1962	.770	.775	
1963	.778	.797	
1964	.812	.834	
1965	.847	.857	
1966	.888	.894	.875
1967	.914	.912	.894
1968	.931	.936	.917
1969	.961	.945	.926
1970	1.000	.976	.956
1971	1.032	1.033	1.011
1972	1.087	1.116	1.092
1973	1.303	1.253	1.237
1974	1.597	1.587	1.554
1975	1.778	1.797	1.760

STOCKBUILDING (ΔS)

Actual	Simul. 59-75	Simul. 66-75
.63		
-1.35	.25	
- .56	-1.45	
2.39	1.63	
.05	2.69	
3.86	3.26	
4.20	4.57	
7.38	3.94	
1.84	5.23	4.47
4.66	2.97	3.05
1.44	4.62	4.60
3.88	4.56	4.69
1.28	6.03	6.15
9.69	8.88	9.09
6.08	11.21	11.45
2.08	14.24	14.52
12.27	16.99	17.21
10.84	9.49	9.72

Year	(ΔPB)	(NKZ)	(NQ)	(NX)	($\dot{P}_m$)	Exchange Rate
1958	.11	5.40	17.50	11.58	-8.37	30.00
1959	1.27	5.92	16.02	11.47	- .73	30.00
1960	1.41	6.49	17.83	11.81	-2.72	30.00
1961	.23	6.86	19.87	13.82	-1.72	30.15
1962	.62	7.01	21.71	15.29	- .87	30.15
1963	1.12	8.46	25.80	17.58	- .22	30.15
1964	1.82	11.85	30.90	18.71	3.32	30.12
1965	1.04	15.79	37.23	20.51	1.28	30.00
1966	1.47	11.46	38.54	27.46	1.48	30.00
1967	2.01	12.80	40.28	28.64	- .94	30.00
1968	3.13	16.64	44.54	28.98	.63	30.00
1968	3.98	18.76	51.52	32.66	.10	30.00
1970	4.98	19.30	57.27	37.76	4.28	30.00
1971	5.67	24.70	63.81	44.88	3.50	30.00
1972	10.08	36.88	79.17	57.33	8.79	30.00
1973	7.29	40.47	126.61	86.51	19.54	29.70
1974	14.32	35.58	151.57	112.61	45.54	30.00
1975	12.10	53.03	189.09	136.31	18.99	35.65

Year	(NBA)	(NCRH)	(NCRI)	(NKH)	(NKI)
1958	11.01	.22	1.08	.78	.34
1959	13.39	.32	1.40	.91	.46
1960	14.00	.37	1.75	1.04	.67
1961	16.61	.24	2.00	1.18	.56
1962	19.81	.35	2.50	1.30	.83
1963	22.73	.62	2.84	1.33	1.35
1964	26.19	.70	3.70	1.58	1.65
1965	29.08	.75	3.53	1.64	2.74
1966	34.29	1.10	6.07	1.70	2.10
1967	38.58	2.17	4.98	1.30	1.83
1968	43.17	4.22	5.68	1.70	1.97
1969	44.94	4.74	7.94	1.96	2.90
1970	47.73	4.43	11.34	2.43	4.95
1971	57.69	5.88	13.12	3.66	3.52
1972	68.95	7.19	17.57	5.16	3.74
1973	82.97	5.97	21.33	7.99	4.82
1974	100.11	2.90	19.90	6.99	6.34
1975	121.67	3.37	32.15	10.17	7.05

A.2 Sources of Variables

The following variables are obtained directly from the National Accounts:

$$Y,\ NY,\ C,\ I,\ H,\ NT^{i},\ NT^{d},\ NG,\ \Delta S,\ NY^{d},\ NQ,\ NX.$$

The variables:

$$R,\ \Delta PB,\ NBA,\ NM,\ \Delta NF,\ NKZ,\ P^{m},\ NKI,\ NKH$$

are obtained from the Monthly Statistical Bulletin of the Bank of Greece.

Finally, the variables NCRI, NCRH are taken from the Annual Reports of the Bank of Greece.

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