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THAILAND: AN ASSESSMENT OF ALTERNATIVE FOREIGN
BORROWING STRATEGIES

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Abstract

This paper assesses alternative foreign borrowing strategies for Thailand using a medium-term dynamic optimization model. The model has five sectors; rubber, other agriculture, manufacturing, services, and construction. All markets clear with endogenous domestic prices. The model solution is a set of annual borrowing and investment levels, which then, through a general equilibrium system, determine domestic output, trade flows, and consumption, and which are chosen so as to maximize welfare.

This model is first applied to an analysis of the historical strategy taken by Thailand between 1975 and 1981. We find that Thailand may indeed have overborrowed toward the end of the 1970s, and attribute the divergence of the actual and the optimal borrowing paths partly to inaccurate expectations on the timing and duration of shocks and partly to government policies that distorted market forces.

The model is then solved for 1985-1992 to generate a future foreign borrowing strategy. The result shows that Thailand can utilize moderate foreign borrowing beneficially, given its potential for strong economic performance in the next decade. This is, however, conditional on export performance as good as in the past, on raising domestic savings and on altering the structure of domestic output towards tradeable goods. The role of lender behavior is critical in assessing the appropriateness of the borrowing strategy. We use an intertemporal

lending constraint that is linked to public finances. Tightening this constraint is one way of reducing the risk of a debt crisis. We then describe alternative foreign borrowing strategies through sensitivity analyses and derive elasticities of optimal responses to various shocks and policy changes.

The analysis suggests that robust foreign borrowing strategies should be based on an understanding of the structure of the economy, its flexibility in adjusting to shocks, on expectations of future events, and on lenders' behavior. The endogenous and simultaneous nature of the interactions of key macrovariables cannot be overemphasized. Thus, the borrowing strategy must be made consistent with fiscal, monetary and commercial policies.

I. INTRODUCTION

1. Thailand has enjoyed steady and strong economic performance since 1960. Real income per capita has grown at an annual average of 4.7 percent, one of the highest rates among developing countries. This was achieved despite high population growth rate in the 1960s (3.3 percent), and 1970s (2.5 percent). During the 1970s, however, Thailand did not fare as well. The impact of the first oil shock was absorbed without major difficulty, aided by the contemporaneous price boom of its own export good, and by a conservative fiscal stance. By 1975, Thailand was ready for another investment spurt in order to regain the growth rate of the 1960s. Various expansionary measures were therefore introduced; many of them distortionary such as fixed energy prices and interest rate ceilings. These measures helped achieve the high economic growth rates during 1977-79, but also left the country vulnerable to external shocks. The second round of oil price rises, therefore, affected the country seriously. With deteriorating terms of trade, structural adjustment became indispensable, and efforts toward the end started in 1980.

2. Despite the difficulty Thailand experienced in adjusting to the second oil shock, the country currently enjoys a good credit rating among international lenders. Major debt indicators are better than those of many developing countries; the acid test is that the country could recently borrow at 0.125 percent above LIBOR. The

sustainability of such easy access to offshore financial markets is one of the central policy objectives of the government. There are, however, some worrying signs as to whether the access can be maintained over a long period of time. The current account deficit in Thailand averaged 6.3 percent of GDP over the years between 1977 and 1981. In 1979, it reached 7.7 percent. Despite efforts at structural adjustment, this trend continues -- the deficit was 7.4 and 5.3 percent in 1983 and 1984 respectively. External debt outstanding has grown faster than nominal GDP or export revenue since the late 1970s.

3. There is considerable debate in Thailand as to the appropriateness of the borrowing strategy. On the one hand, many of the common attributes of debt crisis countries are missing. For the most part, foreign resources have been used for investment purposes, rather than for consumption. Heavy borrowing has also allowed Thailand to absorb the impact of external shocks, including the recent recession without a significant stoppage in domestic economic activity. There is little capital flight; most of the large public enterprises are technically efficient; the tariff regime does not produce excessive distortions that may engender immiserizing or inefficient growth; tight monetary policy has kept inflation under control, even during the high growth period. On the other hand, there is concern amongst policy-makers that foreign borrowing has been excessive -- that it is mortgaging the future, that it is overly risky, that future creditworthiness may be jeopardized, resulting in

high costs of sharp adjustment if the country has to struggle to avoid a debt crisis.

4. This paper presents an assessment of alternative foreign borrowing strategies for Thailand based on a comparison of the costs and benefits of foreign borrowing, evaluated in the context of a dynamic model of optimal growth. The fundamental dynamic choices that must be faced by economic planners revolve around two questions: (i) how should the government establish a medium-term investment and borrowing strategy; and, (ii) what factors should cause the government to modify this strategy? These are the central issues addressed below. The modelling exercise on which the analysis is based, while a gross simplification of the complexity of the Thai economy, focuses attention on the essential parameters of the system. The model is a device to quantify the costs and benefits of borrowing, to be used for planning purposes. It is not intended to represent projections for the evolution of the Thai economy. These latter would involve greater detail in the specification of the lags and constraints in the economy than is attempted here.

5. Our treatment of foreign borrowing is analogous to that of international trade. Indeed, borrowing is simply trade across time -- resources received today in exchange for an obligation to give up resources in the future. Given this formulation, developing countries may be expected to be net debtors in their early stages for several reasons. First, when borrowed funds are appropriately invested in high return projects (evaluated at border prices), they should generate a net

revenue stream greater than the debt service obligation. Second, at low income levels, a country's ability to mobilize resources internally is limited by low levels of consumption, by the inadequacy of financial markets which discourages saving and by a low tax effort. Attempts to raise domestic savings are often highly distortionary (for example, by increasing trade taxes). Foreign borrowing permits some substitution for domestic savings which reduces such distortions. Third, in a volatile world environment, major structural adjustments are often required. Borrowing can provide the resources to enable such adjustment to be made gradually rather than abruptly. Section II provides a detailed description of the methodology of how the costs and benefits of borrowing are evaluated in a growth model. The calibration of the model parameters to fit the Thai experience is discussed, and analysis is made of the sensitivity of the model to key unobservable parameters.

6. The listing of the benefits of borrowing suggests that the assessment of appropriate levels will depend, inter alia, on the real returns to investment, the choice between consumption today and consumption in the future, the vulnerability of the economy to external shocks, the efficiency with which it can reallocate resources from non-tradeable to tradeable production to service debt, the prospects for export expansion without damage to the terms of trade, and for import substitution. These are all factors that are highly country specific. Accordingly, Section III discusses briefly the recent economic performance of Thailand and the initial conditions that shape its prospects for the future.

7. From this review of the past, crucial questions relating to foreign borrowing emerge in a policy context. These are analyzed in Section IV. The issues addressed are:

- (i) Did Thailand overborrow in the past? We conclude that there has, indeed, been overborrowing, especially from non-concessional, private commercial lenders. The overborrowing is most acute in the early 1980s, when high nominal interest rates sent borrowing costs soaring.
- (ii) What caused the overborrowing? It appears that much of the debt accumulation was incurred by public enterprises that were constrained by price controls from generating the internal resources necessary to finance investment. In general, the fiscal deficit was too high given high interest rates. This may be because the authorities expected the interest hike to be a temporary phenomenon.
- (iii) What were the consequences and costs of this overborrowing? The results show the strong real appreciation of the baht associated with overborrowing, and the consequent bias against exports. They also demonstrate the costs in terms of foregone future consumption of the resulting debt overhang.

8. The analysis of the past is important for understanding the nature of economic interactions that will govern choices in the future. In addition, it provides some validation for the choice of parameters, by demonstrating that the systemic properties of the model closely approximate behavior observed in the past. The same parameters

should, therefore, provide a reasonable basis on which to make choices for the future. One complication that arises in the future because of the build-up of debt is the possibility that lending may be constrained at some future time as the risks of difficulties in repayment increase. We incorporate, therefore, a model of lender behavior in the analysis. Section V discusses strategies for the future, based on the initial conditions determined by actual past behavior and forecasts of the main external variables. The main issues are:

- (iv) What should a future borrowing strategy look like?
- (v) What are the implications for associated government policies, especially those governing investment, domestic saving, the real exchange rate and exports?
- (vi) How should the strategy be modified in the light of unanticipated changes in the external environment?.
- (vii) How should lender behavior affect the determination of the borrowing strategy?

9. Answers to these questions, by their very nature, cannot be too precise. Yet the questions must, nevertheless, be addressed in the forthcoming five year plan. We focus on the macroeconomic constraints that affect foreign borrowing decisions. The analysis shows that there is no simple and consistent indicator, such as the debt service ratio, that can effectively shape borrowing strategies. On the contrary, blind application of a rule-of-thumb in all cases may often be dangerous -- appropriate adjustment depends critically on the nature of the disturbance.

II. METHODOLOGY AND THE MODEL

10. In this section we discuss the methodology and the model used for the analysis. We first outline the theoretical background and the characteristics of the basic approach. Next, the model equations and a detailed description of the data requirements and calibration procedures are presented.

11. Using actual values of investment and foreign borrowing, we show that the model replicates the major macroeconomic aggregates fairly closely, especially in real terms. This cannot be taken as a formal test of the validity of the economic structure that we impose, given the large number of free parameters and the small number of dependent variables. It does, however, suggest that our framework incorporates the main characteristics of the Thai economy in the period 1975-81. The section concludes with an analysis of the sensitivity of the model solutions to key non-observable parameters, such as the pure rate of time preference and adjustment costs in investment.

Theoretical Background

12. The general problem is to formulate a foreign borrowing strategy, consistent with Thailand's access to concessional and nonconcessional loans, that incorporates the country's characteristics, prospects and historical performance. Given this, the focus is on a medium-term model which emphasizes the policy choices that actually arise in the context of the five-year planning process. As such, the

model differs from financial-monetary stabilization models whose focus is short-term, and from long-term models in which population growth, technical progress, and other related variables are made endogenous.

13. The basic approach adopted below is one where the impact of foreign borrowing and gross fixed capital formation on consumption possibilities over time is derived. The alternative consumption streams associated with different borrowing and investment strategies are then compared, and the "optimum" borrowing and investment levels are chosen. Formally, this involves solving a non-linear, intertemporal optimization problem, with borrowing and investment as control variables.

14. These three elements -- the non-linearity, the intertemporal nature and optimization -- differentiate our methodology from existing tools used to analyze foreign borrowing issues. The latter encompass the traditional two-gap models (e.g., Chenery and Bruno 1962), linear programming (e.g., Chenery and MacEwan 1966), recursive CGE (e.g., Robinson et. al, 1983), and macroaccounting models (RMSM, Enders and Mattione). They are inadequate to analyze the foreign borrowing problem, which revolves around the intertemporal allocation of resources for several reasons. First, proper analysis requires an inherently dynamic and forward-looking model. What is borrowed today must be repaid in the future with a cost. Whether the funds are used for consumption today or in the future (via investment) changes the evaluation of the burden of debt considerably. This need to incorporate expectations of the future into current decision-making has long been

recognized for project evaluation purposes. As Little and Mirlees (1969) put it: "(this) expresses the entirely plausible proposition that we must know where the economy ought to be going before we can decide on how it ought to start off. This does not mean that the answer will be sensitive ... to what is assumed about the distant future; only that one must assume something ... before one has any idea about initial policies. The moral is that optimum growth calculations in solvable models are the only satisfactory way of telling at what level current accounting prices should be put." Recursive models, which are most often used to analyze debt issues are essentially static in decision-making. They do not capture today's response to anticipated future events except if the latter trigger some indicator (such as an excessive debt service ratio, for example). But an essential characteristic of foreign borrowing is that it permits an accurate prediction of future debt service obligations, which should have a strong impact on actions today. Intertemporal decision-making is needed.

15. Second, optimization is also a useful characteristic in order to give normative content to the analysis. In addressing the appropriate adjustment to external shocks, for example, a key issue raised above, it is not enough simply to simulate one possible adjustment path. We would wish to choose a path that minimizes the costs of adjustment. Optimization provides a benchmark for the levels of main activities and permits quantification of any deviation from such a path. This allows us to value the costs of constraints -- for

example, on the flexibility of the economy to adjust or the willingness of lenders to lend.

16. One draw-back to the use of optimization is the need to specify the arguments and parameters of an objective function. This does not imply, however, that the results are simply a reflection of an arbitrary choice of the welfare function. Some rule is necessary to compare alternative paths of the main macroeconomic aggregates. Specification of a welfare function provides one consistent rule for making such comparisons. Our focus is on the intertemporal trade-offs in consumption associated with foreign borrowing. This provides the rationale for including consumption as an objective. Other concerns, such as the desire to maintain creditworthiness, are not included as objectives per se, but are incorporated as constraints under which the optimization occurs. A remaining weakness of the analysis is that it treats income distribution in a mechanistic fashion. Factor income shares depend only on the technologies of production in different sectors and on the endogenously determined relative prices. In the analysis below, because the non-tradeable sector employs a relatively large number of workers and has a labor intensive technology, a rise in the price of services relative to manufacturing raises the real wage and vice-versa.

17. Our choice of the parameters in the utility function, the pure rate of time preference and the marginal utility of consumption, reflect judgments on the appropriateness of alternative consumption paths for Thailand. Partly, these are based on the experience of other countries:

partly, they are inferred from the consumption-saving behavior of Thailand prior to the heavy borrowing period. The sensitivity analysis demonstrates the change in results as these parameters are varied. It should be noted, however, that much of the analysis reflects changes from a base solution. For such comparisons, the values of the utility function parameters are less important than the fact that they remain constant.

18. Third, the multi-sector, nonlinear aspect of the model is also of major importance for the analysis of foreign borrowing. The ability to affect some change in the trade balance through relative price switching mechanisms is an essential departure from structuralist models in which the foreign exchange gap can only be closed by stagnation in economic activity. The ability to specify non-linear production and demand schedules makes the determination of key relative prices -- between consumption and investment goods, non-traded and tradeables, domestic tradeable and foreign competitive products -- more realistic. Endogenous price determination is crucial to understanding the real cost of foreign borrowing or the real return on capital, but is lost in linear programming techniques. In addition, the structural change that is associated with development becomes much more realistic in a non-linear setting because it avoids the problems of complete specialization often found in linear programming. Finally, productive relationships are made explicit. The important links between the marginal return to investment and the marginal cost of foreign borrowing are brought out. In many growth/macro-accounting models, (RMSM, Enders and Mattione, 1984) these links are hidden.

19. The treatment of all the major macroeconomic demand variables in a consistent intertemporal framework follows the thrust of recent literature on the determinants of current account behavior (see Dornbusch (1983), Svensson and Razin (1983), Martin and Selowsky (1984), Edwards and van Wijnbergen (1985)). There, emphasis is placed on the role of anticipated future events in determining present period behavior. In addition, the change over time of relative prices, especially between non-traded and traded goods, is stressed. This is of particular interest with regard to the analysis of foreign borrowing, which provides traded goods today and must be repaid in traded goods in the future. If the real exchange rate must depreciate in order to generate the exports required for debt servicing, foreign borrowing becomes more expensive than indicated by a simple glance at the interest rate.

20. The solution to a non-linear, intertemporal optimization model will be characterized by a three-way equality between the real social discount rate (RSDR), the real return to capital (RRK) and the real cost of foreign borrowing (RCFB). Because the approach is to maximize the value of the consumption stream, it is simplest to think in terms of the impact of decision-making on consumption. The real social discount rate measures the rate at which consumption next period is discounted to give its equivalent value in terms of consumption today. In general, there will be three terms: the pure rate of time preference is a measure of impatience; the growth rate of consumption indicates the change in the level at which marginal consumption must be valued; and the coefficient

of risk aversion measures the rate at which the marginal utility of consumption falls as the consumption level rises. When the RSDR is below the RRK, it is appropriate to save more and invest in productive capital, reaping the benefits in terms of higher future consumption. Higher investment will raise the growth rate of consumption, thereby driving up the RSDR while reducing the RRK as the marginal efficiency of investment declines. This continues until equality is reached. Similarly, when the RSDR is above the RCFB, it is appropriate to substitute foreign for domestic savings. This lowers the growth rate of consumption, and hence the RSDR, while driving up the RCFB. These are the essential intertemporal relationships governing the analysis. Under certain additional restrictions, governing the technological coefficients in the production of investment goods, these yield unique and stable interior solutions for the levels of investment and borrowing that maximize the objective function.

21. The properties of such a solution -- the way in which borrowing and investment adjust to exogenous changes in the parameters -- have been discussed in Glick and Kharas (1984) in the context of a two-good, two-factor, two-period model. The model below has some extensions and specific features relating theoretical concepts to actual data as gathered in the system of national accounts and the balance of payments, and capturing important aspects of the Thai economy. In particular, we have introduced the following features:

- (i) five productive sectors in the economy with very different market demand characteristics; a rubber sector

which is only exported; construction which is only used for investment; food which is domestically consumed and exported; non-traded services which are domestically consumed; and manufacturing which enters domestic consumption, investment and exports.

- (ii) an explicit input-output structure to capture the role played by intermediate inputs and imports.
- (iii) a time horizon of nine years before the economy converges towards balanced growth;
- (iv) heterogeneous capital stocks in each sector, allowing sectors to have different profitability in each period, which is gradually eroded over time as investment accumulates;
- (v) an allocation of investment that assigns larger shares of new capital to more profitable sectors, but that limits this flexibility;
- (vi) consideration of two distinct labor markets, rural and urban, with different growth rates to simulate the effects of migration;
- (vii) imperfect substitutability between domestic and foreign tradeable goods used for final consumption and intermediate good demands. Thus, while world prices are given exogenously, there is scope for the domestic price level of tradeables to deviate from world prices (in an aggregate sense). This delimits the possibilities for import substitution.

- (viii) imperfect substitutability between Thai exports and competing manufactured tradeables. This formulation makes exports sensitive to domestic demand and supply conditions as well as to foreign demand conditions.
- (ix) different types of foreign borrowing. We distinguish between concessional assistance, usually at fixed interest rates, with long grace and maturity periods, and non-concessional borrowing, at variable interest rates. The availability of supply of the former is limited, whereas the latter is freely available in any period, subject to an intertemporal constraint that is associated with the evolution of public finances. We allow for a rising marginal cost of commercial borrowing that depends on the net flow in any period relative to the stock of outstanding debt. This captures the property that in early years, before Thailand had an established reputation in international capital markets, the marginal costs of a rapid expansion of commercial borrowing were high. Today, given the establishment of close financial links, the marginal costs are much closer to average costs.
- (x) the marginal efficiency of economy-wide investment declines as the level of investment expenditure rises. This sets absorptive capacity constraints on the growth potential of the economy in any one period.

(xi) alternative scenarios illustrate the trade-off between risks of a debt crisis and benefits from foreign borrowing. One major draw-back with the approach is the lack of a satisfactory treatment of uncertainty. This is clearly a major concern in the analysis of foreign borrowing. We address this by tracing out a frontier between the level of borrowing and welfare. We indicate the point where our analysis suggests that the risk will be below a reasonable threshold.

22. The next sub-sections describe in detail the equations of the model, the process of calibration and the sensitivity analysis to key parameters. This analysis is useful for understanding the robustness of the conclusions. It is not, however, essential to the application and the general reader may, accordingly, skip to Section III.

Description of the model for Thailand

23. The model developed below has five sectors: rubber (EX), the rest of agriculture (AG), tradeable manufacturing (TR), nontradeable services (NT) and construction (CO). The exact sector division is based on the 180-sector social accounting matrix produced by NESDB-IDE-NSO (1980). Rubber and rubber processing industry form the EX sector. All other agricultural sectors are in AG. Mining, food processing, machinery and other manufacturing activities are aggregated into the TR sector. All the rest except for construction are categorized as NT. It should be noted that some agricultural final demand appears in the manufacturing sector as the demand for output of the food processing industry. All equations are listed in the appendix.

24. The production relationships in all sectors are assumed to be Cobb-Douglas. Only labor and capital services are factors of production in urban sectors, whereas land is included exogenously in rural sectors (EX, AG), and therefore decreasing returns are postulated with respect to capital and labor in these two sectors. Intraregional labor mobility is fully assumed within rural and urban regions, but interregional mobility takes place at a fixed rate, i.e., urban and rural areas have fixed and different labor force growth rates that are consistent with historical natural population growth rates adjusted for migration. Capital on the other hand has a putty-clay feature; it is completely malleable and mobile among sectors before investment actually takes place, but once installed it can be removed from the sector only through depreciation.

25. Foreign trade is specified as follows. Traditional agricultural export goods -- rubber, maize, and minor crops -- are treated exogenously. So are the net service receipts. In all cases, the values of these exports are fixed at either actual historical values or projected values. The tradeable manufacturing exports are a function of world demand of these goods and the relative domestic price vis-a-vis the world market price: $\frac{1}{}$

$\frac{1}{}$ A clear exposition of the use of Armington trade functions in Computable General Equilibrium models is given in Dervis, de Melo and Robinson (1982).

$$X = \alpha WT^{\zeta} \left(\frac{P}{ePW} \right)^{\xi}$$

where X = manufactured exports

WT = world trade

P = domestic producers' price

e = nominal exchange rate

PW = world price.

The elasticity of Thai exports with respect to world trade in manufacturing (ζ) reflects the capacity of Thai firms to expand into new markets and products and thereby to increase its world market share. The relative price elasticity (ξ) gives the period-by-period world demand curves for Thai goods. ξ will be higher, the more diversified are their export goods. A word of caution is needed here due to the specific sector division we elected to employ. Rice, cassava, tobacco, and sugar exports are included in the tradeable manufacturing exports, because the food processing activities are classified as manufacturing.

26. There are two kinds of imports, both of which occur within the manufacturing sector. One is noncompetitive capital goods imports, proportional to domestic capital formation. The other is competitive imports used for consumption and intermediate inputs. The latter is handled following the tradition of Armington (1969) assuming that people consume hypothetical aggregates of domestically produced goods and imported goods. We choose to use a constant-elasticity-of-substitution (CES) function to get this aggregate:

$$\phi = \gamma (\epsilon M^\rho + (1 - \epsilon) D^\rho)^{\frac{1}{\rho}}$$

where ϕ is the amount of the aggregate manufactured commodity that imported goods (M) and domestic goods (D) produce, and γ, ϵ, ρ are parameters. The price of this hypothetical aggregate commodity can be represented by the unit-cost function of the CES function.

$$PP = \frac{1}{\gamma} (\epsilon^\theta P_M^{1-\theta} + (1 + \epsilon)^\theta P^{1-\theta})^{\frac{1}{1-\theta}}$$

where $\theta = 1/(1 - \rho) =$ elasticity of substitution between M and D

This is the price purchasers pay for these goods. The first order conditions for cost minimization applied to these relationships yields the import demand as a function of domestic and world prices and the total sectoral domestic demand for domestically produced goods (D).

$$M = \left(\frac{\epsilon}{1-\epsilon}\right)^\theta \left(\frac{P}{ePM}\right)^\theta D$$

The ratio of the domestic component to the total of the aggregate ($r = D/\phi$) is derived in similar fashion.

$$r = \gamma^{\theta-1} (1-\epsilon)^\theta \left(\frac{PP}{P}\right)^\theta$$

27. Investment is a control variable in the dynamic optimization version. Expenditure on capital goods for the purpose of investment, I , however, is allowed to differ from actual capital formation, J , to account for adjustment costs in capital formation. This implies a diminishing marginal efficiency of investment that reflects absorptive capacity constraints in the economy.

28. Following Hayashi (1979), we specify investment as:

$$I = J \left(1 + f\left(\frac{J}{TK}\right) \right) \quad f' > 0$$

where TK is the total capital stock. It can be shown that investment depends only on TK , and Tobin's "q" (= ratio of the value of capital to its replacement cost = shadow price of capital in terms of capital goods price). For example, investment of a single optimizing firm that produces its own capital goods can be expressed as

$$J = \frac{q - 1}{v} TK$$

when $f = \frac{v}{2} \frac{J}{TK}$. Investment takes place only when $q > 1$.

29. We assume that construction and manufacturing sectors provide exogenously fixed shares of investment. The share of manufacturing is an exogenous variable increasing over time from about 0.21 to 0.26. Noncompetitive capital imports are also proportional to J , and the proportionality is constant at 0.28. The origins of investment goods therefore are 50 percent tradeable and 50 percent construction.

30. Once total domestic investment is determined, it is allocated across sectors according to the share of total profits originating in the sector. That is, the addition to capital in sector i , J_i is given by:

$$J_i = \frac{r_i K_i}{\sum_j r_j K_j} \cdot J$$

This formulation implies that investment flows into the most profitable sectors, tending to equalize rates of return over time, but without leading to instantaneous equality of profit rates between sectors.

31. We postulate that foreign borrowing also incurs cost of adjustment in a similar manner as in investment. The more a country tries to borrow nonconcessional loans relative to the debt outstanding the more costly it becomes. This is because the borrower must shift to new lenders and more expensive financial instruments if it expands borrowing very rapidly. After allowing for higher fees the foreign funds the country can effectively utilize from any given loan, therefore, is less than the actual debt accumulation.

32. All commodity markets clear by assumption. Supply is the physical output. Demand varies by the sector. Basically, the domestic portion of consumption and intermediate inputs, plus exports, and investment demand must exhaust output. In equation form

$$Q = r (IM + GC + PC) + X + IE$$

where

Q = Output

IM = Intermediate input demand

GC = Government consumption

PC = Private consumption

X = Exports

IE = Investment expenditure

For all sectors except for the manufacturing, $r = 1$ because there are no competitive imports of non-manufacturing goods by assumption. There is no export from construction sector and IE is nonzero only in manufacturing and construction sectors. Both supply and demand are sensitive to the own price of the good and to other prices in the economy. Flexible prices act as the mechanism to equilibrate supply and demand. The endogeneity of price determination is a key feature of the model.

33. Finally, the three agents in the economy (foreigners, public sector, and private sector) have to balance their revenue and expenditure in each time-period. The sum of all foreign exchange inflows must equal all outflows, that is, net capital inflows = current account deficit. Both public and private sectors borrow from foreigners. Public sector resources are net foreign and domestic borrowing and tax revenues, whereas expenditures are exogenous government consumption, government investment and debt service.

34. We define all the productive activities as belonging to the "private sector". One disadvantage of doing this is that it blurs the distinction between the pure private sector and the state enterprises. For the purpose of this model, however, where the aggregate transfer is the main issue, we leave micro-economic questions pertaining to state enterprises for subsequent studies. Due to this definition, private sector income is all the value added at factor cost. In addition, the private sector receives net foreign transfers from abroad (remittances) and net foreign private capital inflows. Expenditures are tax payments, debt service, investment and private consumption. Naturally, the market clearing equations and these three balancing equations assure that the value of investment expenditures equals the sum of foreign savings and appropriately defined domestic private and government savings.

35. The consumption first order condition ^{1/} says that the marginal rate of commodity substitution between two goods equals their price ratio in every period:

$$\frac{\partial U}{\partial C_i} / \frac{\partial U}{\partial C_j} = P_i / P_j \text{ in an obvious notation}$$

Once total consumption is known, from the income-expenditure balance above, this rule determines the allocation of consumption demand across sectors.

^{1/} First-order conditions are redundant in the optimization model version. But for expository purposes as well as to lessen the computation cost they are always included in the program.

36. The nominal wage rate is assumed to be equal among sectors in urban and rural areas:

$$\frac{\partial Q_i}{\partial L_i} PV_i = W,$$

where PV is the value-added price (producers' price less indirect tax and intermediate input cost) and W is the nominal wage rate. W is perfectly flexible and adjusts to ensure that full employment is always attained.

37. We solve the model in two ways. One is to treat it as a recursively dynamic computable general equilibrium model. Investment and foreign borrowing are fixed exogenously. Agents in the model can then only make intersectoral decisions in each period, on consumption demand and labor allocation. The other solution form is to solve the system as a dynamic optimization model, maximizing the discounted sum of each period's utility by choosing appropriate levels of investment and borrowing. Three consumables enter the utility functions: agricultural goods, manufacturing goods, and services. These are combined into a Cobb-Douglas aggregate consumption good, c . We impose concavity by introducing a relative risk aversion parameter "b". Utility is then written as: $u = \frac{c^{1-b}}{1-b}$, The "b" parameter measures the desire for intertemporal consumption smoothing, i.e. $1/b$ is interpreted as the elasticity of intertemporal utility. When $b = 0$, consumption is infinitely substitutable across time and the desire to smooth consumption is zero. A marginal unit of consumption gives equal utility at all levels of consumption. A positive value of b , means a higher

desire for intertemporal consumption smoothing -- a diminishing marginal utility of consumption. Welfare is given by the sum of utility over time discounted by the pure rate of time preference, δ .

$$W = \sum U_t / (1+\delta)^{t-1}$$

38. The numeraire is the international price of manufactures. World prices for manufacturing goods that are relevant in determining foreigners' demand for Thai goods, PW , and import prices the Thais pay to buy foreign good, PM , are parametrically given. These two kinds of international prices are assumed to coincide for the future analysis. With the assumption of an exogenous nominal exchange rate (e), ePW and ePM are fixed in each period. A narrowed resource gap is achieved by increasing exports and decreasing imports. This can occur through a lower domestic tradeable price relative to international prices. In other words, the "level" of the domestic price for tradeables has to come down in order to reduce the trade gap. At the same time, the domestic excess supply of tradeables should increase. This is achieved by increasing the relative price of tradeables vis-a-vis other domestic prices. Given the small size of agricultural sectors and construction, and partially exogenous nature of the agricultural exports, the excess supply of tradeables is largely determined by the movement of relative price of tradeables and nontradeable services. Thus, once foreign borrowing is chosen, domestic prices must adjust to generate the trade deficit that satisfies the balance of payments equilibrium.

39. Real Exchange Rate. In multi-sector models such as the present one we cannot define "the" real exchange rate exactly. The most critical relative prices are those between domestic and foreign tradeables prices (to determine demand for tradeables), domestic tradeables versus non-traded services (to give supply), and domestic tradeables versus construction (to determine Tobin's 'q' and hence investment). Because of our assumptions on factor intensities, all of these tend to move together. We therefore choose to call the price of domestic tradeables relative to non-traded services the "real exchange rate". As this rises -- a depreciation -- the supply of tradeables rises, the resource gap narrows, and investment rises.

40. Terminal Conditions. Terminal conditions are required to prevent last period borrowing from rising to infinity and investment from falling to zero. The terminal conditions give a value to the stock of capital remaining at the end of the planning horizon, and penalize the existence of a high stock of debt outstanding. The valuation functions are necessarily arbitrary in a finite horizon model. These are derived as follows: First, we make use of the turn-pike theory (e.g., Chakravarty 1960) that states that the optimal evolution of the economy over time will follow a balanced growth path. Next, we assume that the economy has reached the turn-pike by our final period. This implies that investment and new borrowing are determined as functions of the next-to-last period's capital stock and debt outstanding, because steady growth in these stocks is required. (see Appendix 2). The associated consumption and utility levels along the balanced growth path

can then be calculated, and are discounted back to the present to yield the impact value of capital and debt. Thus, our terminal conditions give us an upper bound on the value of capital and the cost of debt. Expanding the planning horizon would therefore tend to give lower values for investment and higher levels of borrowing. This is confirmed in the sensitivity analysis. In general, length of the planning horizon only affects the results significantly for two years prior to the last period.

Data and Parameters for Calibration of the Model

41. Data requirements. In order to utilize the model as an empirically relevant tool of analysis, estimation of model parameter values should be carried out so that specific features of the Thai economy can be highlighted. The following data sets were used.

- (1) social accounting matrix (SAM) for 1975 (base year);
- (2) time series values of sectoral outputs and prices;
- (3) time series data on manufacturing exports together with their world price indices and the total world trade values quantity indices;
- (4) time series data on imports together with the world prices and the decomposition of imports into capital goods and other imports;
- (5) time series on foreign borrowing and other international transfers.
- (6) time series on investment and labor force

- (7) at least one year (base year)'s sectoral capital stocks ^{1/}
- (8) at least one year (base year)'s data on fiscal revenues.
- (9) time series values of exogenous variables, i.e.,
government consumption, agricultural and service sector
exports.

The following paragraphs describe the way in which these data sets are used to calibrate all the parameters values needed for the operationalization of the the model.

42. The first step of this process is to choose a base year and then find complete and consistent data sets for the base year. These data sets are used to calibrate a certain sets of parameters such that the endogenous variables in the base year equal historical values, with the assumption of all unitary prices. The year 1975 has been chosen as most appropriate for the base year because of the following reasons:

- (1) we are interested in analyzing the foreign borrowing paths of Thailand both in the past and the future, and the major debt accumulation in Thailand occurred toward the end of the 1970s.
- (2) a detailed 180 sector social accounting matrix is available in 1975 (NESDB-IDE-NSO 1980).
- (3) 1975 was a year when Thailand was still free from major economic problems, and the economy was functioning relatively well without excessive

^{1/} See below for how we estimated these figures.

distortions that developed in Thailand later in the decade.

The social accounting matrix (SAM) for 1975 in producers' price provided the majority of the parameter values. The detailed sector divisions were first aggregated into the five sectors employed in the present model. Table 1 expositis the modified aggregate social accounting matrix used here. Inter-industry flows are specified by exogenously given intermediate input-output coefficients, a_{ij} .^{1/} These IO coefficients are simply taken from the SAM as

$$a_{ij} = \frac{IM_{ij}}{Q_j} \text{ where } IM_{ij} \text{ is the intermediate input from sector } i \text{ to sector } j$$

43. Final demand vectors are derived straightforwardly from the SAM. Essentially all that was involved was to aggregate the large number of sectors into the five sectors we elected to use. Due to the fact that there is no satisfactory behavioral assumption to handle changes in stock in general equilibrium modeling, these are reduced to zero. Minor changes are added on to fixed capital formation. Large changes (agriculture, some manufacturing) are adjusted in view of the trend of changes in stock in these sectors before and after 1975. This involved some adjustment of the rest of the SAM.

^{1/} Some coefficients, especially the rural inputs into the tradeable manufacturing sector are allowed to decline with an exogenous trend.

Table 1. Modified Social Account Matrix of Thailand 1975

(Billion Bahts)

	EX	AG	TR	NT	CON	(Intermediate Total)	Private Consumption	Government Consumption	Investment	Export	Import	(Total Final Demand)	Total Use
EX	2.1		2.0	0.3		4.4	-	-	-	2.9	-	2.9	7.3
AG		5.6	55.7	1.8	0.3	63.4	34.5	-	-	6.9	-	41.4	104.8
TR	1.1	12.0	74.9	29.5	18.9	136.4	105.2	4.6	23.8	31.8	-61.7	165.4	240.1
NT	0.6	4.3	24.3	23.0	7.0	59.2	113.5	35.0	-	13.3	-	161.8	221.0
CON		0.2	1.1	1.9		3.2		0.8	37.5	-	-	38.3	41.5
(Intermediate Total)	3.8	22.1	158.0	56.5	26.2	266.6							
Labor Income	1.8	65.5	32.8	70.1	7.2								
Capital Income plus Land rent	1.4	16.4	38.5	84.9	7.4								
Indirect Tax	0.3	0.8	10.8	9.5	0.7								
(Value-added Total)	3.5	82.7	82.1	164.5	15.3								
Total Cost	7.3	104.8	240.1	221.0	41.5								

44. Export functions are obtained in the following manner. For the exports of EX (rubber), AG (the rest of agriculture) and net service payments, the values are set exogenously at historical levels. This simply means the export demands have unitary domestic price elasticities in these sectors. A manufacturing exports function is estimated through regression analysis for Thailand and from results in the literature for equivalent parameters for others comparable countries, such as Japan, Korea and Taiwan. The elasticity with respect to the domestic price level is assumed to be 1.8. The world trade elasticity is 2.2. A one percent increase in the total world trade would raise Thai exports by two percent. This reflects the past success of Thailand in expanding its market share in the international market. Imports were disaggregated into competitive imports, and non-competitive capital goods imports. The share of capital goods imports in the total capital formation is assumed to be fixed in the short-to-medium run at this 1975 value (27 percent). All other imports are assumed competitive. In reality, there are a large number of non-capital goods imported into Thailand. Some of them are clearly noncompetitive, and others competitive. Some may be import-substitutable in the medium-run and others in the short-run. A multisector modeling deals with aggregates of these as a sector good. Instead of going through difficult judgments as to which imports are noncompetitive in the original SAM, therefore, we follow the tradition of Armington (1969) assuming a finite elasticity of substitution between imports and domestic products. The elasticity can be estimated econometrically or specified exogenously. Reflecting

the high level of noncompetitiveness of Thai imports, the elasticity for manufacturing imports chosen is 0.5. Sectoral consumption shares are also given in the SAM in the base year. For the rest of the simulation years, consumption of each consumable good is estimated such that sectoral output is exhausted by its uses. This results in different consumption shares from the base year, and indicates possible changes in taste, or non-unitary income elasticities. The tradeable share of consumption increases from 0.4 and stabilizes at 0.44. The share of nontradeables oscillates without a trend between 0.46 and 0.48, averaging 0.476, while the agricultural consumption share declines from 0.12 to 0.08.

45. Other data come from CEM reports of the World Bank. Land is exogenously given at the level of 1975 throughout the simulation. This reflects the slowdown of land expansion during the second half of the 1970s in Thailand. The total urban labor force, and total rural labor force are available in various CEM reports for several years including the base year.

46. The absence of conformable data on the sectoral allocation of labor is not a serious problem, because we employ the assumption of intraregionally mobile labor. Thus, sectoral labor allocation within a region is determined endogenously through wage equalization. Reflecting rural-urban migration, the urban labor force grows at around five-six percent p.a. whereas the rural labor grows around one percent. The aggregate national labor force as a result grows at 2.9 percent.

47. The most difficult task is to estimate the capital stock by sector in 1975. We use the time-series data on fixed national capital formation and ICORs since 1960. We also have the results of various manufacturing surveys that report book-value capital stocks. From these sources, we proceeded as follows. The total economy-wide capital stock is estimated using a perpetual inventory method. This value was then compared with a value derived from assuming that an average of recent ICORs is the average capital-output ratio. Arbitrary judgments were used to reconcile these into an estimate of the aggregate capital stock. Next, a measure of the manufacturing sector's capital stock is estimated from a survey, and the rate of return on capital in that sector calculated. We then allocated the rest of the capital stock in the economy in a manner that improved the compatibility of the simulations with actual experience.

48. Taxes on wage and capital income are calculated as average ad valorem rates from the government revenue statistics in CEM reports, and are assumed to remain constant. Constant indirect tax and tariff rates are also calculated as sector averages from the SAM.

49. Production functions are "guesstimated" according to the following rule. Because of the Cobb-Douglas production relations assumed in this model, the factor shares stay constant and can be derived directly from the SAM. The NESDB-IDE-NSO SAM, however, reports only the actual payment of wages and salaries and the operating surplus. The latter, in case of small scale firms and family farms, includes an imputed wage for family member workers and the land rent for

agriculture. Some adjustments and imputations were made through the use of wage data in CEM. We use these factor shares as the production elasticity of each factor in each sector. What remains to be estimated are Hicks neutral constants of the production functions. They are in fact calibrated within the sample periods such that with historical price levels and our assumed factor allocation rule, historical values of each sector output in each year is reproduced. They are allowed to change year by year, because:

- (1) this allows us to capture changes in technical progress, and oscillating capital utilization: and,
- (2) we can similarly capture past supply shocks, such as bad weather for agriculture.

Table 2 shows the values of these coefficients. The agricultural sector enjoys a rapid productivity improvement initially, but hits a plateau in 1978. Similarly, the tradeable manufacturing seems to enjoy rapid technical progress (7.8 percent p.a.) until 1979. In 1980, the technical coefficient is reduced. This can be attributed to lower capital utilization due to the world-wide impact of the second oil-shock. The nontradeable service sector has a consistently declining coefficient value.

50. Government consumption, values of net service receipts and rural sector exports, unrequited transfers, concessional borrowing, and international parameters (world trade in manufacturing, world interest

Table 2: Hicks Neutral Technical Coefficients

	1975	1976	1977	1978	1979	1980	1981
EX	0.619	0.533	0.526	0.498	0.466	0.420	0.502
AG	0.248	0.263	0.259	0.285	0.282	0.281	0.286
TR	1.094	1.201	1.301	1.422	1.478	1.450	1.472
NT	0.884	0.845	0.814	0.758	0.723	0.699	0.696
CO	0.819	0.866	0.975	1.306	1.346	1.283	1.153

rate, and international prices) are all given exogenously year by year.

51. Indices of world trade in manufacturing goods and export prices have been taken from the U.N. World Trade Yearbook. The MUV (manufacturing unit value) estimated at the World Bank has been used as the manufacturing import price index. World interest rates come from the World Debt Tables. We have three types of borrowing: official, concessional loans; nonconcessional loans borrowed by the government, and nonconcessional loans borrowed by the private sector. Average interest rates on loans of official sources are assumed to apply on all loans of the first type. The average rate of all other loans is applied to the other two types of loans, regardless of whether the borrower is private or public.

52. Finally, there are unobservable cost of adjustment parameters for investment and borrowing. For the investment installation cost (α), a factor of three was chosen. For the borrowing cost, two values have been used. In the historical analysis the value is 1.0 and in the future simulation the value is 0.4. This tries to capture the property that the marginal costs of a rapid expansion of commercial borrowing were high until Thailand had an established reputation in international capital markets. These values mean that the marginal cost of investment and borrowing are between eight to ten percent higher than the average cost.

Testing the Model

53. The model is under-identified in the sense that it has many more parameters than there are observations to track. Therefore; there are no established statistical tests for estimating the empirical validity of the model. We therefore simply choose parameters that generate economy-wide behavior similar to that actually observed in Thailand.

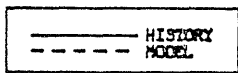
54. We focus on the model's ability to reproduce the truly endogenous variables that have a key role in the determination of foreign borrowing. These are sectoral private consumption levels, output, manufacturing exports and competitive imports. These all depend on the relative prices calculated by the model. The production and demand parameters were chosen such that history would be reproduced given actual relative prices. Thus, the deviation of the calculated variables from history depends mainly on the model's success in generating appropriate prices, when borrowing and investment are fixed at historical levels.

55. Overall, the model replicates the economic history of Thailand during 1975-1981 well. Figure 1 compares actual with simulated values for GDP, consumption, tradeable and nontradeable outputs, manufacturing exports competitive imports. All real variables are in 1975 billion bahts. Clearly, the model is able to replicate the real aspects of the Thai economy with a comfortable degree of precision. The explicit domestic price comparison is shown in Figure 2. One problem lies with observing actual prices for the composite goods implicit in each of our

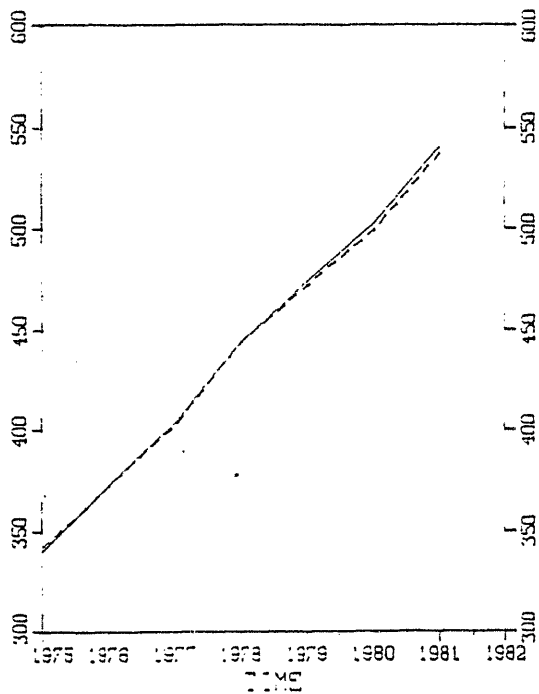
Figure 1

TRACKING OF HISTORY:

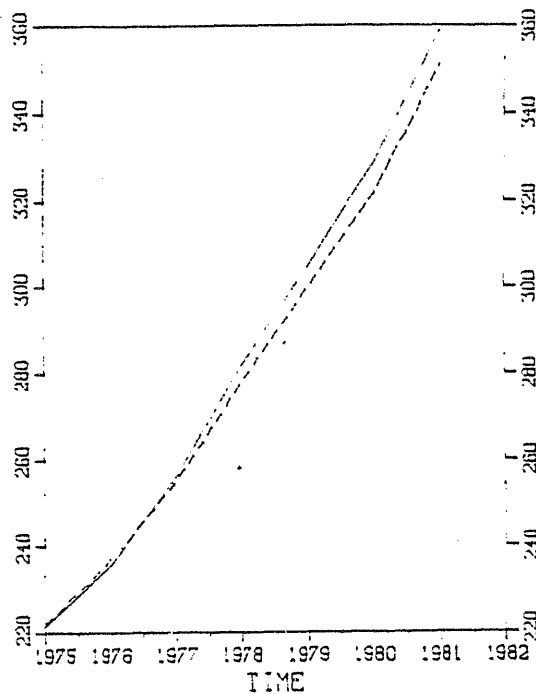
Real figures are in 1975 billion bahts



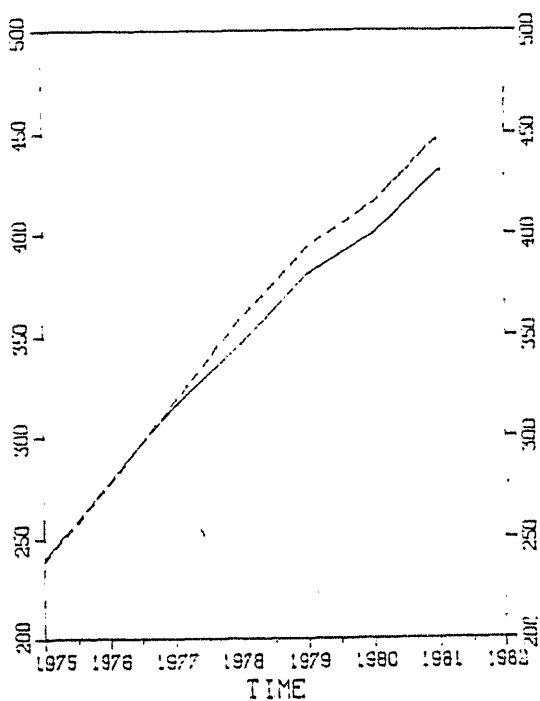
GDP IN CONSTANT PRICES (1975)



NONTRADABLE OUTPUT



TRADABLE OUTPUT



COMPETITIVE IMPORTS

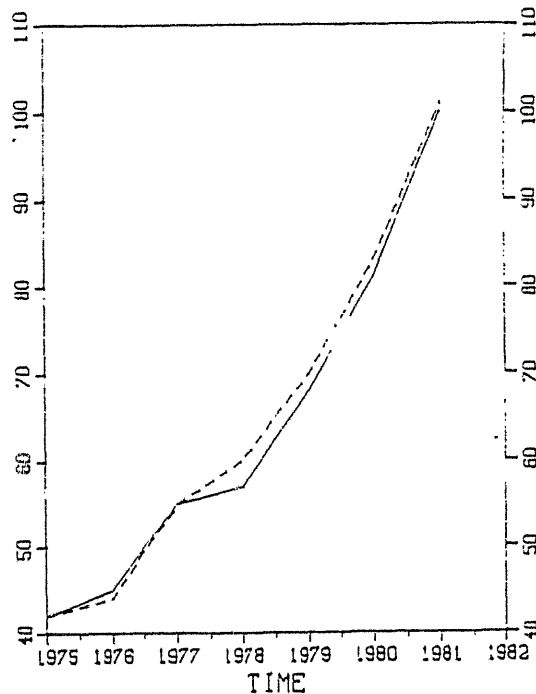
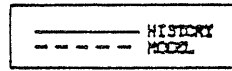


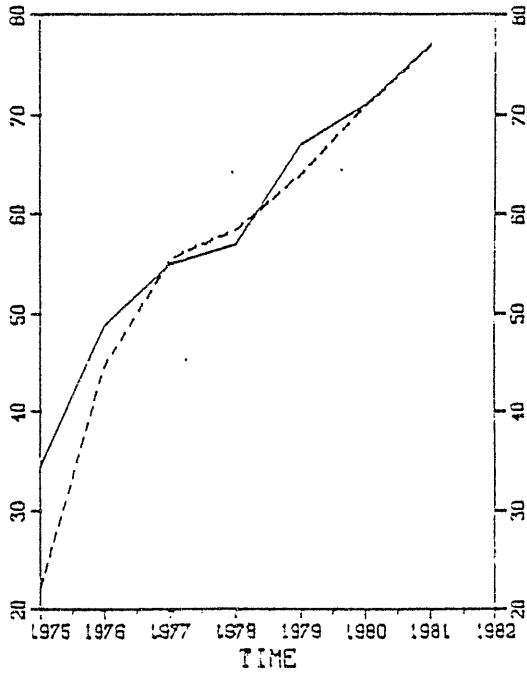
Figure 1

TRACKING OF HISTORY:

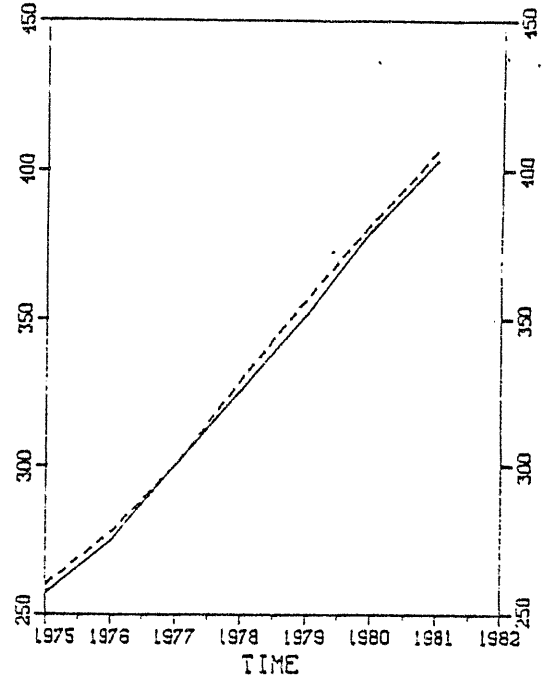
Real figures are in 1975 billion bahts



MANUFACTURING EXPORTS



CONSUMPTION



REAL EXCHANGE RATE

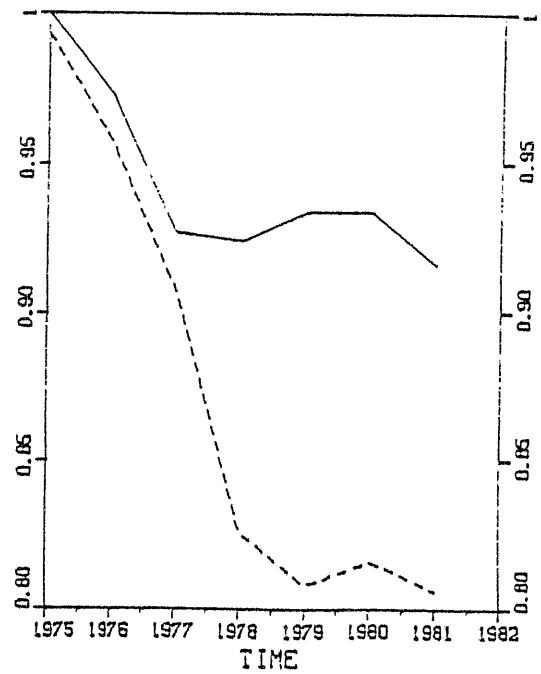
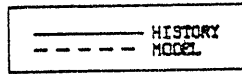


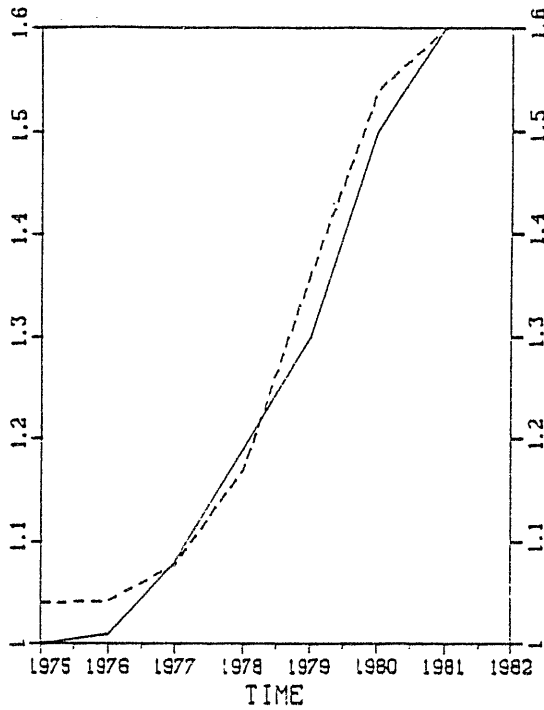
Figure 2

TRACKING OF HISTORY

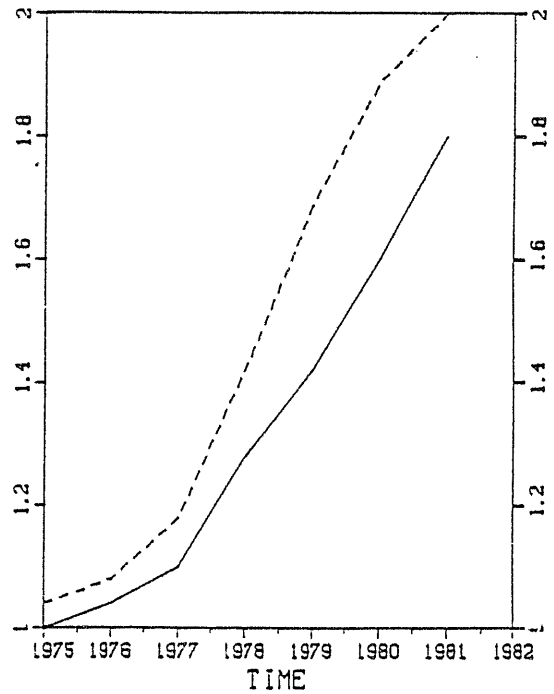
Real figures are in 1975 billion bahts



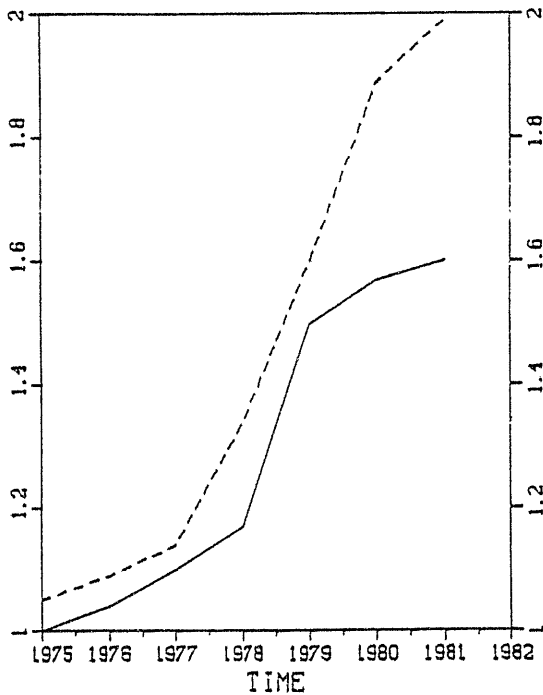
PRICE OF TR SECTOR



PRICE OF NT SECTOR



PRICE OF AG SECTOR



PRICE OF EX SECTOR

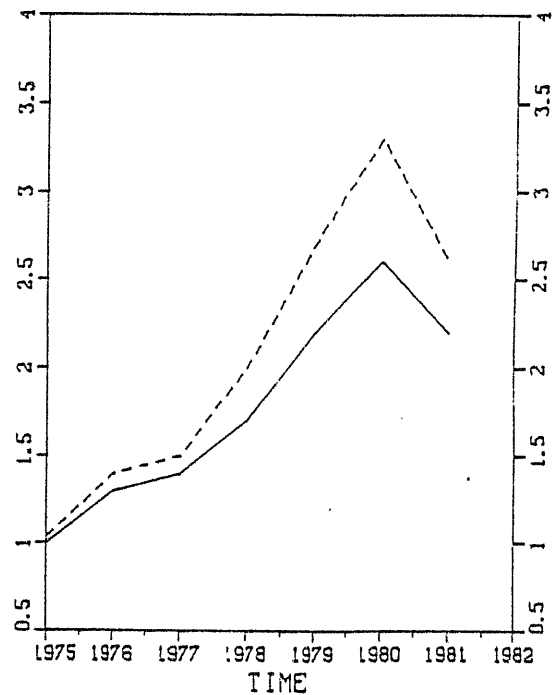
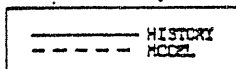
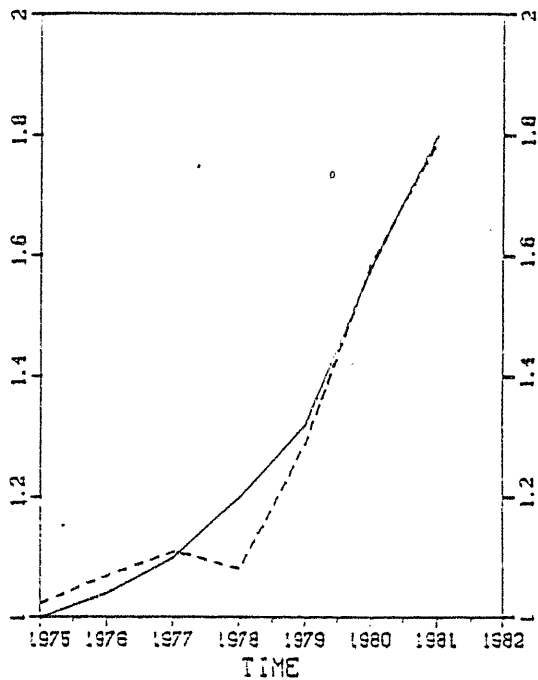


Figure 2
TRACKING OF HISTORY
Real figures are in 1975 billion bahts



PRICE OF CON SECTOR



sectors. A rough approximation is derived from the national income accounts in current and constant prices. Prices of the manufacturing good are the closest to the actual historical time-series. This is due to the fact that the tradeable prices are related with international prices, through the positive substitutability between domestic and foreign goods. The two rural sectors and the non-tradeable service sector tend to have higher prices than actual. As a result, the relative price of tradeables divided by that of nontradeables (one measure of the real exchange rate) shows a sharper appreciation than shown by the sectoral national account indices. On the other hand, the model simulation prices shows a pattern of real exchange rate movements that is close to the pattern displayed by in-depth analysis of the trade-weighted real effective exchange rate. Given, this, and the success of the model in explaining the evolution of the real side of the economy, we use in the sequel of the paper the ratio of the tradeable to nontradeable price of the CGE simulation as the implicit actual real exchange rate of the economy, rather than the national accounts prices with their associated index number and aggregation problems.

Sensitivity Analysis

56. The credibility of the model is enhanced if results are robust with respect to minor changes in parameters, especially those whose values were obtained through educated guesses rather than calibration or statistical estimation. We also benefit from knowledge of what the cost of not using the "right" values for the parameters. We therefore tested the model by performing sensitivity analyses with regard to the following five parameters.

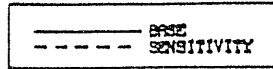
- (1) the inverse of intertemporal elasticity of utility (or relative risk aversion of the utility function);
- (2) the pure rate of time preference;
- (3) the cost of adjustment in investment;
- (4) the terminal period balanced growth rate; and,
- (5) the length of the planning horizon.

57. Consumption Smoothing: The sensitivity test involved increasing "b" from 0.6 to 0.9, (by 50 percent). The desire to smooth consumption over time increases (Figure 3). Results, however, do not change very much from the base run. Private consumption is smoothed over time by being raised earlier (1.6 percent) and lowered later (0.1 percent). Investment is the mirror image. Borrowing is marginally and later higher investment. Earlier it finances higher consumption, and later higher investment. Divergence of any of these variables from the base run does not exceed three percent.

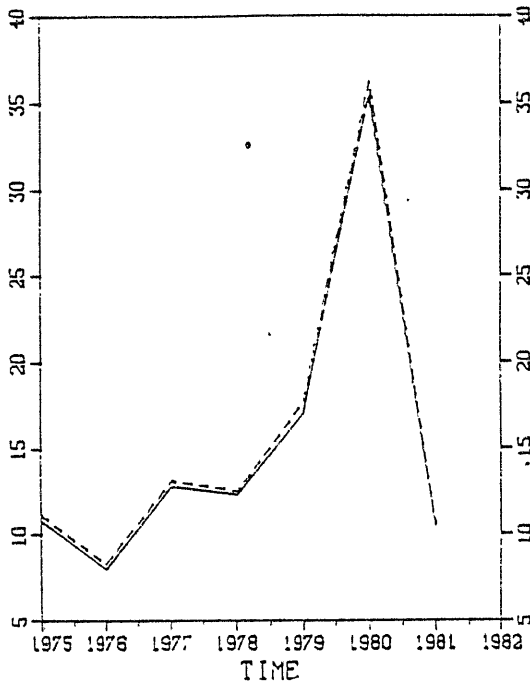
58. Higher Rate of Pure Time Preference. An increase in the pure rate of time preference from 5 percent to 5.5 percent also has a visible but relatively minor effect on major variables (Figure 4). Consumption increases throughout the transition path to balanced growth, at which point it falls below the base case. This is financed by slightly higher borrowing and reduced investment. Here, again, the results are as predicted, but not large to a bothersome extent.

59. Higher Cost of Adjustment of Investment. When the cost of adjustment on investment is raised from three to five, the resulting solution does not change very much. Borrowing and consumption are both

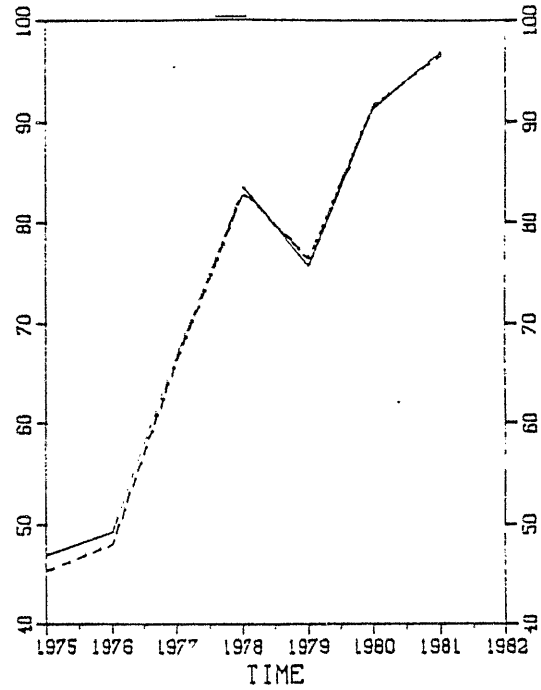
SENSITIVITY ANALYSIS, HIGHER
CONSUMPTION SMOOTHING
Real figures are in 1975 billion bahts



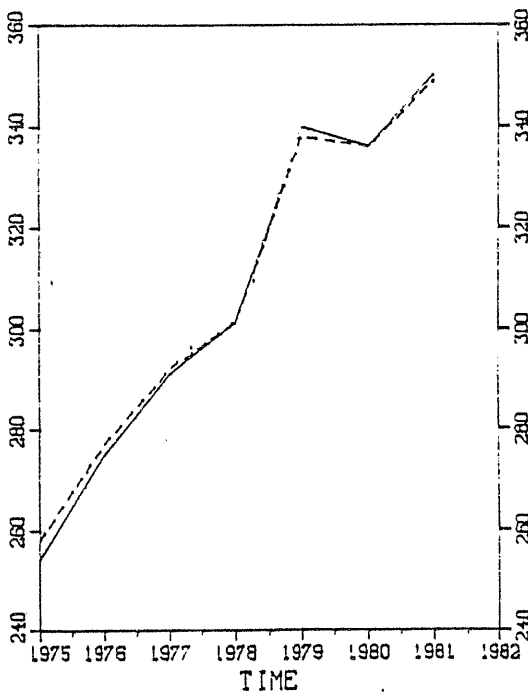
BORROWING



INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE

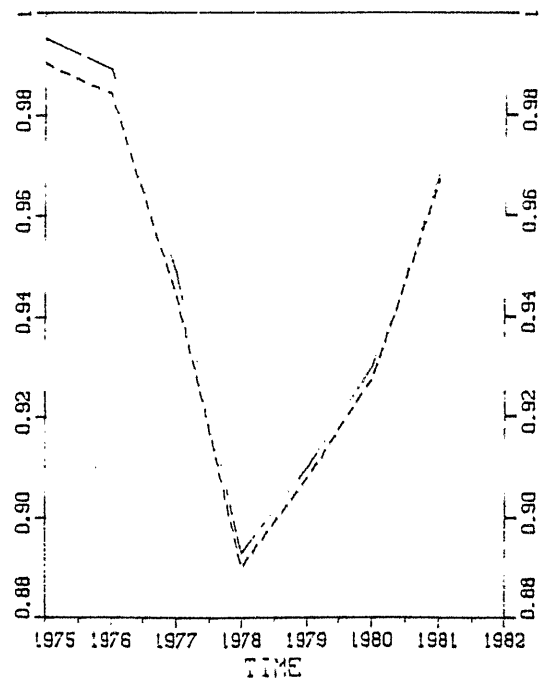
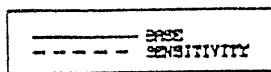


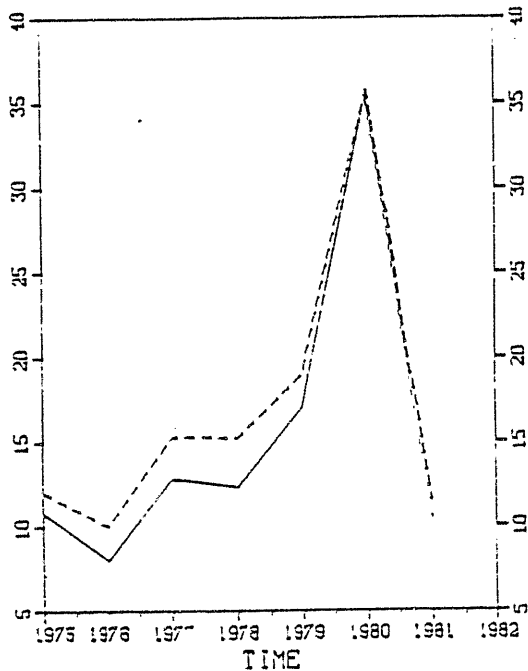
Figure 4

S.A., HIGHER PURE RATE OF TIME PREFERENCE

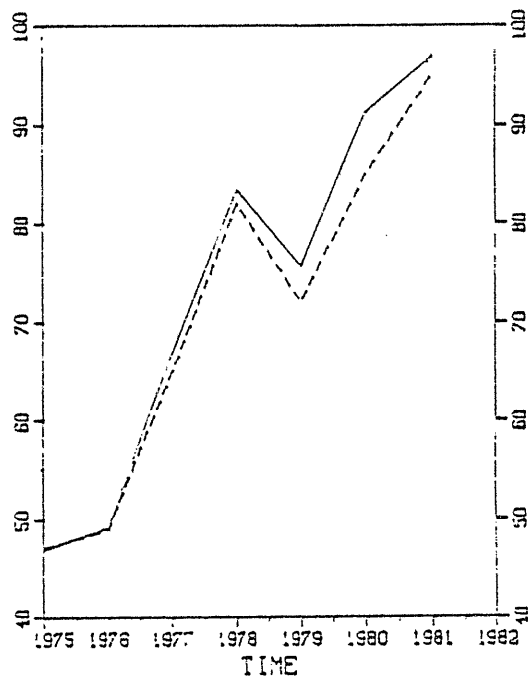
Real figures are in 1975 billion bahts



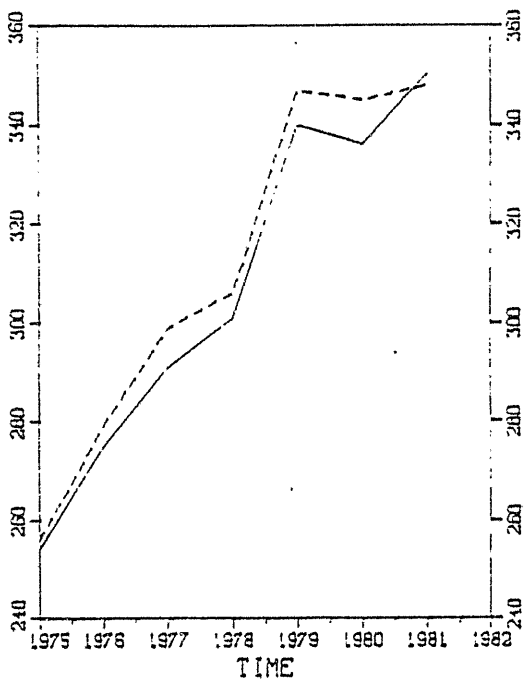
BORROWING



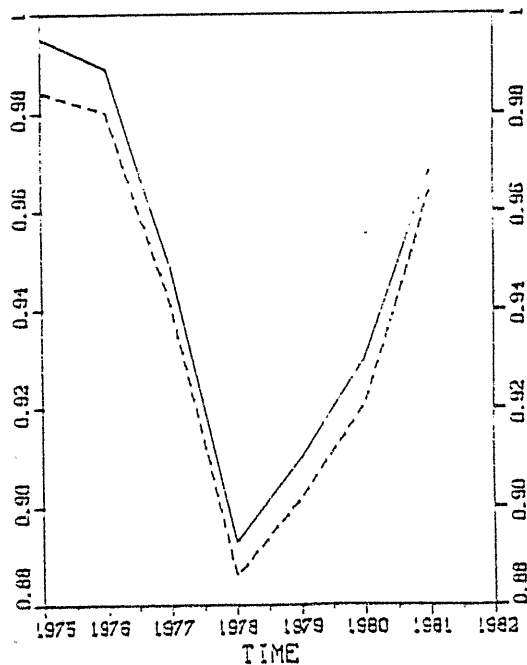
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



reduced slightly. Capital formation declines by five percent, but actual investment expenditure changes very little from the base run. The resulting solution, therefore, is quite similar to the base solution (Figure 5).

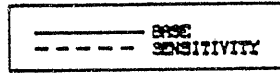
60. Lower Balanced Growth Rate. A reduction of the balanced growth rate by 0.5 percent from 5.2 percent to 4.7 percent, on the other hand has effects that are more substantial than three tests above (Figure 6). Because of lower expected future income, more resources must be transferred to the future. Consumption declines at first by three percent. Investment also goes up by 11-16 percent. Borrowing, however, is only raised by less than 80 million U.S. dollars. Due to the extra capital formation throughout the simulation, the terminal consumption levels would be eight percent higher than in the base case.

61. The Planning Horizon. Because of the computational problems involved with solving a model with as many non-linearities as ours over many periods, we cannot simply lengthen the planning horizon. Accordingly, the test of the sensitivity to the short, seven-year, transition to balanced growth is performed as follows. We first generate a base solution. We then take the values of the capital, labor and debt stocks from the beginning of period three and re-run a seven-year model. The divergence between these solutions and the original ones indicates the sensitivity of our results to the length of the planning horizon (Figure 7). We see that the assumption of a forced balanced growth in the eighth year only has a marked effect on the

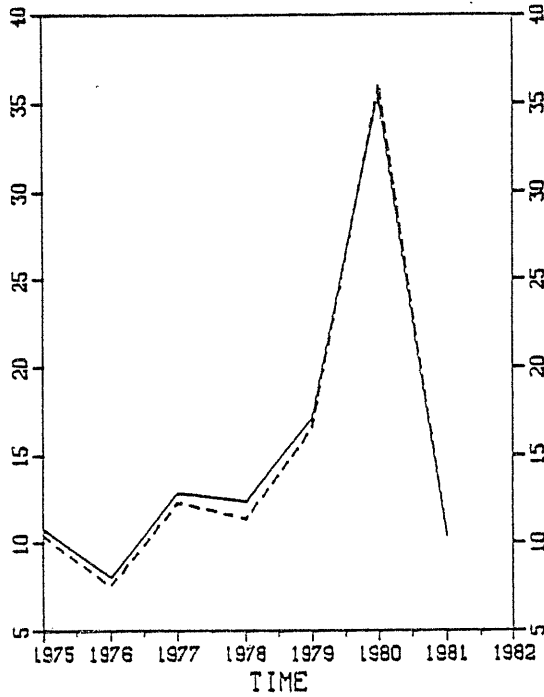
Figure 5

S.A. HIGHER INVESTMENT ADJ. COST:

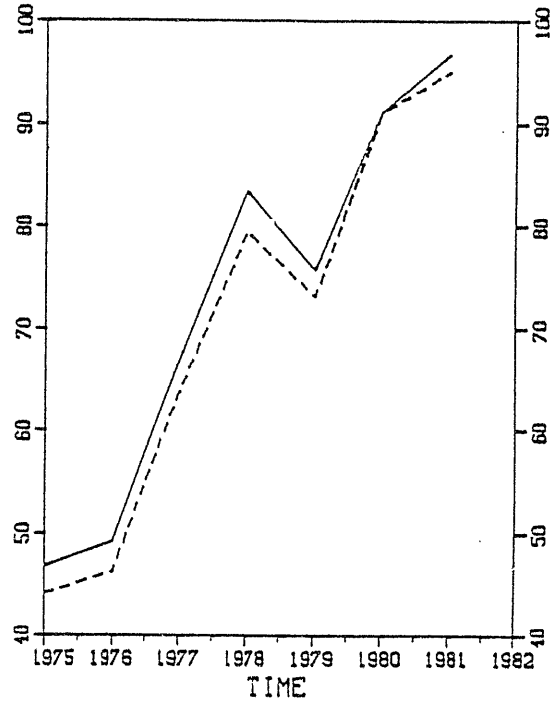
Real figures are in 1975 billion bahts



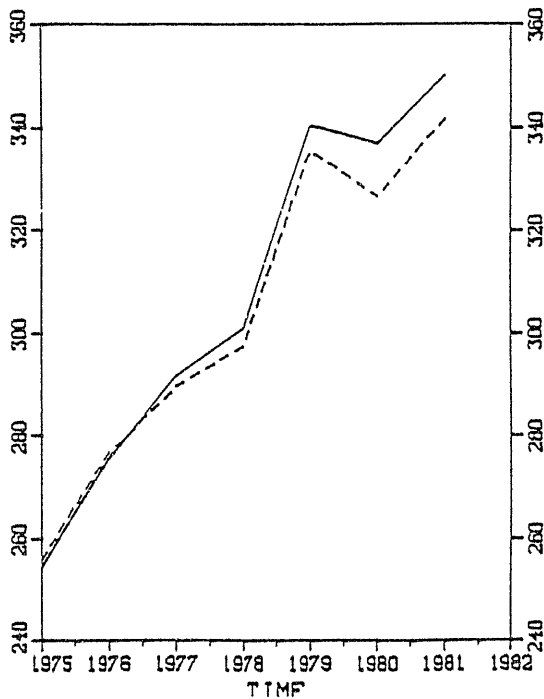
BORROWING



INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE

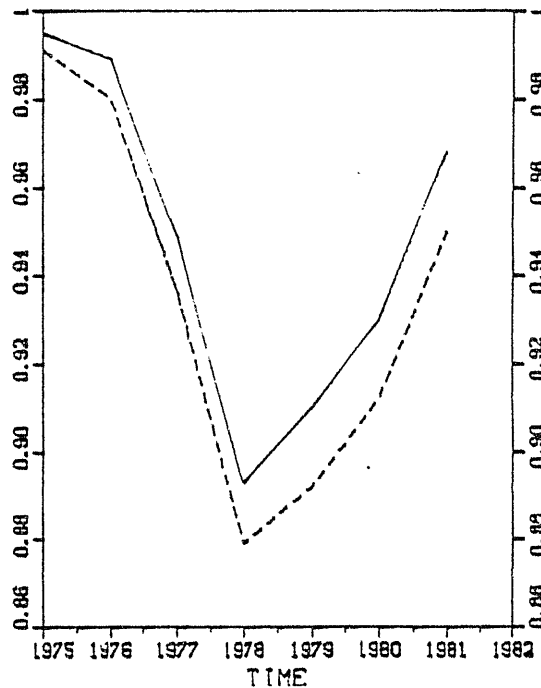
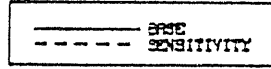
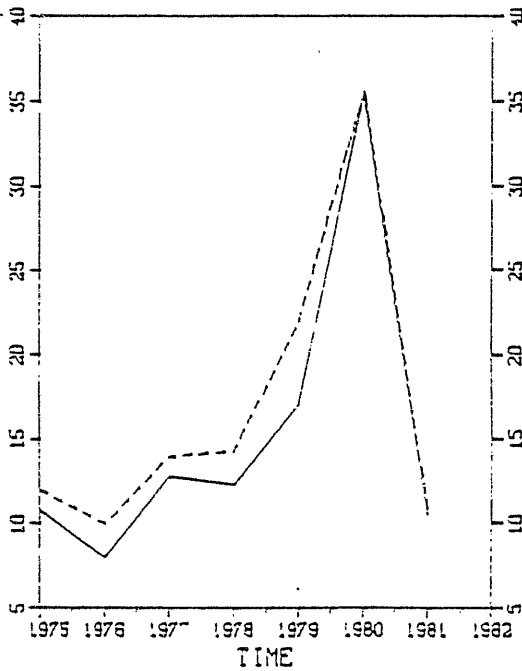


Figure 6
S.A., LOWER STEADY GROWTH STATE
GROWTH RATE

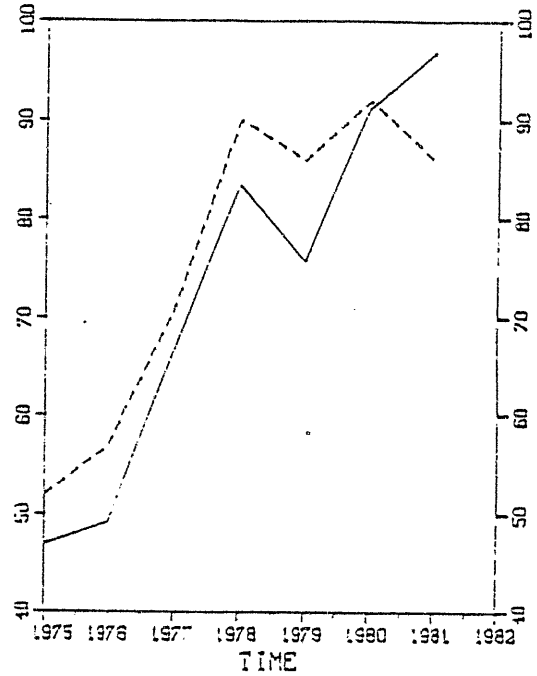
Real figures are in 1975 billion bahts



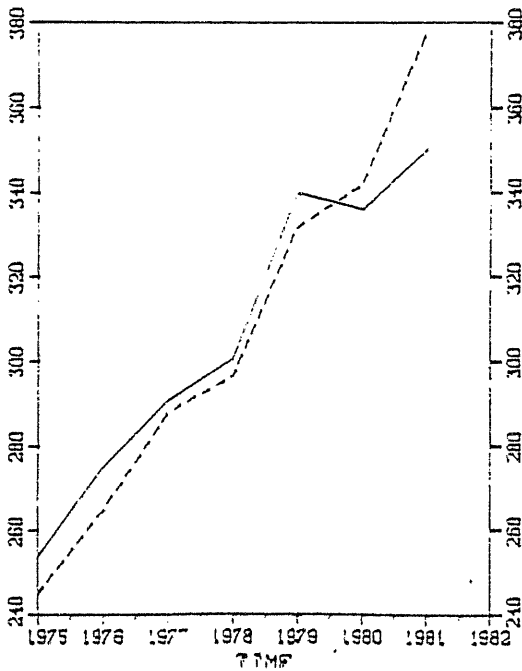
BORROWING



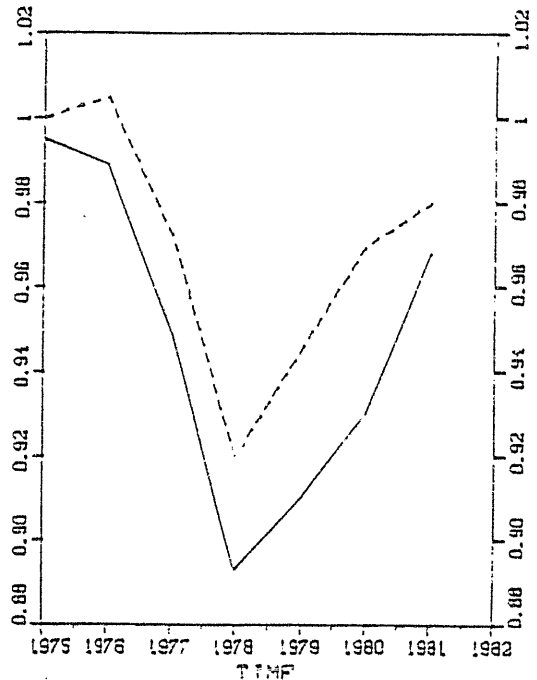
INVESTMENT



CONSUMPTION



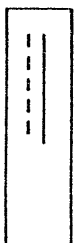
REAL EXCHANGE RATE



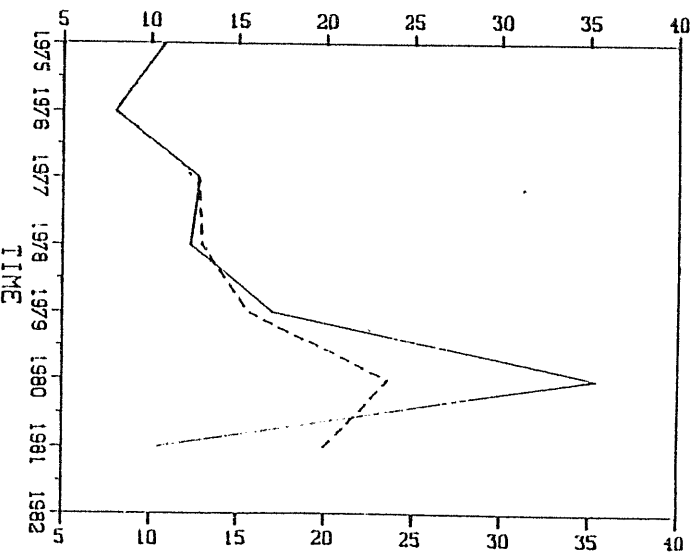
S.R. EFFECTS OF TERMINAL CONDITIONS

Figure 7

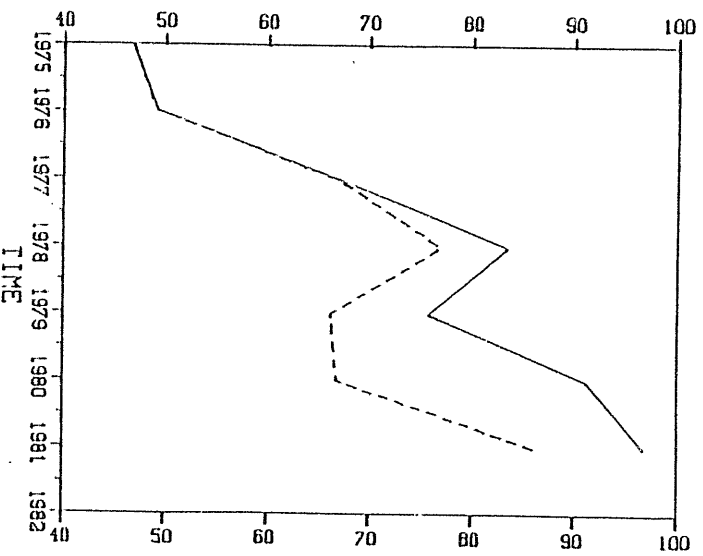
Real figures are in 1975 billion bahts



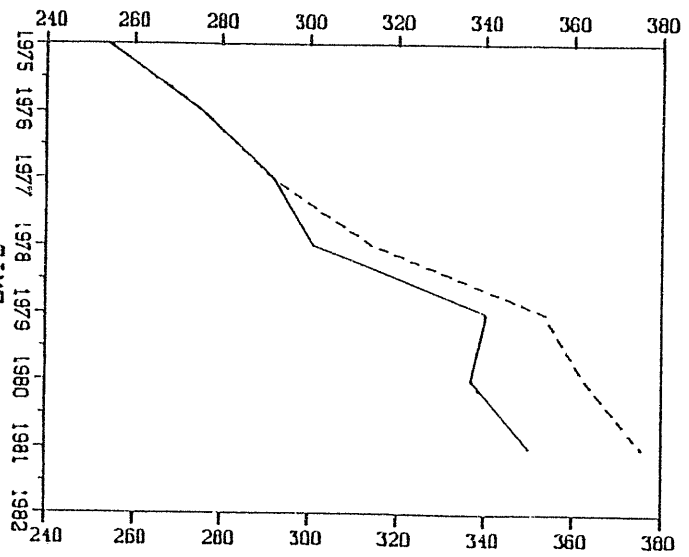
BORROWING



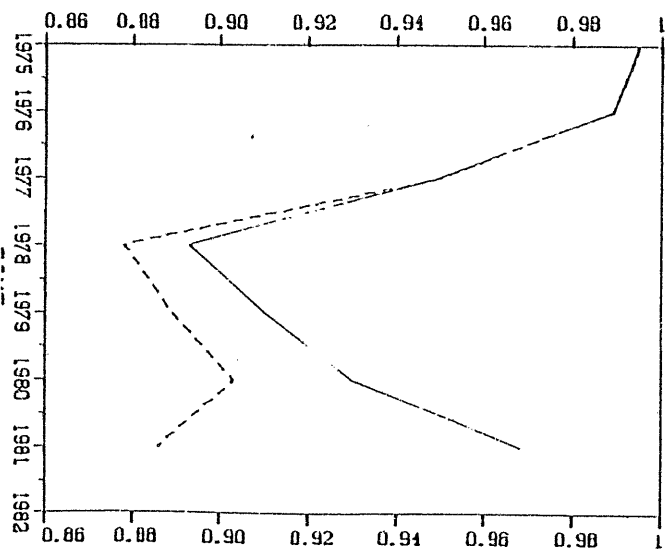
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



solution for years five, six and seven. The earlier values are relatively unaffected.

62. Summing up, the model is not overly sensitive to the changes in parameter values in the utility function, namely "b" and " δ ", insofar as these parameter values stay within reasonable intervals, based on empirical work for other countries and on theoretical conjecture. Changing the cost of adjustment of investment also has very little impact on the solution values. The terminal conditions, however, require more attention. A one percentage point change in the balanced growth rate could change investment by 20-30 percent, and consumption by 10 percent. The effect on borrowing, however, is relatively small. To the extent that our terminal conditions are derived from the long-run historical performance of the Thai economy, the reasonable range over which the growth rate should reasonably vary is narrow. Nonetheless, further examination, is needed on the terminal conditions in the future.

III. HISTORY REEXAMINED

63. This section uses the model to evaluate Thailand's historical borrowing strategy. First, the economic structure and performance is briefly reviewed. This indicates the role of investment in fuelling growth; the growing importance of the manufacturing sector and its contribution to exports; the continued vulnerability of export earnings to agricultural supply shocks; and the rapid build-up of foreign debt by the public sector associated with a sharp expansion of public

investment. Second, we present the results of an alternative borrowing and investment strategy that would have yielded steadier consumption growth without a large debt overhang. Third, we attempt to explain historical behavior in terms of mistaken expectations and limited flexibility in macroeconomic adjustment.

Economic Structure and Performance

64. Aggregate indices show that in the past, Thailand has performed well relative to the average of middle-income-oil-importing countries (MIOIC). Table 3 compares Thailand with some major countries in the region and with averages of MIOICs. Thailand is surpassed only by Korea in terms of growth rate of GNP per capita in constant prices between 1960 and 1982. This good performance comes largely from its high growth rate during the 1960s. Real GDP grew at 8.4 percent p.a. The growth rate slowed down to around seven percent during the 70s. This is lower than Korea, and oil-exporters (Indonesia, and Malaysia) but still substantially higher than the average of MIOICs.

65. The slower growth during the 70s is attributed partially to the two oil shocks, and partially to the slow growth in agriculture in the second half of the decade caused by volatile weather conditions and deteriorating internal and external terms of trade. Thailand absorbed the impact of the first oil shock with relative ease due to the contemporaneous and offsetting impact of price boom for Thai export commodities. It also benefitted from a tight fiscal stance during the inflationary period. By 1975, Thailand shifted its attention to regaining the higher growth rates of the 60s. Growth promotion measures

Table 3: Aggregate Growth Rate A Comparison (Percentage Growth Rates of Real Aggregate Output)

	1960-1982 GNP Per Capita	1960-1970 GDP	1970-1982 GDP	1970-1975 GDP	1975-1980 GDP
Thailand	4.5	8.4	7.1	6.3	7.5
Indonesia	4.2	3.9	7.7	7.9	7.9
Philippines	2.8	5.1	6.0	6.0	6.3
Korea	6.6	8.6	8.6	9.5	7.6
Malaysia	4.3	6.5	7.7	7.1	8.6
MIOIC average	3.5	5.8	5.1	-	-

Source: World Development Report, World Tables

were therefore introduced. They included control of certain key prices, interest ceilings on domestic credit, raising effective rates of protection, and expansion of credit creation. This resulted in relatively high growth rates between 1976-1979. With increased fiscal and current account deficits together with the price distortion, however, Thailand increased its vulnerability to external shocks. As a result, the second oil shock, was much more serious for Thailand than the first one.

66. Along with the good growth performance, structural change occurred steadily. Table 4 shows the production structure in current price GDP. The agricultural share of GDP declined from an average 34 percent during the 1960s to about a quarter in early 1980s. The manufacturing sector grew from 15 percent to 20 percent of GDP. The agricultural share is still high compared with the average of MIOICs and the industrial share low. This reflects the importance of agriculture and agricultural exports in Thailand. In terms of growth rates, manufacturing naturally grew fastest. When we compare the growth rate with the major countries in the region, it is again noteworthy that Thai manufacturing grew more slowly than all the comparator countries except for the Philippines (Table 5). Furthermore, the contribution of manufacturing to GDP growth ^{1/} decreased between 1970-1975 and 1975-

^{1/} This share is defined as $\frac{s_i g_i}{g}$ where s_i is the value-added share of sector i in GDP, g_i is the growth of value added of sector i , and g is overall GDP growth.

Table 4: Production Structure of Thailand
(Percentage of Current GDP)

	Average of 1960-1970	1975	1980	1982	(MIOIC)
Agriculture	33.6	31.5	25.4	22.	(17)
Industry	23.2	24.8	28.5	28	(35)
(Manufacturing)	(14.7)	(18.0)	(19.6)	(19)	(23)
Services	43.2	43.7	46.1	50	(48)

Table 5: Percentages Growth Rates of Sectoral GDP
(Annual Average in Constant Prices)

	Agriculture			Manufacturing			Service		
	1960-70	1970-75	1975-80	1960-70	1970-75	1975-80	1960-70	1970-75	1975-80
Thailand	5.6	5.2	3.2	11.4	9.6	10.5	9.1	6.6	7.9
Indonesia	2.7	4.1	4.0	3.3	12.3	15.0	4.8	9.7	9.4
Philippines	4.3	4.3	5.4	6.7	6.9	7.0	5.2	5.3	5.2
Korea	4.4	4.8	-2.0	17.6	17.9	13.0	8.9	8.6	7.9
Malaysia	-	4.8	5.4	-	11.6	11.3	-	8.0	8.9

Source: World Tables

1980, while the service sector contribution to GDP growth increased. Thailand is the only country that exhibited this combination of changes among the five countries compared here. This rapid expansion of the service sector coincides with the period of high foreign capital inflows. As discussed below, one explanation focuses on real overvaluation of the baht as a result of the capital inflows causing investment to be directed toward the nontradeable service sector.

67. Demand. Table 6 shows the growth rates of final demand components. Private consumption maintains relatively steady growth rates despite the slowing down of the aggregate output growth rate. Government consumption clearly shows the conservative fiscal stance in the early 1970s, and more expansionary measures over the second half of the 1970s. Growth rates of investment and exports oscillate more drastically; the latter is a function of continued high dependence on agricultural exports which are susceptible to weather conditions.

68. Table 7 shows the shares of major exports. The structural change is also clearly visible here. Non-principle commodity manufacturing exports increase its share in total exports from 5.7 percent in 1970 to 30.4 percent. The share of principle commodities (traditional export goods) declines from 77 percent to 54 percent although the absolute level of this type of export is rising.

Table 6: Growth Rates of Final Demand

	1960-1970	1970-1975	1975-1980 ^{a/}
Private Consumption (Unadjusted for Statistical Discrepancy) ^{1/}	6.8	6.5	6.8
Government Consumption	9.5	6.0	11.3
Gross Domestic Investment	15.0	3.1	8.2
Fixed Capital Formation ^{2/}	15.7	1.5	11.5
Exports (f.o.b.)	10.2	3.9	15.1
Imports (c.i.f)	12.6	1.4	11.4

^{a/} Constant 1972 prices, annual growth rate in percentage.

^{1/} National accounting data yield statistical discrepancy and are therefore internally inconsistent. Private consumption usually absorbs all the statistical discrepancy. We have no correct method of distributing these discrepancies, and therefore have decided to use the estimated private consumption before adjusting for statistical discrepancies as our "historical consumption".

^{2/} Fixed capital formation was used as our "historical investment".

Table 7: Export Shares (Current, Percentage)

	1970	1975	1980
Principle Commodity Exports.	76.7	68.0	54.4
(Rice)	(17.6)	(23.2)	(14.8)
(Rubber)	(15.6)	(7.8)	(9.4)
Other Manufacturing	5.7	18.2	30.4
Other Agriculture	7.8	5.9	5.3

The Evolution of Foreign Debt in Thailand

69. By international comparison, Thailand's creditworthiness remains strong. Large amounts were borrowed at 0.125 percent above LIBOR both by the public sector and private firms in 1984. These are certainly among the lowest in the international capital market.

70. Table 8 presents the overall evolution of debt in Thailand in the past. Table 9 compares growth rates of indebtedness of Thailand with those of the major countries in the region. During the 1970s as a whole the average growth of foreign indebtedness of Thailand was similar to that in other developing countries over the same period. What distinguishes Thailand from most other developing countries is the time profile of borrowing. Thailand's growth in external debt was modest during the first half of the 1970s when global liquidity was high and real interest rate low. Many developing countries borrowed heavily then but had to undertake major adjustment measures to mitigate the impacts of the second oil shock and the substantial real interest rise during the second half of the 1970s. By contrast, Thailand's external indebtedness accelerated during this period. The peak in the growth rate of total debt came in 1979 and 1980 reaching 50 percent. This coincided with record high nominal (and real) international interest rate.

71. Table 9 also indicates that the rapid growth in Thailand's foreign debt during the second half of the 1970s is mainly attributable to the high accumulation of debt by the public sector. The central government and public enterprises increased outstanding debt at a speed of 42.6 percent p.a. between 1975 and 1981. Private MLT debt increased
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Table 9. Growth Rate of MLT Obligations

	Thailand	(Public)	Malaysia	Philippines	Korea	Indonesia	MIOIC
1971-75	14.3		36.3	12.4	24.2	31.6	24.8
1975-80	33.9		21.7	26.7	23.9	11.8	21.6
1978	38.0	(62.6)	26.1	22.9	30.1	11.4	27.2
1979	47.6	(55.4)	19.3	15.3	21.8	1.4	19.8
1980	43.1	(45.8)	15.5	16.6	16.8	10.4	15.4
1981	24.1	(25.8)	33.9	20.6	23.6	6.0	10.7

Source: World Debt Tables

by only 19 percent p.a. over the same period. The contrast comes from the combination of the private sector's sensitivity to changes in world interest rates, and the public sector's tendency to accommodate internal imbalances by external borrowing. ^{1/} The high rate of increase in public debt reflected a high public investment-saving gap. Public savings financed half of public investment during 1970-1975. This figure goes down to less than 10 percent in 1981.

72. Nominal debt statistics overestimate the real growth of debt in an inflationary environment. Inflation erodes the real value of assets denominated in nominal terms, independently of any flow of funds. Any analysis based on a flow of funds that does not take inflation into account may be misleading. For example, a country which borrowed heavily in yen at lower nominal interest rates would have smaller interest payment, and therefore, higher domestic savings than one which borrowed more in US dollars, even if the expected real cost of borrowing in these currencies, and hence the underlying macroeconomic positions, were identical.

^{1/} See Kharas (1983) for the analysis of the public sector debt, and Shishido (1985) for crude estimates of private and public sectors' sensitivities to interest rates.

73. In addressing these concerns, two considerations are of special relevance. First, as argued in the preceding paragraph, the real net flow of foreign capital into Thailand was substantially less than the nominal borrowing rates might suggest. The erosion of the real value of debt through inflation results effectively in an amortization of debt over and above recorded amortization than can be added to the capital account of the country's balance of payments. In order to stay within a consistent accounting framework, an offsetting adjustment is made by reducing interest payments by an equal amount, thereby reallocating total debt service between the current and capital account, while holding its amount constant. Even after this adjustment is carried out, and the country's real accumulation of net foreign liabilities has been estimated, it is apparent that there was indeed a high and probably unsustainable real rate of accumulation of foreign obligations toward the end of the 70s (Table 10) reaching almost six percent of GDP in 1979. In 1980 and 1981, however, this rate dropped to three to four percent; more recently, with world inflation much reduced, the adjusted current account deficit will be close to the recorded deficits of five to seven percent.

74. The second consideration relates to the type of adjustment process that took place during the late 1970s and early 1980s. The deterioration in the terms of trade that has occurred over this period required structural changes in expenditure patterns. Consumption should be reduced in response to the decline in real income, whereas real

Table 10: Adjusted and Unadjusted Current Account Deficit
(As Percentage of GDP)

	1975	1976	1977	1978	1979	1980	1981
Unadjusted Current Account	4.1	2.7	5.7	5.0	7.7	6.2	6.9
Adjusted Current Account	3.1	1.9	5.3	4.6	5.7	3.6	3.5

Source: Kharas (1983)

investment needs may be increased to hasten changes in the pattern of production. Net resource transfers from abroad can be useful in speeding up the adjustment process especially if channelled into productive investments in support of structural adjustment without imposing an undue reduction in consumption. In assessing the changes in real resource transfers in Thailand it is possible to decompose the total annual change into a component associated with structural changes in real investment and consumption and into a component required by changes in the price of investment and consumption relative to the GDP deflator. ^{1/} Table 11 shows the results. During 1975-1976, the transfer was less than the 1970/72 average due to the slow-down in investment, and accompanying decline in prices of capital goods. In 1977, the transfer starts to pick up primarily caused by the higher share of real investment in GDP. Later in 1980 and 1981, real investment slows down, but the need for the transfer is kept high by an increase in the relative price of capital goods. If real investment demand had continued to grow at similar rates seen in 1977-79, the

^{1/} See Appendix 3 for the decomposition method.

Table 11: Changes in Resource Transfer From Abroad
(Percentage of GDP)

	1975	1976	1977	1978	1979	1980	1981
Actual Resource Transfer	2.1	0.9	2.9	2.4	4.4	3.1	3.8
Δ Transfer from 1970/72	-0.3	-1.3	0.9	0.4	2.4	1.4	2.0
Structural Change	-1.0	-2.1	3.3	0.9	2.8	-0.5	-2.3
Investment	(-0.2)	(-2.4)	(2.0)	(1.9)	(2.5)	(0.5)	(0.0)
Consumption	(-0.8)	(0.3)	(1.3)	(-1.0)	(0.3)	(-1.0)	(-2.3)
Price Effects	0.4	0.2	-3.1	-1.2	-1.0	0.8	3.4
Investment	(2.0)	(2.0)	(0.4)	(1.6)	(2.8)	(3.1)	(4.4)
Consumption	(-1.6)	(-1.8)	(-3.5)	(-2.8)	(-3.8)	(-2.3)	(-1.0)
Growth Effort	0.8	1.0	1.2	1.5	1.6	1.7	1.9
Exchange-Rate Effect	-0.5	-0.5	-0.8	-0.8	-0.9	-0.7	-0.9

Source: Kharas (1983)

demand for foreign resources would have been much higher in 1980/1981 because of the high capital goods price.

75. This review illustrates certain features of the Thai economy that provide the empirical underpinnings of the analysis. First, high nominal borrowing has been associated with high levels of real resource transfers to the economy. This has not always been the case. In many other countries, high borrowing was associated with world inflation and with private capital flight. Second, the additional resources have, for the most part, been used for investment. Third, the continued high per capita GDP growth suggests that rates of return in Thailand are high. Fourth, the economy has been diversifying output and exports by building up a substantial manufacturing base. These facts give the impression that behavior may have been appropriate, despite the rapid growth of debt. They highlight the key issues in assessing past borrowing:

- (i) how much should Thailand have borrowed?
- (ii) what were the costs and consequences of actual borrowing?
- (iii) what institutional features contributed to overborrowing?

Base Optimization Run and Reality

76. Dynamic optimization is used to derive the optimum path of the economy, using investment and net borrowing in each year as control variables. The terminal conditions, as described earlier, impose a balanced growth rate after the last period. Dynamic optimization, by definition, takes into account what happens throughout the simulation periods. The major features of the Thai economy and the world environment during the simulation period (1975-1981) are as follows.

The nominal world interest rates Thailand faced at the margin ranged from 8-9 percent during 1975-1977 to 11 percent in 1978 and finally 13.8 percent in 1980-1981. The Thais were paying 8.5 percent average interest on loans of official sources committed in 1981. International prices increased by at most nine percent annually, except for 1979 when they went up by 21 percent due mostly to the second oil shock. This external inflation eroded the real value of the stock of foreign debt, but it raised the cost of import, especially the cost of importing capital equipment. The world demand for manufacturing goods in general grew at a rate of four to six percent p.a., but a significant slow down was witnessed in 1981 as a result of the widespread recession among OECD countries.

77. The domestic environment was not so negative. Agricultural exports showed an encouraging upward trend. Rubber related exports increased in value from 3.5 billion bahts in 1975 to 10.8 billion in 1981. Non-processed agricultural exports went up from 6.9 billion bahts in 1975 to 14.2 billion in 1981. Rice remained the most important single agricultural crop -- exports rose from 5.9 to 26 billion bahts during the same period, supported by a slower growth of domestic demand than production. Under these conditions, what would have been the appropriate paths of foreign borrowing and investment? In order to answer this question, the model was solved sequentially: first, for the years 1975-1981, and second, for years 1978-1984. The second version was solved with the debt, labor and capital stocks of 1978 given by the first version as the initial conditions. This was done in order to

minimize the impact of too short a planning horizon. We therefore look at only 1975-1977 of the first version, and 1978-1981 of the second.

78. The optimal solution given by the model can be compared with actual behavior. To ease comparison, this latter is taken as the results of a recursive CGE simulation in which actual levels of investment and borrowing are exogenously inserted.^{1/} The results of the calibration exercise (paras. 52-54) show this to be a reasonable approximation. Figure 8 illustrates optimal and actual levels for key macroeconomic variables. In general, there is a close correspondence in the early years, 1975-77. If anything, Thailand could have borrowed more in these years given the low nominal and real interest rates. The extra borrowing would have financed more investment in order to enhance productive capacity in the future when international conditions would deteriorate. Consumption is very close to optimum levels during this period.

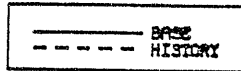
79. During 1978-1981, however, after the nominal interest rate rise, oil price hike, and the slow-down in world demand became apparent,

^{1/} The reason for not using actual history, as published for example in the World Tables, is that we must allocate statistical discrepancies and changes in stocks to the variables considered in the model. Also, we wish to compare price changes for which no historical series are available (see para. 54). Discussion of real figures is in 1975 prices.

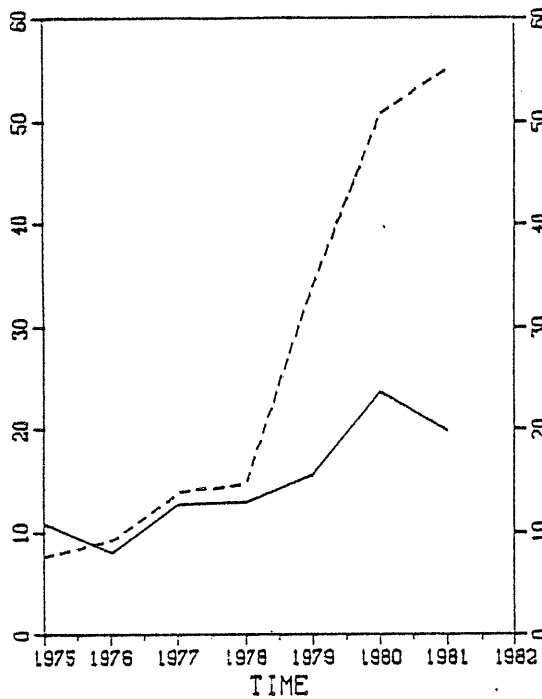
Figure 8

COMPARISON OF BASE RUN WITH HISTORY:

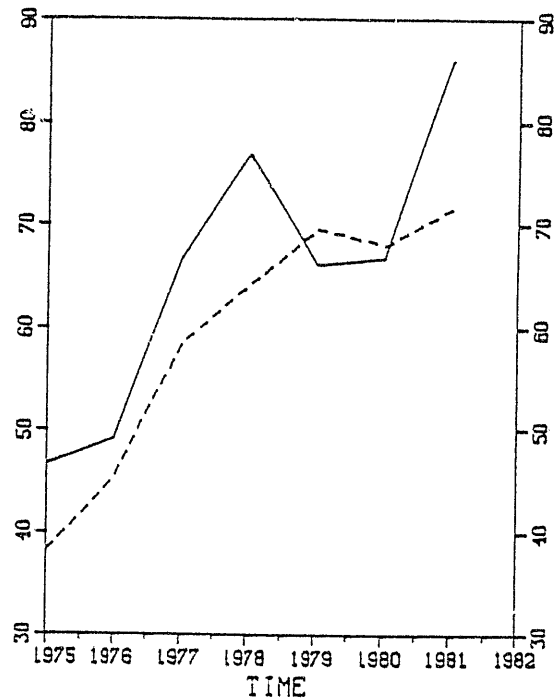
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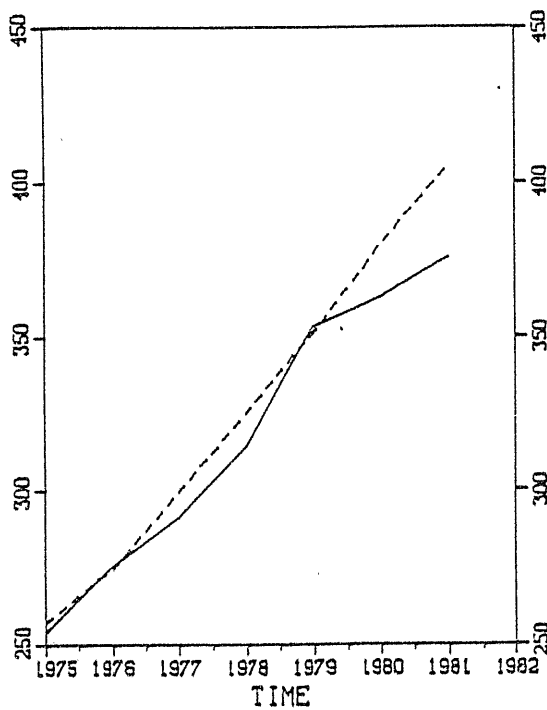
BORROWING



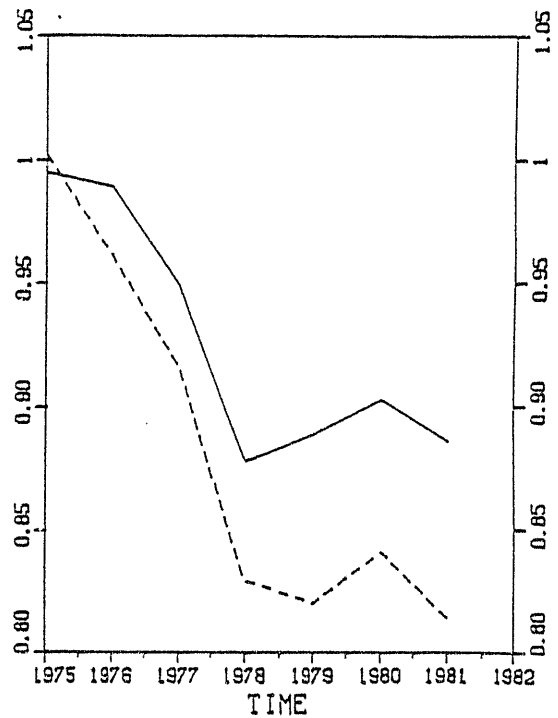
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



a significant divergence between actual and optimal behavior emerges. Foreign borrowing should have been 54, 53, and 64 percent below actual levels in 1979, 1980, and 1981 respectively. This reduction in foreign resources should have been translated into lower consumption, especially in 1980 and 1981. The shocks that impinged on the economy were permanent in nature and required an adjustment of consumption to sustainable long-run levels. Investment, on the other hand, is reasonably close to historical levels. A sharp fall is observed in 1979, reflecting both high international real interest rates and high costs of importing capital equipment. By 1981, however, investment recovers.

80. An immediate consequence of these changes, especially the low optimal borrowing levels, is to reduce the appreciation of the real exchange rate. The actual experience shows a sharp appreciation of about 17 percent between 1975 and 1978 and then stabilization at this level. In the absence of heavy borrowing after 1978, there would have been a depreciation that would have restored the real exchange rate to its 1975 level. This gradual depreciation after the external shocks hit the economy would have increased the labor force in the manufacturing sector and would have redirected the allocation of investment towards tradeables and away from non-tradeables. The result would have been production of tradeables some 17 percent higher than actual production in 1981. This would have supported a higher value of manufactured exports of 30 percent and lower competitive imports of 10 percent.

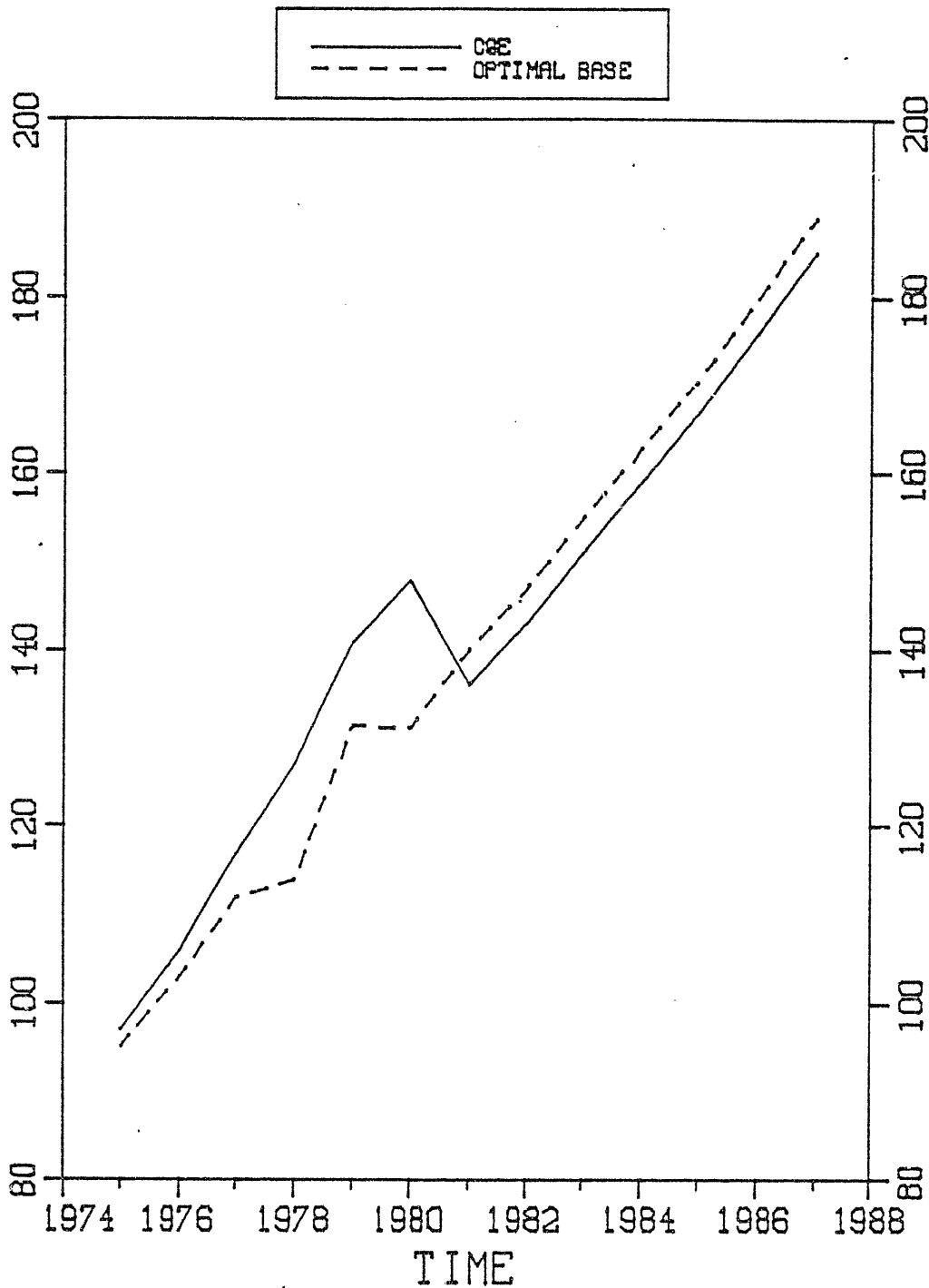
81. In order to generate the local and foreign demand for domestic tradeables, the price must be held below international prices. In our model, with a fixed nominal exchange rate, this can only be achieved by tight control of inflation. Not only must the level of the tradeable good price be held below international prices, but it must also increase relative to the non-traded goods sector to achieve the required shift of resources to the traded sector. As a result, the model solution shows significant lower inflation rates than actual levels. If these could not have been controlled through monetary policy, then equivalent relative price changes would have necessitated earlier nominal exchange rate devaluations.

82. A second consequence of excessive borrowing is the emergence of a significant debt overhang that must be serviced. Along the optimal path, the debt/exports ratio would have risen gradually from 0.53 in 1975 to 0.67 in 1981. In reality, it reached 0.8 in 1981. Although this permitted higher consumption during 1979-81, it jeopardizes the future long-run sustainable level of consumption. This point is illustrated in Figure 9. If we assume that the economy were to reach a balanced growth rate in 1981, then the associated level of consumption would have to fall from its 1980 value, before resuming an upward trend. On the other hand, in the optimal solution, the capital stock is higher than actual by 1981 while debt and debt service obligations are substantially lower. Thus, the long-run sustainable consumption path is correspondingly higher. This more than offsets the reduced welfare in

Figure 9

Real figures are in 1975 billion bahts

OPTIMAL MODEL AND CGE WITH SAME OPTIMAL CONDITIONS: CONSUMPTION



1979-81, when historical consumption exceeds optimal levels by three to ten percent.

History Reexamined

83. The previous section shows that Thailand's actual borrowing and investment strategies diverged from those produced by a full-information optimization solution. The divergence has different characteristics in two sub-periods, 1975-78 and 1979-81. In the former, borrowing was about right but the mix of domestic expenditure was tilted towards consumption and away from investment. In the latter period, borrowing was too high, helping to finance continued consumption growth and an over-appreciated real exchange rate, rather than contributing to the higher investment which would have been warranted to achieve structural adjustment. This section examines the possible sources of the divergence between actual and optimal borrowing strategies. There are three. First the optimization model assumes full information. That is, the proposed strategy is generated with the advantage of hindsight. This may be unreasonable in reality. Policy makers may have found that actual events deviated from their ex ante perceptions. We consider three likely forecasting errors: failure to anticipate (i) the rise in interest rates from 1978 on; (ii) the surge in global inflation associated with the 1979 rise in oil prices and (iii) the slow-down in world trade growth as the OECD business cycle turned downward. Second, it is possible that even after these events happened policy-makers failed to perceive the nature of the shock correctly. Expectations that the changes in interest rates and world trade were temporary phenomena,

rather than the medium-term phenomena that they have proven to be, could have been a second source of error. Third, it is possible that Thailand may have had certain non-economic objectives, such as the avoidance of political difficulties that might have followed a strategy in which national consumption was reduced to achieve adjustment to external shocks. Each of these requires specification of a different set of assumptions under which borrowing and investment strategies are chosen. These are discussed below.

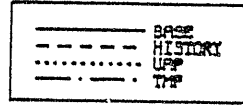
External disturbances

84. Higher interest rate. Figure 10 shows the effects of expecting, in 1975, that nominal interest rates in 1978 and thereafter would be one percentage point below actual levels. The initial impact is to increase borrowing during the period 1975-77. This is because of lower expected future costs of servicing the debt and, correspondingly, higher national income. On average, annual foreign borrowing would have been higher than in the base solution by \$150 million. Most of this would have gone to finance higher consumption. Investment levels would have been barely affected. This is because of two opposing tendencies. On the one hand, lower expected interest charges tend to raise the incentives to invest. But, on the other hand, the higher levels of borrowing lead to an appreciation of the real exchange rate and a rise in real wages, reducing the profitability of new investment.

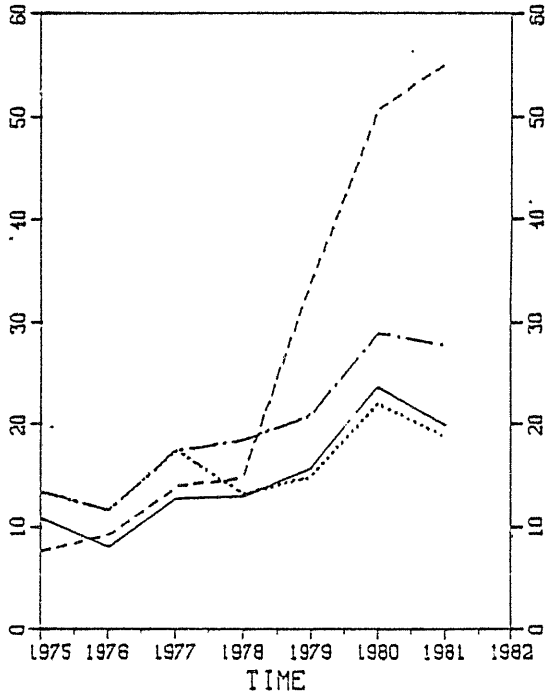
85. Once interest rates rise in 1978 above their anticipated level to the actual level, the impact is greater. We assume, first, that policy-makers correctly perceived the rise in interest rates to be the first stage of an era of higher world interest and adjusted up their

Figure 10

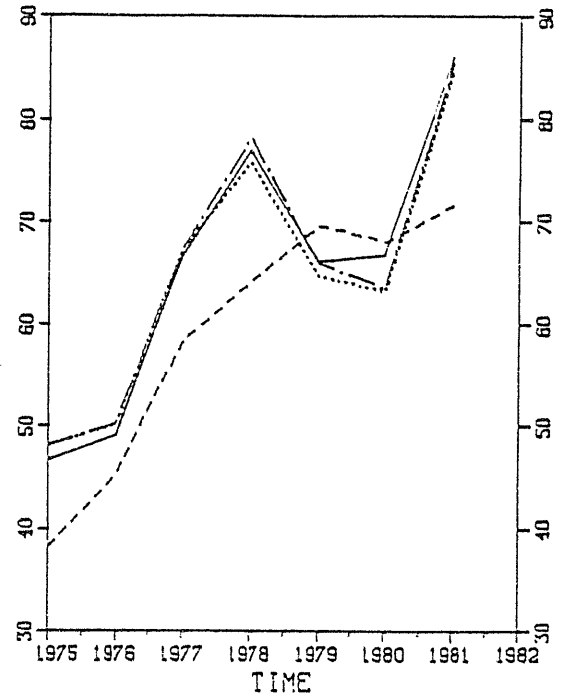
LOWER EXPECTED INT. RATE:
Real figures are in 1975 billion bahts



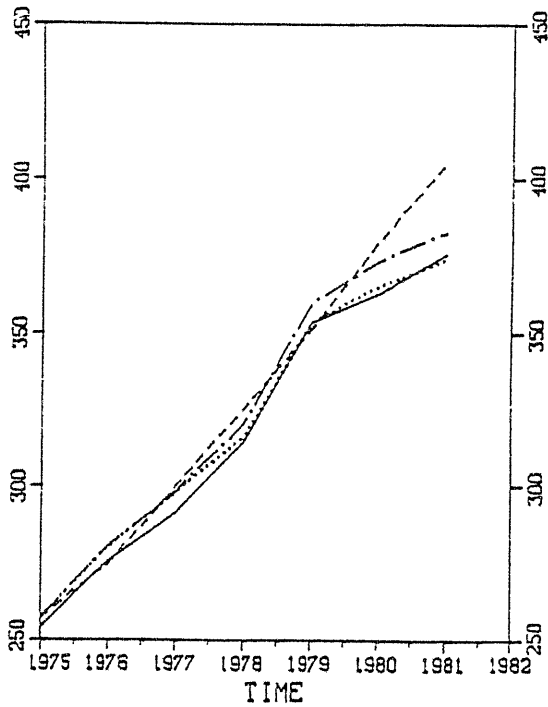
BORROWING



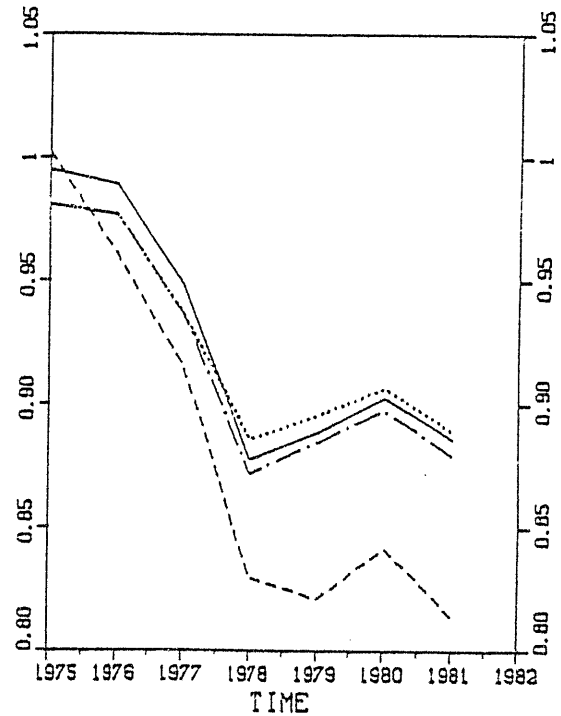
INVESTMENT



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expectations of future interest rates as well (denoted as UAP in figures). Then, borrowing and consumption would have immediately adjusted down to the base case levels. Although there would be an overhang of excessive debt because of the forecasting error, there should not have been any tendency to rectify this by a period of underborrowing. To meet the higher interest payments, however, resources would have needed to shift into the traded goods sector. This would be achieved by reversing the appreciation of the real exchange rate.

86. If, on the other hand, the interest rate rise was perceived to be temporary, (denoted as TMP in figures) with no change in expectations of future interest rates, then the pattern is one of delayed adjustment. We assume that each year, borrowing decisions are made on the basis of expected future interest rates one percentage point below actual levels. Consumption remains higher than the base solution, and higher than the case where the interest shock is considered to be permanent. This is financed by higher foreign borrowing of almost \$250 million per year. Again, investment is unaffected by the forecast error. The real exchange rate, however, becomes more overvalued, to accommodate the higher borrowing and consumption levels. Thus, resources continue to be misallocated away from the manufacturing sector. In summary, the failure to treat higher interest rates as a medium-term phenomenon partly explains the overborrowing in 1978-80.

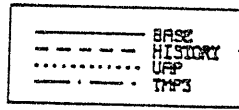
87. Slower world trade growth. World demand for Thailand's manufacturing exports grew at seven percent annually in 1975-78, but only four percent from 1978-81. Assume that policy-makers anticipated

higher volumes of world trade than actual, by ten percent in each year after 1978. How would the borrowing and investment strategies have looked? Figure 11 shows the results. Consider first the early period 1975-78. Actions are affected by the anticipation of high future world demand for exports. Accordingly, investment rises even higher than the base solution (which in turn exceeded historical investment), to build up capacity in manufacturing. At the same time, the rate of appreciation of the real exchange rate is slowed down, again helping to divert resources to tradeables production. Consumption remains essentially unchanged. The extra investment is fully financed by additional foreign borrowing, so that although output grows over time, debt servicing requirements also rise leaving national wealth unaffected.

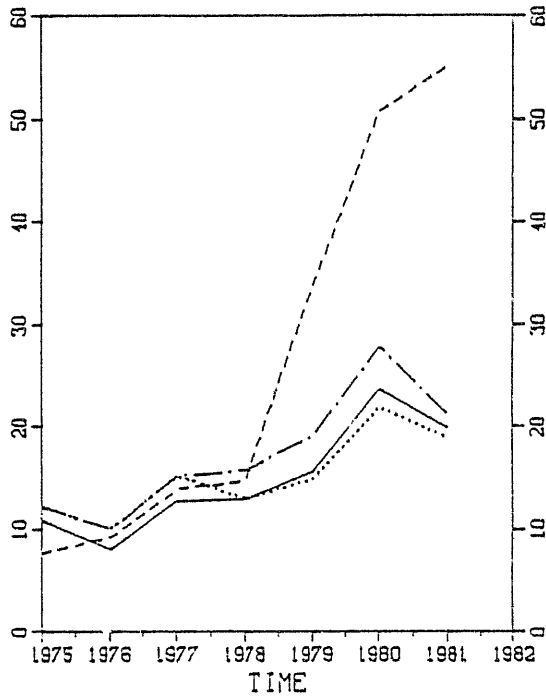
88. When the high world demand fails to materialize in 1978, adjustment must occur. Again, assume first that expectations of future world demand are also revised down (UAP in figures). The economy is left with an excessive stock of debt, but with a production capacity biased towards tradeables. This mitigates the need for structural change. The burden of adjustment falls on investment, the level of which drops sharply below the previously planned target. New borrowing, too, is cut back to the base solution levels. Thus, although the value of exports and the growth of exports are both severely affected by the shortfall in demand, the deficit and new borrowing do not grow. Reductions in absorption (investment) and switching policies through an exchange rate depreciation bring imports down.

Figure 11

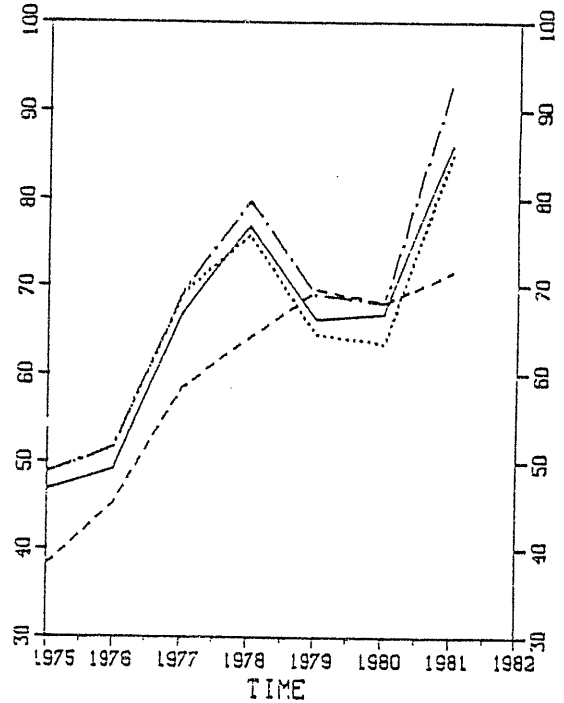
HIGHER INT. DEMAND EXPECTED:
Real figures are in 1975 billion bahts



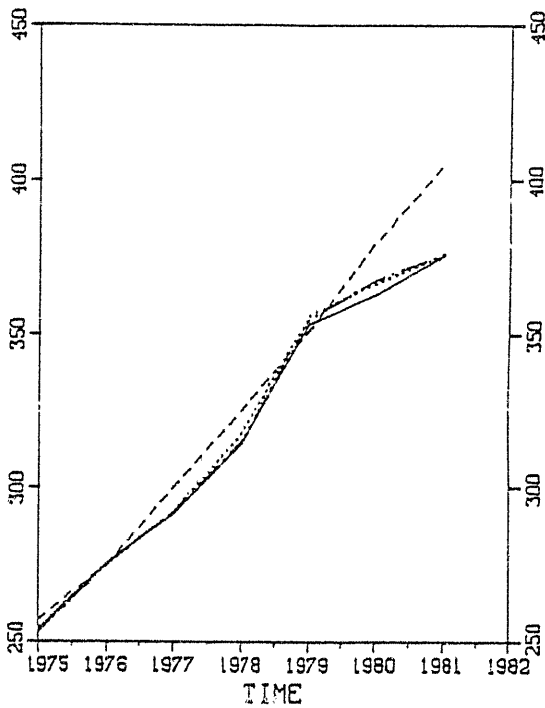
BORROWING



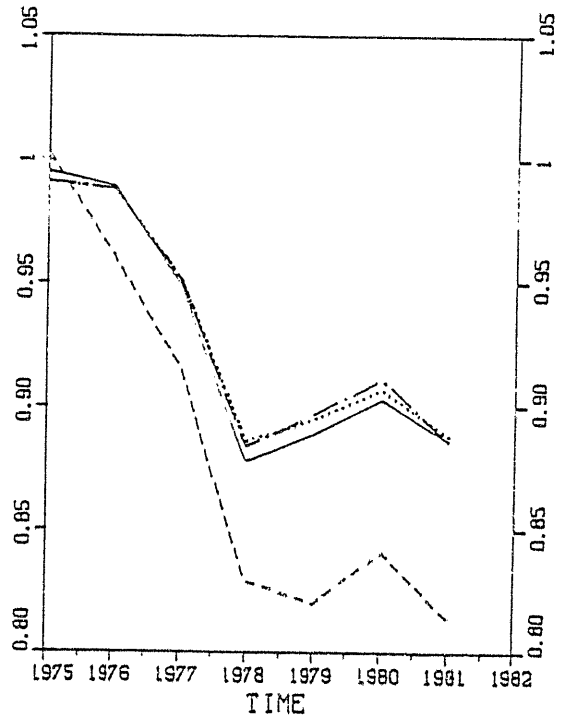
INVESTMENT



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89. This scenario changes significantly when the world slow-down is believed to be temporary. Assume now that policy-makers viewed the slow-down as a transitory phenomenon associated with a global business cycle of three years duration, which would be reversed thenceforth (TMP3 in figure). Then investment continues to rise even after the dip in world demand. This is partly financed by domestic savings and partly by higher foreign borrowing. The growth rate of debt shoots up, predicated on high expected future exports. This simply represents the traditional maxim that one should borrow through a temporary shock. What is of interest here is the magnitude of such borrowing. Even in the face of a substantial unanticipated "temporary" short-fall in world demand, it is difficult to justify Thai borrowing levels in the amounts prevailing in 1979-81. At the same time, a shock of this nature does not help to explain the deviations of consumption and investment from their optimal paths. On the contrary, the higher borrowing would have been associated with even higher investment than in the base solution.

90. Higher import prices. Fuelled by the rise in oil prices and the adjustment policies followed by the OECD countries, import prices, including those for capital equipment, rose steeply in Thailand. From 1975-78, the rise in the import unit value index was 6 percent; from 1978-80 it was 14 percent, and then stabilized in 1981. We simulate the initial expectations of import prices as a constant rise of seven percent from 1979 on. This means that prices were expected to be lower than actual by 13-14 percent in 1979 and 1980. The effects are of two kinds. First, there is an anticipation of better terms of trade for the

country, and hence a presumption of higher national wealth. Second, there is an expectation that the cost of imported, non-competitive capital equipment, a key component of investment, will rise at a slower pace in the future. This encourages investors to delay the installation of fixed capital.

91. The results are shown in Figure 12. The impact on the early years, 1975-78, is to lower investment, and raise consumption. The latter is due to the higher perceived wealth. One consequence is an appreciation of the real exchange rate, despite a decline in foreign borrowing associated with lower investment. These shifts bring modelled consumption and investment behavior close to the historically observed patterns.

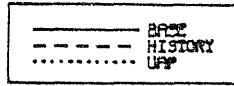
92. Once higher prices are observed in 1979, an adjustment is required (UAP in figure). With future expectations of world import price inflation raised, it becomes attractive to raise investment slightly above base run levels, and close to historical levels. Foreign borrowing also increases somewhat to finance this. The combination of higher investment and foreign borrowing lead to initial appreciation of the real exchange rate, but this serves to accentuate the future expected depreciation and is instrumental in directing resources towards manufacturing.

Consumption Constraint

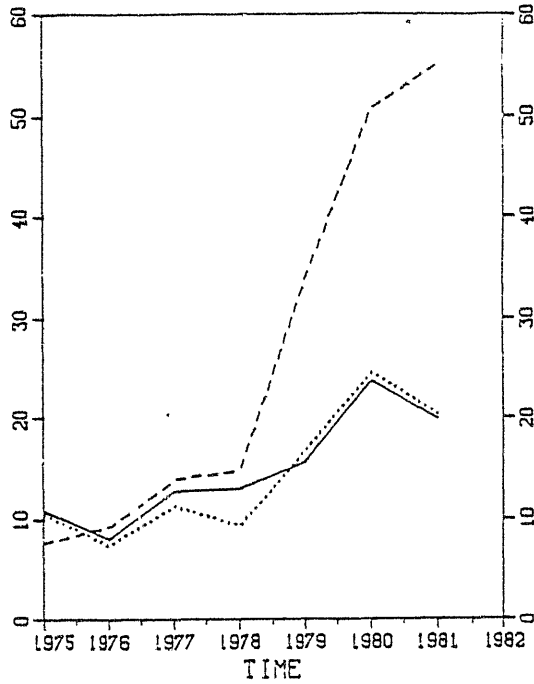
93. One feature of the base case scenario is that per capita utility declines relative to the previous year in 1978, 1980 and 1981. This may be politically difficult to achieve. Alternatively, our

Figure 12

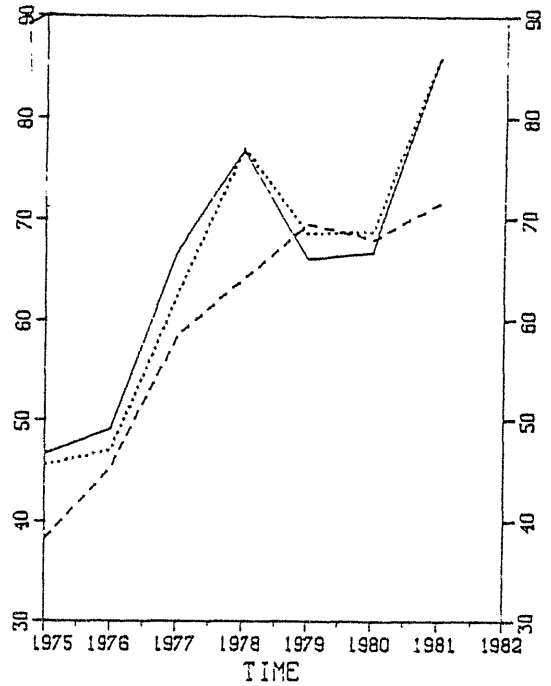
LOWER EXPECTED IMPORT PRICE
Real figures are in 1975 billion bahts



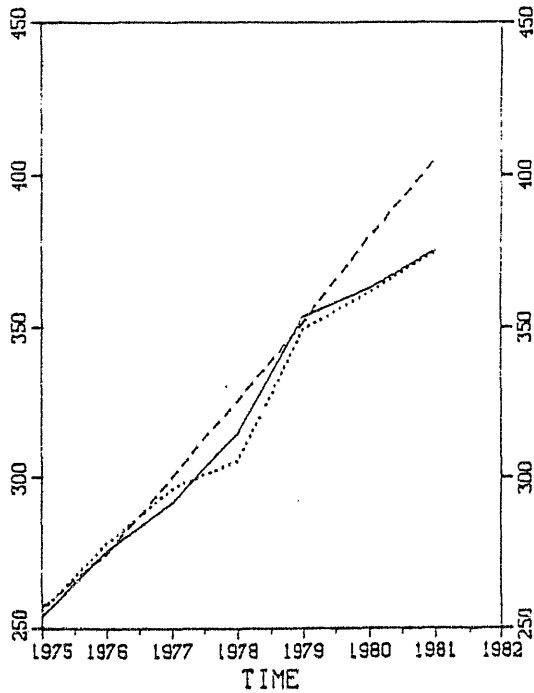
BORROWING



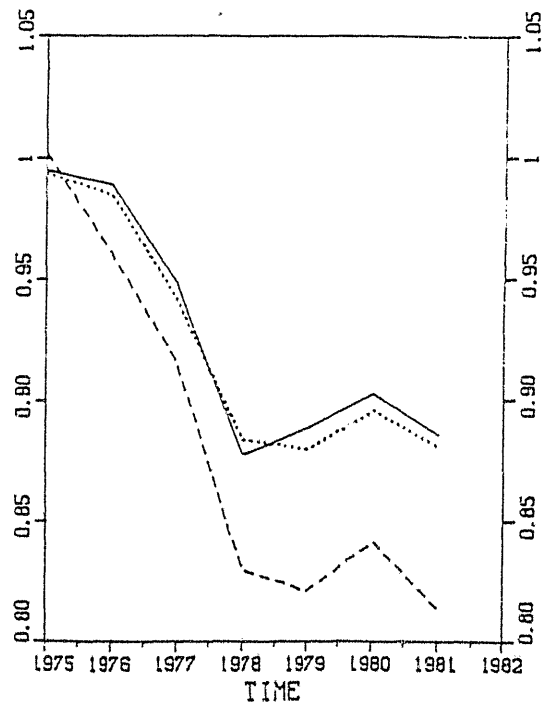
INVESTMENT



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assumption of an additive, separable utility function may be too strong. Accordingly, we impose a constraint that forces per capita utility in each year to grow by at least 1.6 percent over the previous year. This precludes flexible adjustment to disturbances by an abrupt reduction of consumption. The new solution to the constrained optimization problem is shown in Figure 13. Consumption and investment are now closer to historical levels. Given foreknowledge of the constraint, the solution leads to a slow-down in the growth rate of consumption in 1979, but leads to higher consumption than the base case in 1980 and 1981. This is financed by lower investment, however, and not by increased foreign borrowing; the latter is even lower than in the base case.

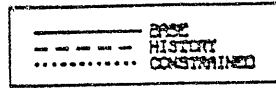
Historical Summary

94. For the most part, Thailand's borrowing and investment strategies appear to have been close to optimum levels. This is particularly so in the early years of high non-concessional borrowing, 1975-78. The rapid build-up of debt during this period was justifiable given the prevailing low real interest rates and high returns on domestic investment. Although the pattern of domestic absorption seems slightly tilted towards overconsumption and underinvestment, this is readily explained by reference to excessively optimistic expectations about future developments, either on interest rates, world demand or import prices. Thailand would have borrowed more and consumed more had they anticipated lower interest rates, lower import prices or higher export demand towards the end of the decade. They would have invested

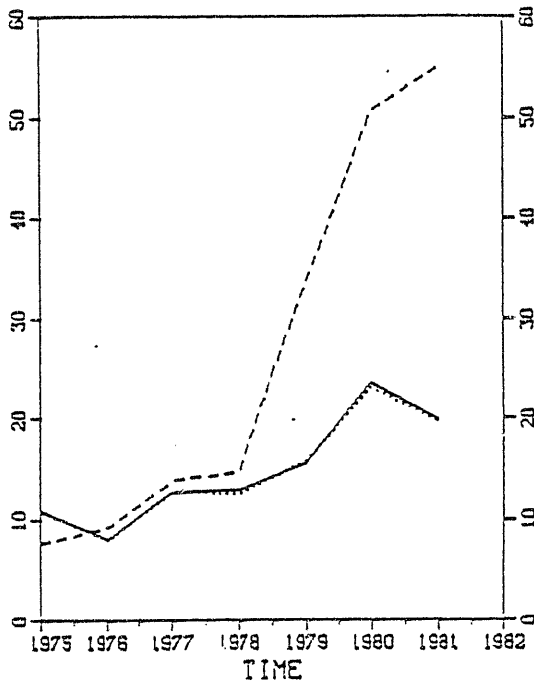
Figure 13

FORCED GROWTH IN CONSUMPTION:

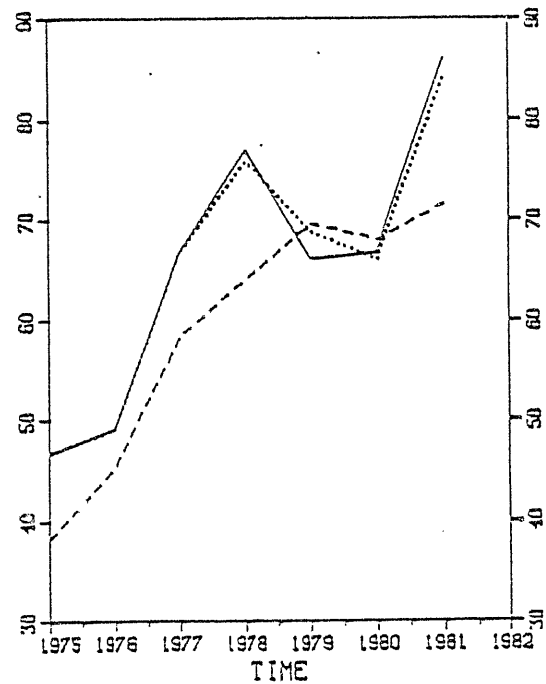
Real figures are in 1975 billion bahts



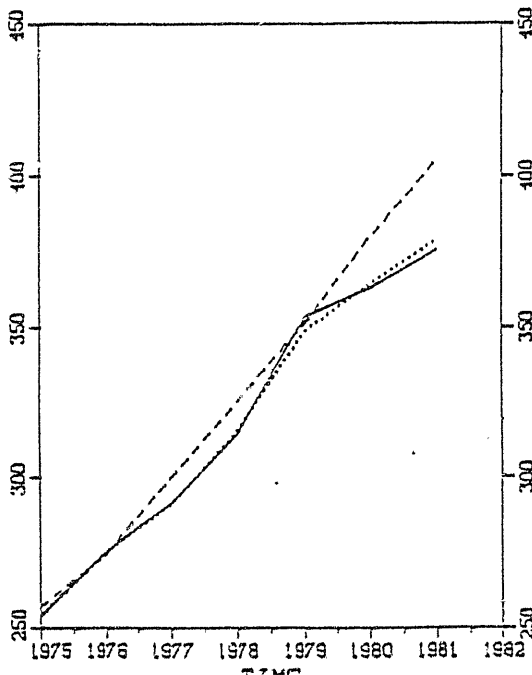
BORROWING



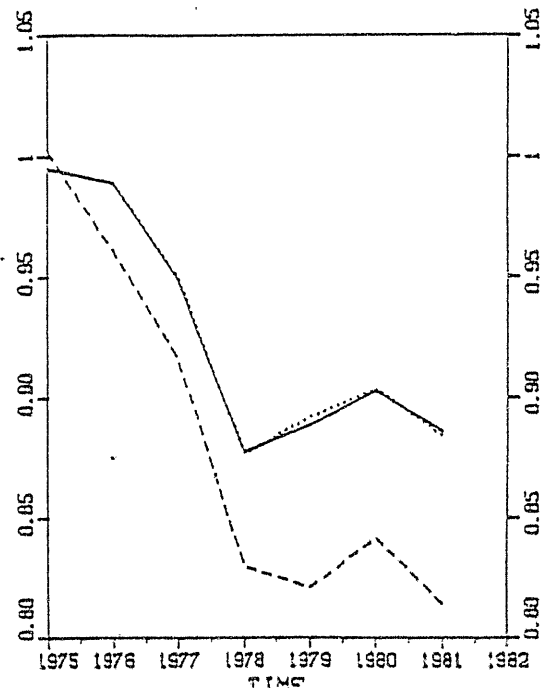
INVESTMENT



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less had they failed to anticipate the rapid rise in the prices of imported capital equipment that was to occur in 1979-80.

95. Thus, Thailand entered a period of a volatile, and adverse, world environment with slightly less capital stock than desirable. In addition, because of the appreciation of the real exchange rate due to overconsumption, the distribution of this capital stock was biased towards the non-traded sector and away from manufacturing tradeables. This made the economy more vulnerable to the subsequent external shocks.

96. During the second sub-period, 1979-81, a marked divergence emerges between optimum strategies and historical paths. Given the deterioration in world conditions, consumption and foreign borrowing should have been reduced and investment stabilized to achieve an adjustment of productive capacity. In addition, a sizeable real depreciation of the baht was desirable. Such adjustments, however, never did occur. Foreign borrowing and consumption accelerated. Investment rose at a more moderate pace than desirable. The magnitude of this divergence, especially with respect to consumption and foreign borrowing, cannot be easily explained by forecasting errors, as in the earlier period. Simulations with unanticipated shocks show a pattern of adjustment similar to the perfect foresight case. Despite the slight ex post facto mistakes in the early period, the new borrowing and investment strategy should quickly converge to the base solution: that is, stabilized investment, with a sharp switch in its financing towards domestic sources (reduced consumption) and away from foreign borrowing.

97. Two alternative explanations for the historical evolution of the macroeconomy are presented. The first is that despite evidence that global conditions were deteriorating, Thai policy-makers failed to revise their expectations about the future, treating high interest rate and low world demand changes as temporary phenomena whereas they have proven to be of a medium term nature. However, while mistaken perceptions on the permanent or temporary nature of high interest rates would help to explain foreign borrowing and consumption behavior, they would also imply a greater divergence between simulated and actual investment. A similar inconsistency emerges in explanations of past behavior that focus on a perceived temporary slow-down in world demand. This can, therefore, only be part of the full explanation.

98.. The alternative story suggests that non-economic factors, or nonoptimizing behavior, were important in this period. One feature of the desired adjustment path in several years (1978, 1980, 1981) without any expansion in per capita consumption. This may not have been possible to achieve politically. The imposition of an arbitrary constraint on adjustment that forces per capita utility to rise by at least 1.6 percent generates a solution with higher consumption, but without higher borrowing.

99.. The difficulty in explaining the high levels of foreign borrowing in 1980 and 1981 partly suggests that market forces, on which our model behavior rests, were being distorted by government policy. Several features of this period stand out. The results clearly show that a desirable program of adjustment to the adverse world development

should have included a depreciation of the real exchange-rate. The historical real exchange rate was overvalued by about ten percent. An official objective, however, was to retain the system of a fixed nominal parity of the baht against the dollar. When this system came under pressure, reflected in a run-down of reserves, the government failed to take adequate measures to reduce balance of payments pressure by a more austere fiscal stance. Instead, loose fiscal policy, and a growing overall public deficit, were supported by heavy public foreign borrowing especially by state enterprises. It was only when fears of the problems associated with rapidly rising indebtedness became acute that action was taken to devalue the baht and reduce public external borrowing. Thus, foreign borrowing was not the result of a decision on least cost sources of finance in this period. The authorities did not internalize the rising cost of external borrowing into their decision-making, and failed to substitute these funds with lower cost domestic resources.

IV. STRATEGIES FOR THE FUTURE

100. This section present medium-term borrowing and investment strategies for the future, based on the parameters calibrated for the past. The successful performance of the model in explaining past behavior and in generating borrowing and investment strategies that look reasonable from an ex post perspective generates some confidence that the results for the future are not too sensitive to arbitrary choices of the parameters. Nevertheless, the main purpose of this section is to

explore the qualitative magnitudes of changes in response to unanticipated disturbances, rather than to make projections of what will or should occur. Our simulation period covers 1985-92, which includes the entire Sixth Plan. We first proceed to describe the risk-return trade-off, then choose one point as the base case and finally discuss the modifications in the strategy as exogenous conditions change.

The Risk-Return Trade-Off

101. The analysis of the past was conducted under conditions of certainty that credit availability would be forthcoming from lenders. This is a reasonable approximation for that period, both because of the high liquidity in the international banking system and generally favorable track-record of developing country loans and because Thailand was a small borrower from international capital markets relative to the size of its economy and its exports. These factors are no longer representative of the actual situation. Concern over preserving market access in the future is an important determinant of the borrowing strategy.

102. The availability of funds is ensured in our model through the incorporation of a lending constraint. This is based on the balance of payments and government revenue positions in the balanced growth state. The former is a re-statement of the terminal conditions. It states that lenders will be prepared to lend as long as the net present value of their debt tends to zero.

$$\lim_{t \rightarrow \infty} D(t) e^{rt} = 0$$

The balanced growth conditions give us the path of debt over time as a function of debt outstanding in the terminal year of the planning horizon. The lenders' transversality condition then simply implies that the balanced growth increase in the stock of debt be less than the interest rate. Lenders will also, however, take note of the government's fiscal position. ^{1/} If debt service can only be met by continued net resource transfers from lender to the government, then the expected value of the outstanding debt is low. Thus, we force the surplus of the government sector (tax revenue plus net new borrowing minus expenditure minus interest payments) to be greater than an arbitrary constant along the balanced growth path. Coupled with the lenders' transversality condition, this ensures that the expected value of debt at the end of the planning horizon equals its nominal value and, hence, given risk-neutral lenders, that new funds will be made available along the transition path. The arbitrary constant of the government revenue surplus can be thought of as a measure of the risk of the end-period debt. The higher its value, the shorter the time horizon until debt could be paid off and the less risky it is. In turn, less risky

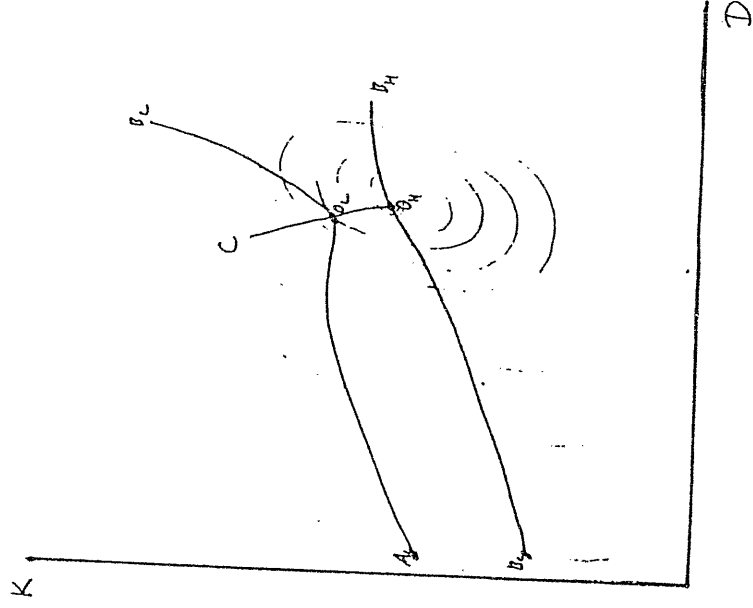
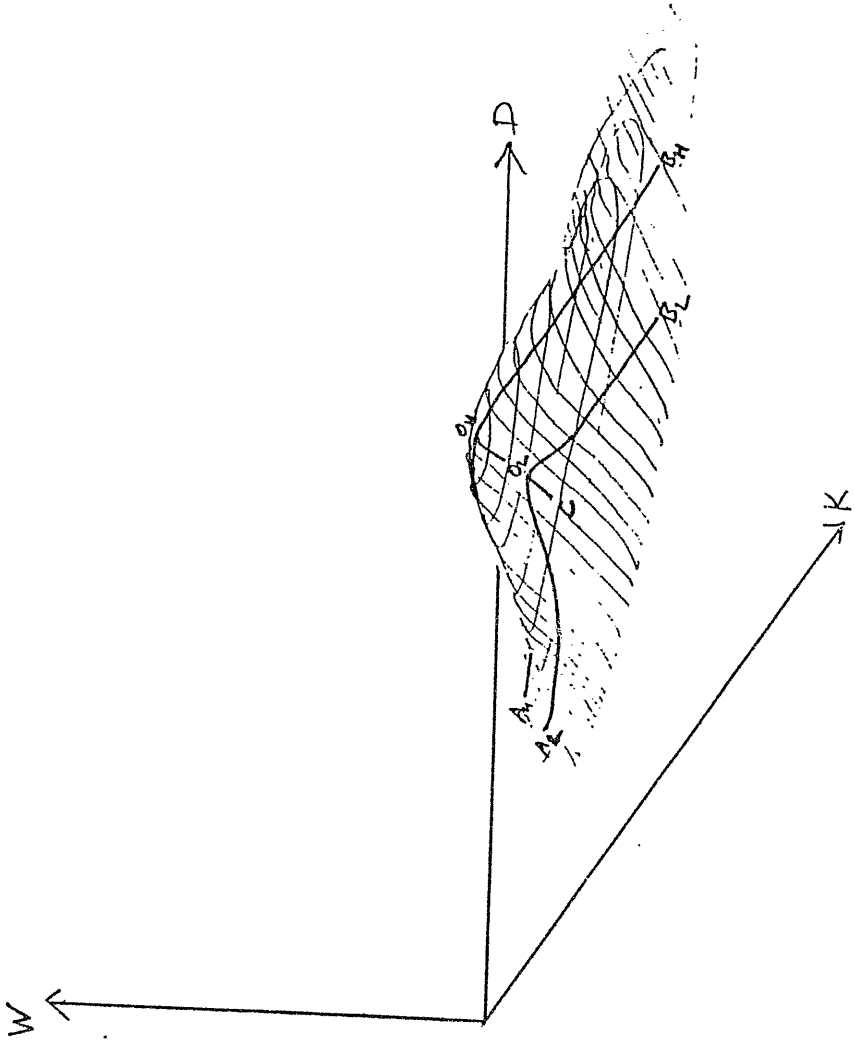
^{1/} Econometric work (Kharas and Shishido, 1984) indicates the significance of this in actual lender behavior.

future debt implies less risk of lenders not making available the funds required over the transitional path.

103. Figure 14 shows welfare as a function of the borrowing and investment strategies chosen. These are summarized by the outstanding debt and capital stocks in the terminal year. For any given level of debt, welfare increases as the capital stock increases upto a certain point and then diminishes as overinvestment occurs. Conversely, for any level of investment, welfare rises with higher borrowing up to a point after which diminishing returns set in. Our formulation of the lending constraint permits us to define risk explicitly as a function of the end-period capital and debt stocks. In general, higher capital stocks and lower debt result in lower risk.

104. By exogenously changing borrowing levels, and devising the optimal level of investment associated with each level of borrowing, we can trace a sequence of debt-capital coordinates that keep the level of risk constant. $A_H - O_H - B_H$ is the iso-risk curve when the risk parameter value is such that the lending constraint is never binding. Clearly, the economy tends to O_H by trying to maximize welfare, for the given risk level. Similarly, $A_L - O_L - B_L$ is an iso-risk curve that is associated with the lower risk level of our choice. This curve is where the hyperplane formed by the lending constraint cuts through the welfare surface. It shows that an even larger amount of investment is required for a country to stay on the same risk level when it overborrows. Once again, the economy chooses the point O_L through welfare maximization. The points O_H and O_L explicitly characterize

- 91 -
Figure 14



the optimal risk-return trade-off. The line $O_H - O_L - C$ is a sequence of such optimal levels of debt-capital mixes at varying levels of associated risk.

105. Two characteristics of O_L are worth noting. First, it will never be at the unconstrained welfare optimum, O_H . The intuition is straightforward. At this level of borrowing and investment, a small decline in borrowing and/or increase in investment will lead to no change in welfare (by definition of the optimum) but a reduction in risk. If risk minimization is valued, some movement in this direction is called for. This provides an important justification for active government macroeconomic management. In a pure laissez-faire environment, individual maximizing agents would end up at O_H because no individual takes into account macro issues, such as national creditworthiness preservation, in making decisions. Second, risk aversion implies that for any given level of borrowing, investment will be higher than the unconstrained welfare maximizing level. Conversely, for any given investment, borrowing will be lower than the welfare maximizing levels. Thus, O_L cannot fall anywhere in Figure 14, but lies within a much narrower range, i.e., along $O_H - O_L - C$. This implies that the failure to incorporate uncertainty explicitly is unlikely to alter dramatically the qualitative properties of the solution.

The Base Case

106. The base case results from the choice of an arbitrary parameter to reflect risk. It is also conditional on domestic and external

conditions. ^{1/} The model parameters are the same as in the history run, with minor changes. The Hicks-neutral production coefficients are fixed at the 1979-81 average levels. Initial values of the capital stock in each sector for 1985 have been derived by extending the recursive CGE simulation between 1981-85 with investment and foreign borrowing fixed at historical levels.

107. The modeling framework developed can be used to determine borrowing and investment. The period chosen is 1985-1992. We can carry out our analysis within the framework and policy objectives of the Sixth Five Year Plan because our future simulation period includes the Sixth Plan Period entirely. We first proceed to describe the base path projected by the extension of the model used for examining history. We then examine the change in the solution depending on changes in assumptions of the future world environment (world interest, commodity prices and trade volume) and domestic factors.

108. As in the case of the analysis of the history, the future borrowing and investment path depends crucially on how the exogenous domestic and world variables are expected to evolve. Rubber and

^{1/} The latter are identical to the assumptions used in World Bank country economic projections, e.g, May (1985).

nonprocessed agricultural exports are exogenous, their values are taken from Bank staff projections of volume and price. They grow at an average nine percent nominally and two percent real. Manufacturing exports include all nontraditional manufacturing exports and the products of food processing industry. We assume that the world demand schedule for these exports will grow at 10-12 percent per year in real terms at each relative price.

109. World prices of foreign manufacturing goods are taken from international price indices (IPI) estimated by Bank staff. The IPI goes up by nine percent in 1985, then falls to six percent and stabilizes at four percent. The World nominal interest rate on nonconcessional loans is 11.8 percent; official loans carry a 4.5 percent interest charge. The volume of official loans fixed at around 6-700 million US dollars. The cost of adjustment parameter on foreign borrowing (v_b) is assumed to be 0.4, about half of what was used in the history model. This reflects the development the Thai domestic financial sector, which is now able to handle much larger amounts of debt without incurring further cost. The nominal exchange rate is pegged at 26.5 bahts/US dollar. The supply of natural gas is taken to be lowest of the various projections currently made, with the dollar price per standard cubic feet fixed nominally at present levels. This gives a pessimistic picture. Higher gas values are analyzed through sensitivity analyses.

110. Based on these assumptions, the macroeconomy should evolve as follows:

Foreign Borrowing: The current account deficit would be 5.3

percent of GDP in 1985, the same as in 1984 reflecting the rise in investment that is expected following the improvement in competitiveness created by the recent devaluation. This deficit will be rapidly reduced over time. In the balanced steady growth state the deficit would be 1.2 percent. This, in absolute terms, means a decline of net new borrowing (gross borrowing - principle repayment) from 3.3 billion US dollars in 1985 to 2.3 billion in 1992. The debt-to-export ratio starts at 1.13 in 1985, peaks at 1.15 in 1986, then quickly falls a steady-state level of 0.76. Net transfers (net borrowing less interest payment) are negative from 1989. This is an inevitable stage in the debt cycle. Promoting positive net resources transfers through higher borrowing would not be justifiable.

Growth: GDP would expand at the average rate of 7.5 percent p.a. High levels of capital formation support this growth. The growth rate of the tradeable sector (manufacturing) is consistently high at around nine percent p.a. With the initial large foreign capital inflows, however, the real exchange rate appreciates, raising the profitability of the nontradeable (service) sector. Over time, as new borrowing falls and debt service mounts, the real exchange rate must depreciate. Then, growth in the manufacturing sector accelerates, while it slows down in the service sector. The share of manufacturing sector value added in current GDP, therefore, rises from 20 percent to

27 percent in 1991. This structural change is a necessary consequence of effective use of foreign borrowing.

Trade: The inability of Thailand to continue receiving positive net resource transfers from international capital markets implies that its trade position must also narrow sharply, despite continued expected growth in non-factor service inflows. Exports must expand strongly. The share of exports in GDP would grow from 17 to 25 percent by 1991. Thailand is, however, still dependent on agriculture for two-thirds of its exports. The potential for further expansion is limited. Thus, it is manufacturing exports that must rise. Real growth in these averages between 14-19 percent, considerably faster than world demand. This can only be achieved, therefore, by compressing domestic price increases for manufactures below world price increases by three - four percent per year. A variety of export promotion policies, including active exchange-rate management, would be required to generate this sustained improvement in competitiveness. Imports would grow as well, but slower, in real terms, than GDP. Competitive manufacturing imports would grow by 6-7 percent reflecting a limited amount of import substitution. Because of the need to generate a real depreciation, however, the value share of imports would continue to rise slowly from 20 percent to 24 percent by 1991.

Private Consumption: Private consumption grows in real terms by six percent p.a.; 1.5 percent less than the average of GDP growth rate p.a. This is because, with the rising debt service obligations and the narrowed resource gap of the economy later in the simulation, domestic savings have to finance an increasing share of investment. Real depreciation helps achieve this end. The consumption of tradeables as a result increases even more slowly; annually compared to 9.2 percent for nontradeable consumption.

Public Finance: Government revenue from domestic sources consists of income taxes indirect taxes, and tariffs on competitive imports. All these are fixed at historical average ad valorem rates. The share of the revenue in total GDP is, therefore, relatively fixed at 16 percent throughout the simulation. Government consumption on the other hand is exogenously given and grows at five percent annually in real terms. For accounting purposes, public investment is assumed to be one-third of the total domestic capital formation. The net foreign transfer to the public sector declines quite rapidly as new borrowing drops and debt service obligations accumulate. Consequently, the aggregate public surplus, tax revenue plus borrowing less government consumption and investment, minus debt service payments, shows a rapid decline.

The Laissez-Faire Solution

111. The base path of the future described above incorporates some public intervention to reduce the risk that credit markets will suddenly

stop lending to Thailand. By constraining the present value of the long-run net public sector income to be nonnegative, it is effectively constraining the amount the country can borrow. What happens in the absence of such considerations is now explored (Figure 15).

109. Thailand would borrow six percent more foreign loans in 1985 or an increase of 225 million U.S. dollars. The current account deficit is now 5.5 percent of GDP; the ratio goes down to 1.3 percent in the balanced-growth-state. Investment declines, despite the higher borrowing. Consequently, consumption in 1985 through 1991 would be about 1.4 percent higher, although the long-run consumption would be 0.3 percent lower than the base path because of a lower capital stock and higher debt service obligations. The debt stock in the terminal period is 7.4 percent higher than in the nonconstrained case, and the aggregate capital stock (simple arithmetic sum of sectoral capital stocks) is 0.5 percent lower. The real exchange rate naturally appreciates relative to the base. This is also reflected in the shadow price of foreign exchange which falls by four percent. Thus, exports grow slower and imports faster than in the previous example. Public finances also deteriorate because of higher debt service payments and lower revenues due to slower growth. Thus, both public finances and the balance of payments are more dependent on foreign capital inflows, while demonstrating less capacity for servicing the debt. The strategy is, accordingly, riskier.

Possible Future Shocks and Policy Changes

112. The base path was derived given certain assumptions about likely world conditions. But Thailand is susceptible to exogenous disturbances. Domestic policies may also be changed. We examine the

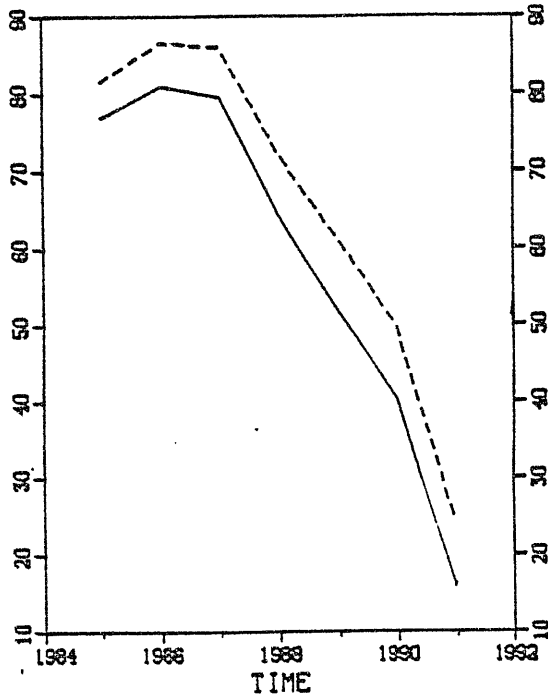
Figure 15

WITH AND WITHOUT LENDING CONSTRAINT:

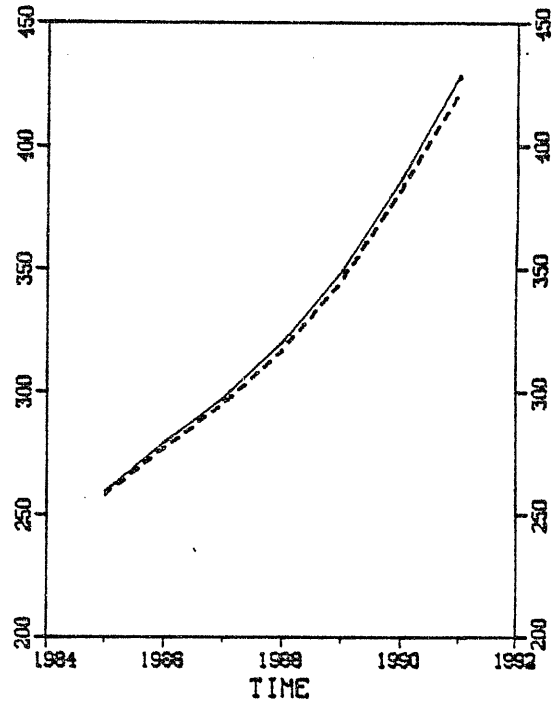
Real figures are in 1975 billion bahts



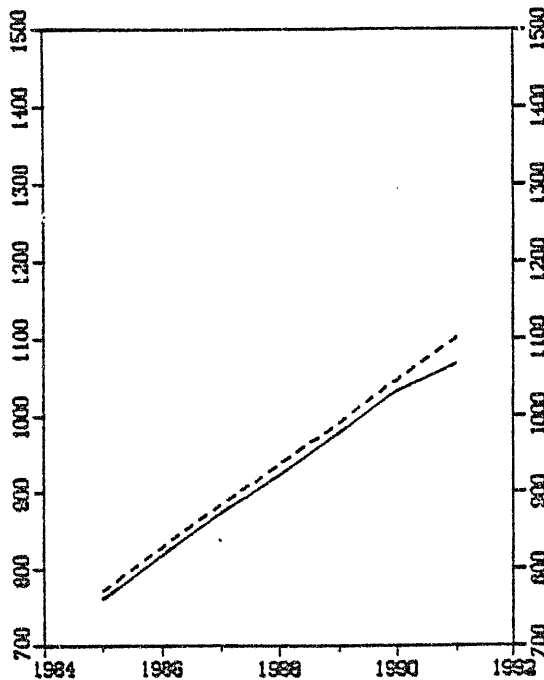
BORROWING



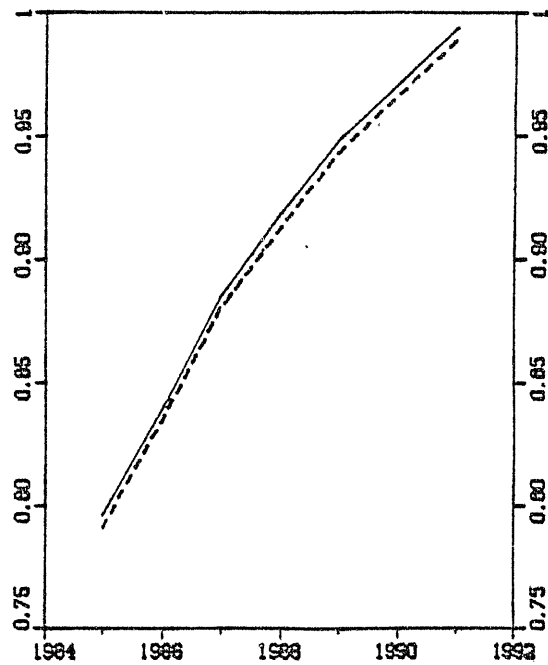
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



influence of external and internal shocks, and domestic policy changes on borrowing, investment, consumption, and the real exchange rate. We consider the following changes starting in 1986.

External Shocks

- (1) change in world interest rates
- (2) change in growth in rubber export
- (3) change in world demand for Thai tradeable goods

Internal Shocks

- (4) change in natural gas supply
- (5) change in technical progress in the tradeable sector

Policy Changes

- (6) public resource mobilization through higher income tax on urban residents
- (7) lower tariff on competitive manufactured imports
- (8) no slow-down in investment in Eastern Seaboard Development

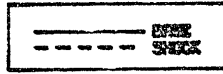
Interest Rate Rise

113. In the event of a one percentage point rise in world interest rates from 1986 onward a sharp adjustment should take place (Figure 16). Recall that this represents about a 20 percent rise in the real interest rate. Net new borrowing should decline 48 percent in 1986 and the net resource transfer would become negative earlier, in 1987. Real capital formation is pushed down by six percent because, due to the high cost of foreign borrowing, marginal investment projects become unprofitable. Real consumption goes down by four percent. The scope of adjustment can be best appreciated by considering the material balances equation of the manufacturing sector.

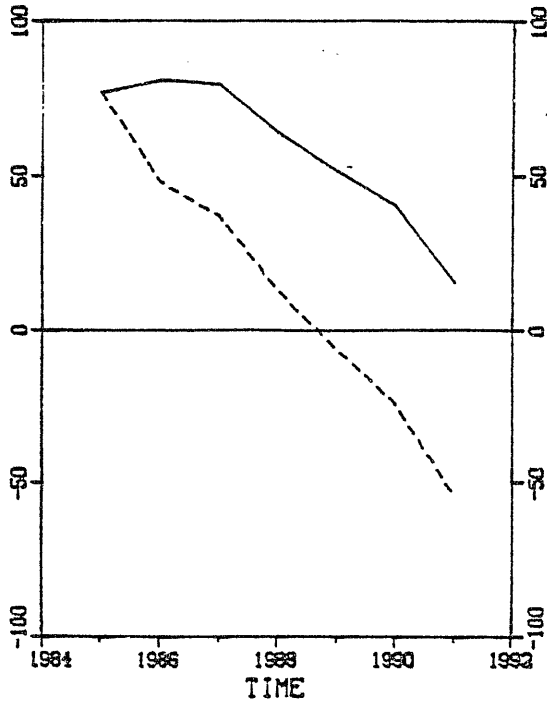
Figure 16

HIGHER WORLD INTEREST RATE:

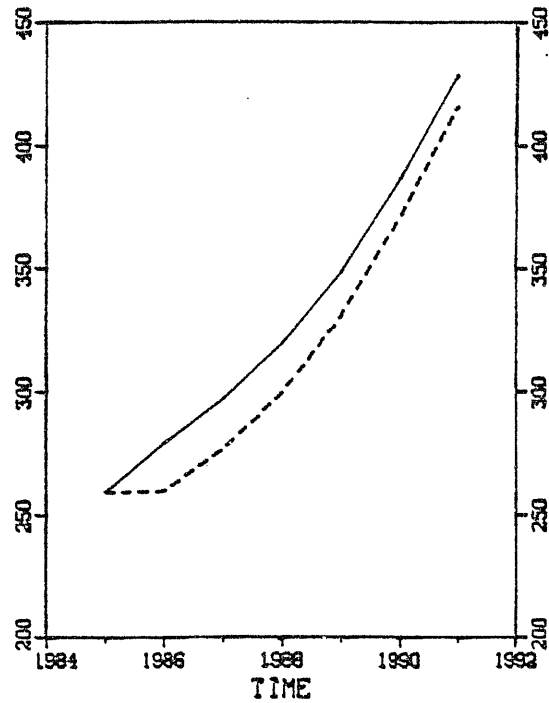
Real figures are in 1975 billion bahts



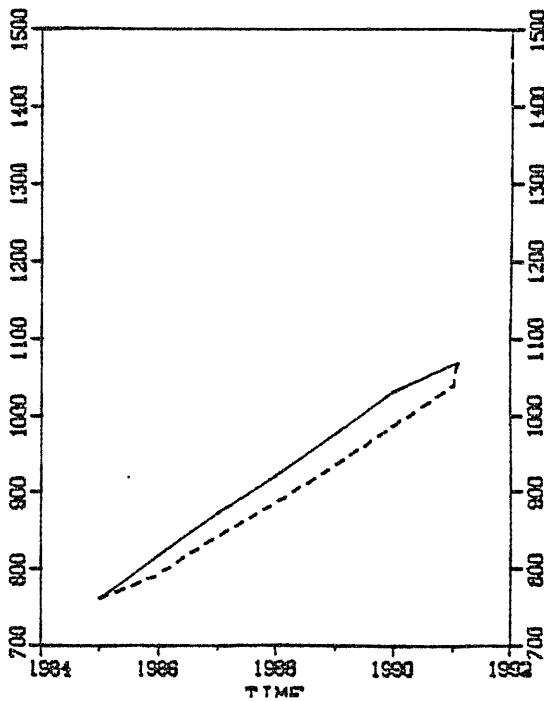
BORROWING



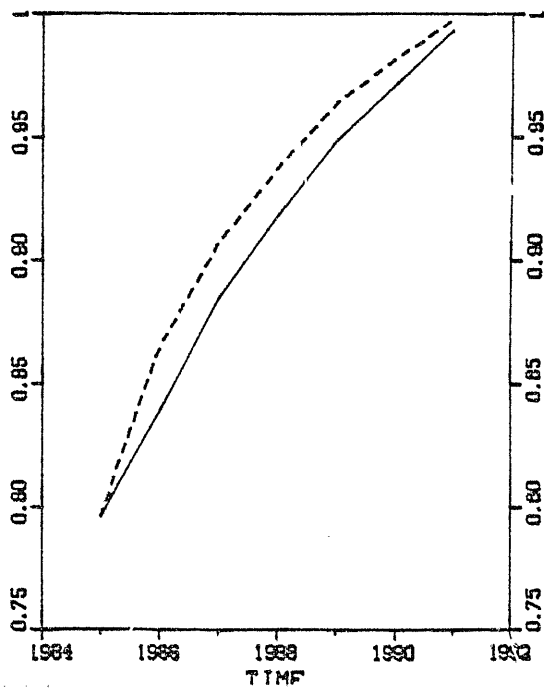
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



$$\begin{aligned} \Delta Q_{TR} &= \Delta(C_{TR} r_{TR}) + \Delta(\alpha \frac{I}{K}) + \Delta X_{TR} + \Delta(M_{TR} r_{TR}) \\ 14 &= (12) + (-5) + (29) + (2) \end{aligned}$$

The change in production, ΔQ , is the sum of changes in the domestic components of consumption and intermediate inputs, plus changes in exports and investment. Adjustment takes the form of higher output and tradeable exports, and lower consumption, triggered by an exchange rate depreciation. The fall in investment is not so large in absolute terms. This is because rates of return to capital go up. The nominal urban wage declines relative to the GDP deflator. The tradeable sector capital return goes up most (two percent). The current account deficit in 1986 is 2.9 percent of GDP. The deficit would be stabilized at 0.6 percent in the steady-growth-state.

114. In this experiment, optimal adjustment is very large. A change in interest rate of only one percentage point necessitated a 3.1 percent real devaluation, a 1.6 percentage point change in the current account to GDP ratio, (down to 2.9 percent in 1986), a 12 percent nominal devaluation and a 1.5 percent increase in tradeable production.

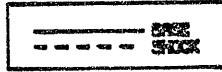
115. Slow Growth in Rubber exports: Assume that the nominal value of rubber exports stays at the level of 1986 in the near future instead of growing by nine percent p.a. (Figure 17). Thus, the magnitude of initial shock in 1986 is zero, i.e., the value of rubber exports does not change from the value in the base run. However, expectations of the future decline in wealth forces the country into early adjustment.

116. The current account deficit declines 0.2 percent relative to GDP from 1986. The real exchange rate depreciates 0.4 percent. Foreign

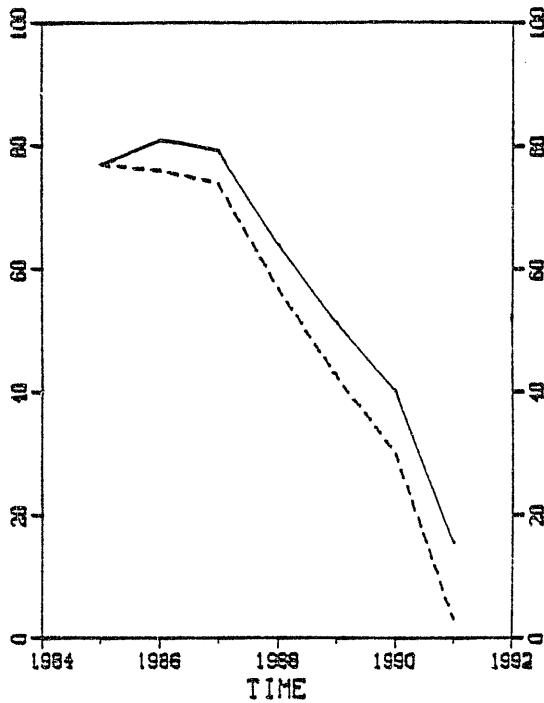
Figure 17

LOWER RUBBER EXPORT VALUE:

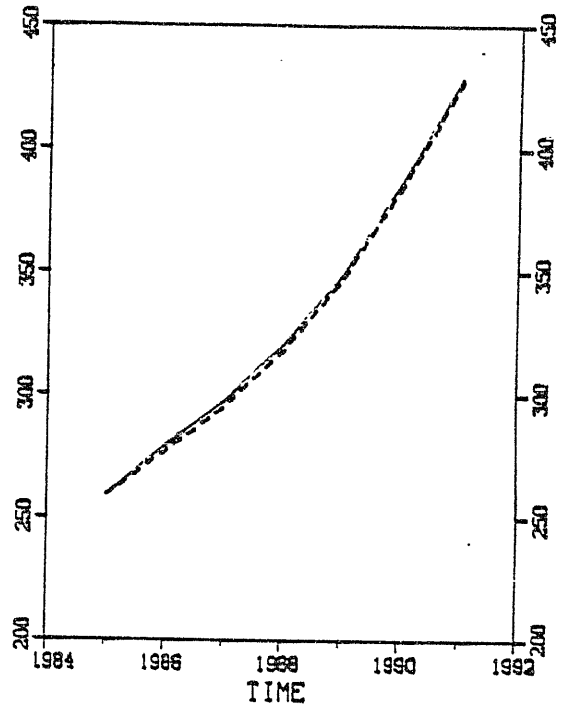
Real figures are in 1975 billion bahts



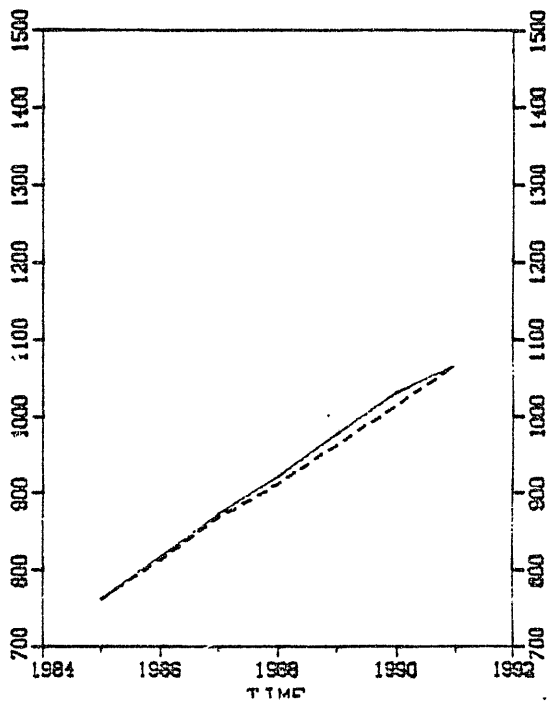
BORROWING



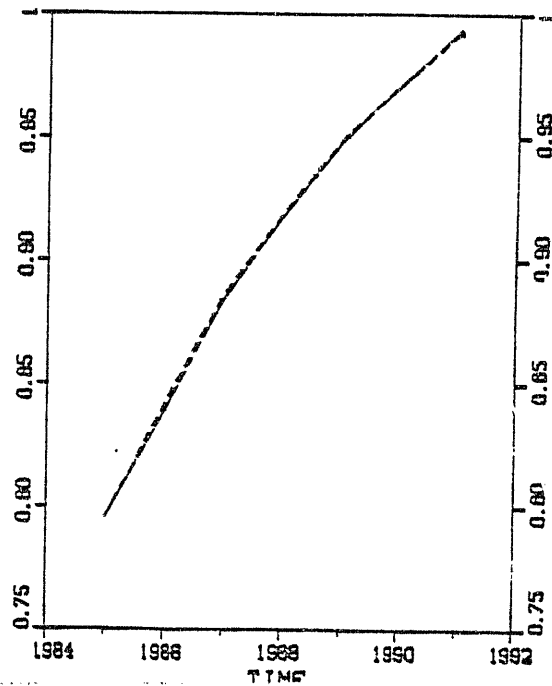
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



borrowing declines by six percent; investment by one percent; consumption by 0.4 percent. A two percent nominal devaluation is required. Manufacturing exports rise by two percent. Two characteristics of the shock dominate the pattern of adjustment. Lower wealth (the terms of trade effect) leads to lower consumption and lower borrowing. In addition, the shortfall of actual exports relative to initial expectations gets larger over time, requiring successive depreciations. This raises the costs of borrowing and the returns to domestic saving, adding a 'price' effect to the wealth effect. Debt stock in the terminal period therefore will be seven percent lower than the base, and the capital stock is 0.4 percent below the base level steady-growth-state.

Slower Growth in World Demand for Tradeables

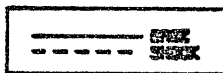
118. Assume the world demand for Thai nontraditional and processed exportables grows at 14 percent rather than the 15 percent rate assumed in the base run (Figure 18).

119. Despite the minor change in assumption, the response is significant. The real exchange rate depreciates immediately by 1.3 percent. Borrowing goes down by 18 percent or 630 million US dollars. Lower demand precipitates a fall in investment. The GDP deflator goes down by 5.5 percent; equivalently, the nominal exchange rate should decline the same amount. The potential export revenue stream of the country is permanently reduced. In order to mitigate the effects of such a negative shock, the country tries to decrease its future indebtedness by narrowing today's resource gap. This can only be

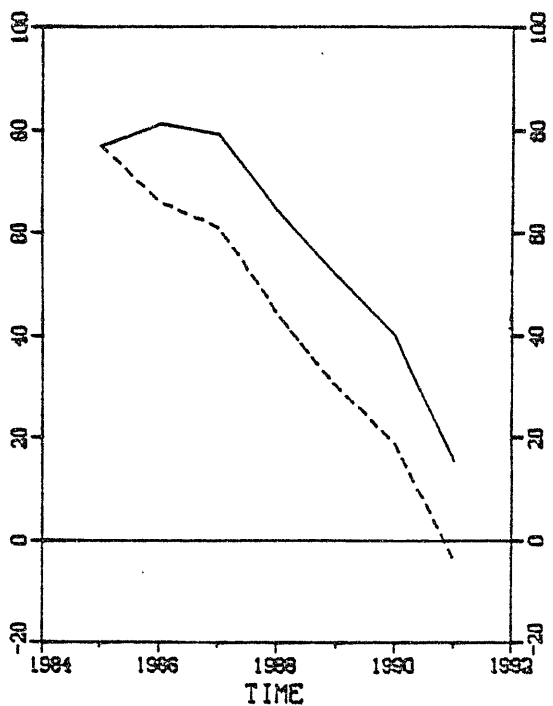
Figure 18

LOWER WORLD DEMAND

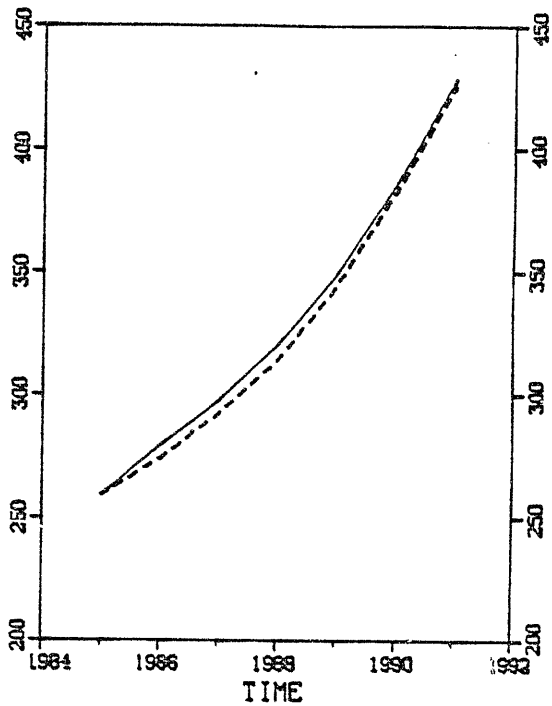
Real figures are in 1975 billion bahts



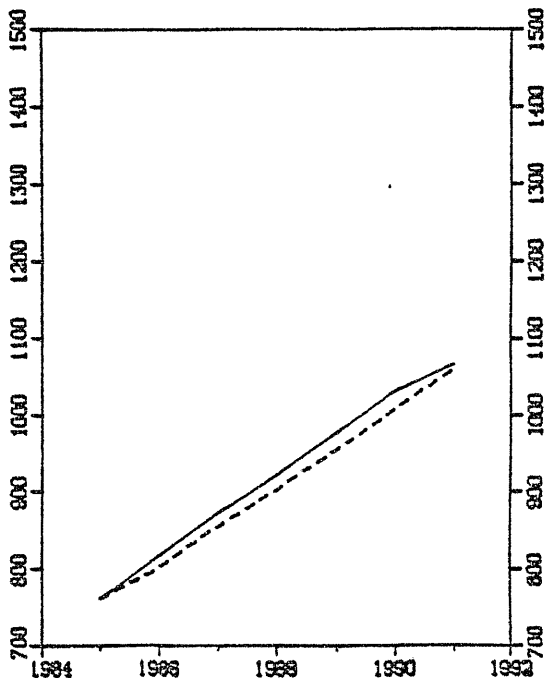
BORROWING



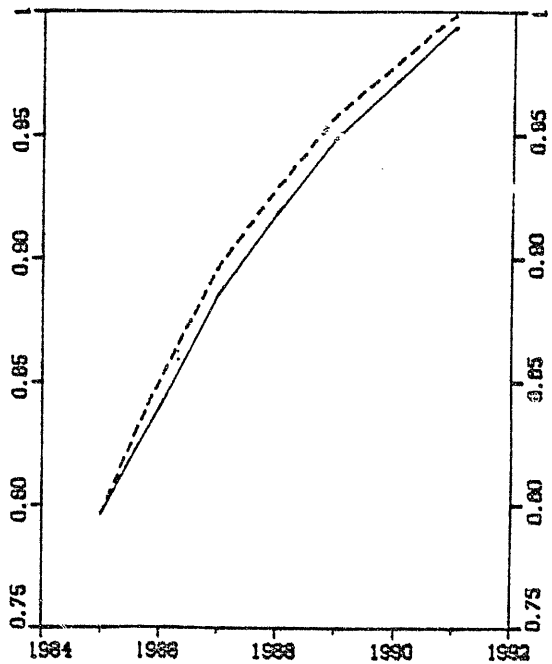
INVESTMENT



CONSUMPTION



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achieved by encouraging more exports despite the associated terms of trade decline. Thus real tradeable exports actually increase by eight percent despite the decline of world demand due to the price effect. Again, the material balances equations for manufacturing illustrates the nature of adjustment.

$$\begin{array}{ccccccc} 6 & = & (-7) & + & (-1) & + & (12) & + & (2) \\ \Delta Q & & \Delta C & & \Delta I & & X & & \Delta M \end{array}$$

The economy responds in a similar manner as in the interest rate shock: increase exports, decrease consumption, and to a lesser extent reduce investment. The current account deficit falls to 4.1 percent of GDP in 1986 and stabilizes at 1.1 percent. The net transfer is negative from 1988. This analysis shows the extent to which a borrowing strategy must be linked to assumptions of the growth in demand for Thai manufacturing goods from the rest of the world. If these assumptions or not borne out, or supply problems develop, a significantly more conservative external foreign borrowing path should be adopted. With the above response coefficients, a 2 1/2 percentage point slower growth in world demand for Thai goods would drive the current account into surplus from the outset.

120. The strength of this result is partly a reflection of the existence of the lending constraint. Lower world demand growth reduces the aggregate growth rate of the economy. This lowers government revenue, worsens the balance of payments and decreases lenders' willingness to lend. The resource gap is, therefore, forcibly narrowed even further by the constraint. The shadow price of foreign exchange

becomes seven percent higher than in the base in 1986 reflecting the effects of the lending constraint. There is, therefore, strong pressure to increase exports immediately to avoid balance of payments problems.

121. Higher Expected Production of Natural Gas: Uncertainties still surround the volume of future natural gas extraction in Thailand.

Assume that the value of natural gas import-substitution goes up to 2.5 billion US dollar by 1991 from 1.2 billion US dollars in 1986, compared with base run values of one billion US dollars in 1986 and 1.3 billion in 1991. How would things change?

122. Borrowing goes up -- by 500 million US dollars or 15 percent -- with the higher (expected) national wealth (Figure 19). The real exchange rate appreciates by 1.3 percent immediately (1986) but gradually depreciates to the base path levels as debt service pressures mount. Consumption and investment both rise slightly. There is slight evidence of "Dutch disease" problems. Resources switch out of the manufacturing sector into services. Lower output combined with higher domestic demand implies that exports fall significantly. Adjustment in the manufacturing sector in 1986 is as follows:

$$\begin{array}{cccccc} -6 & = & (6) & + & (2) & + & (-12) & + & (-2) \\ \Delta Q & & \Delta C & & \Delta I & & \Delta X & & \Delta M \end{array}$$

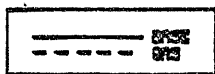
Higher Technical Progress

123. In the base run, we kept the productivity coefficients of production functions to be invariant over time. This is rather a pessimistic assumption: empirical evidence of positive technical

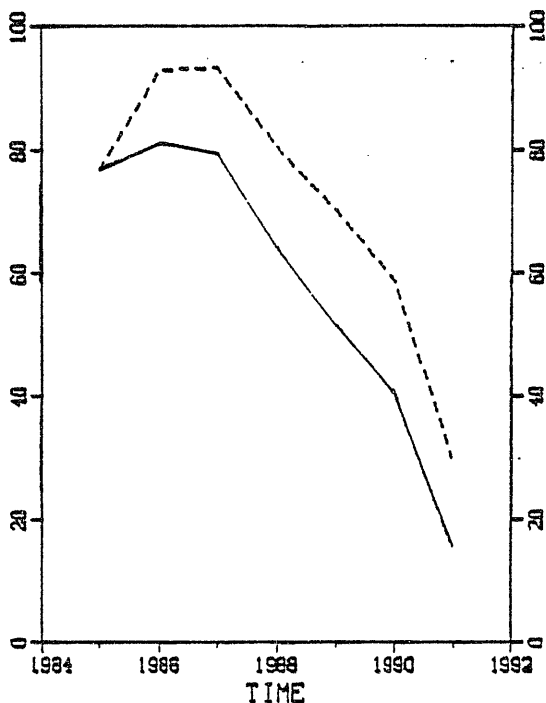
Figure 19

HIGHER NATURAL GAS SUPPLY:

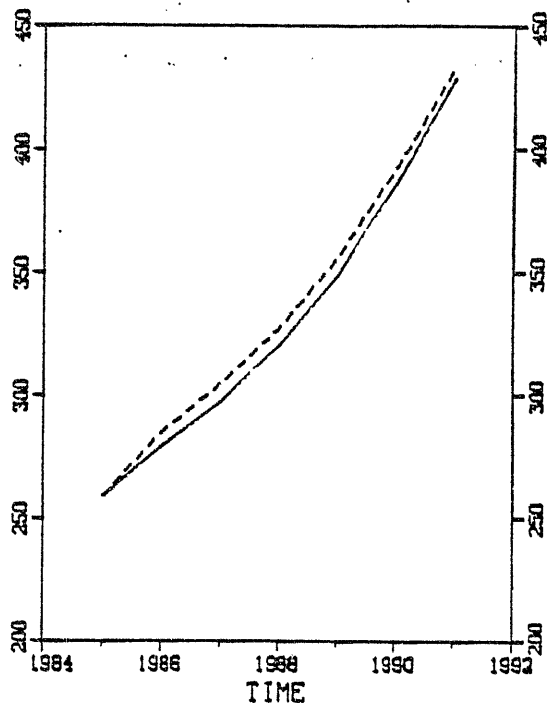
Real figures are in 1975 billion bahts



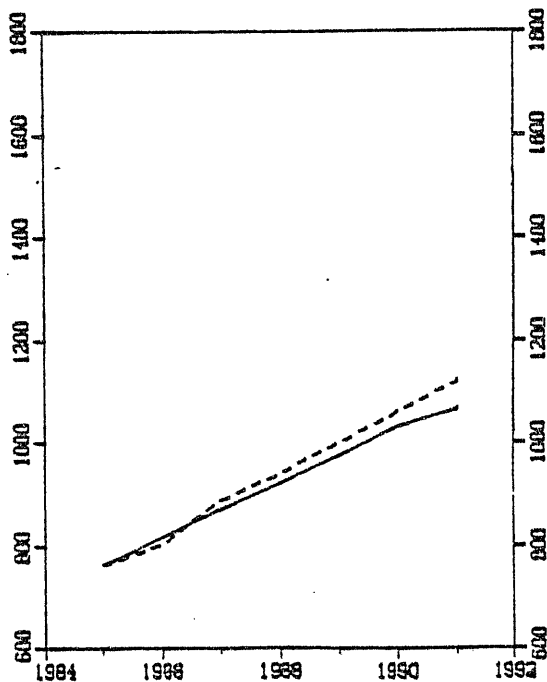
BORROWING



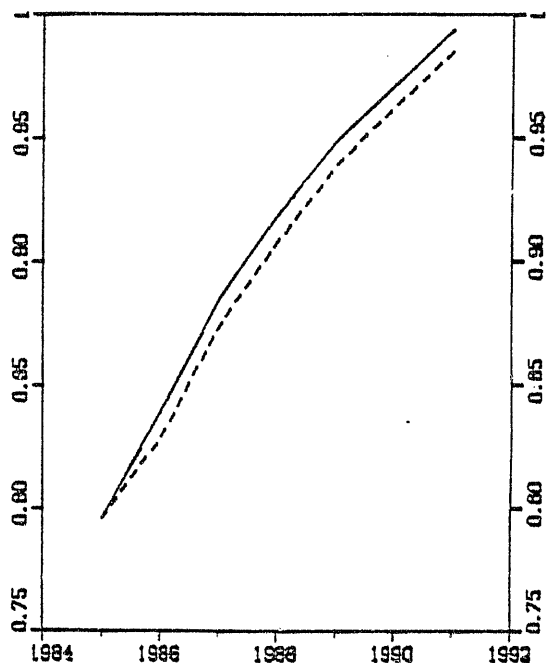
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



progress in developing countries abounds. Here, we assume a modest technical progress of two percent p.a. in the tradeable sector (Figure 20). Borrowing goes up by nine percent in 1986, because of improved debt service capacity. The terminal period debt stock is about 12 percent above the base. Investment on the other hand declines about three percent throughout the simulation. Private consumption as a result jumps up by five percent in 1986, and by ten percent in 1991. The real exchange rate as expected appreciates because of the additional supply of tradeables. The required fall in the current account/GDP ratio is much less steep.

124. In order to have a satisfactory economic performance Thailand needs a steady and strong growth in its exports. In the experiment of changing the world trade growth rate, we found that a small decline would have serious negative effects on the economy. This experiment on technical progress, however, shows that small improvements would be sufficient to offset weaker world demand than projected in the base scenario.

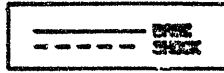
Domestic Policy Changes

125. Our choice of a base path reflects a certain element of risk concerning lenders' willingness to lend. This willingness is a function of the government's ability to mobilize resources from domestic sectors, among other elements. It can, therefore, be altered endogenously. In this and the next two experiments, we demonstrate that, given this formulation of the lending constraint, fiscal policies changes can have a large impact on borrowing and therefore consumption patterns.

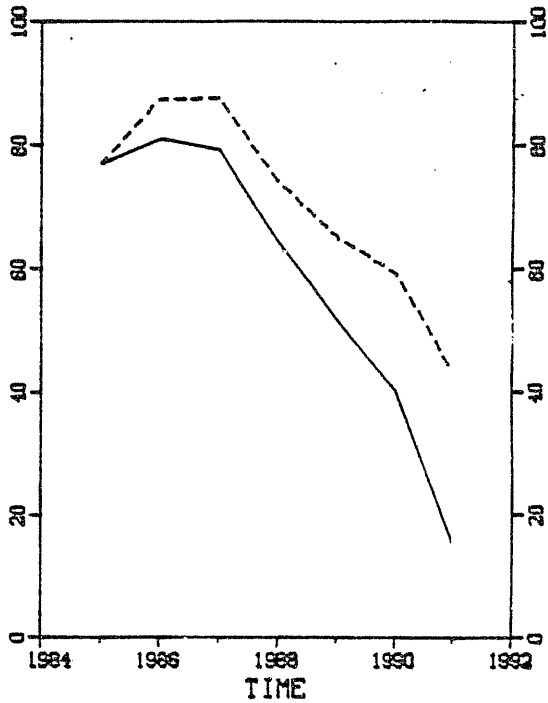
Figure 20

HIGHER TECHNICAL PROGRESS:

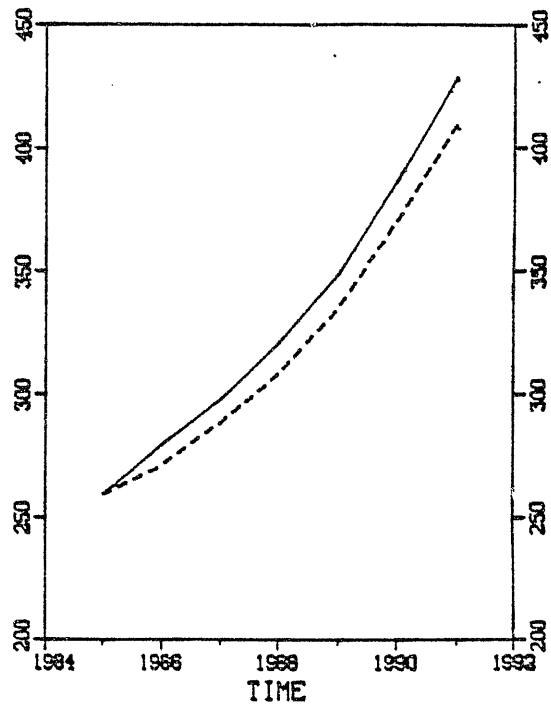
Real figures are in 1975 billion bahts



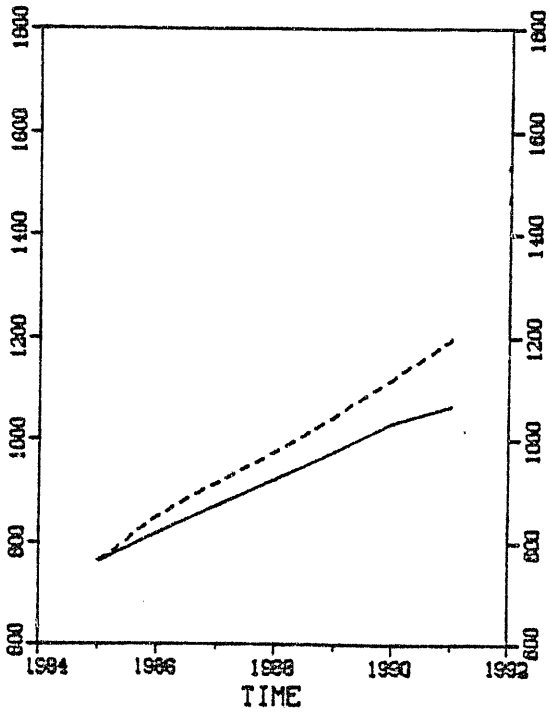
BORROWING



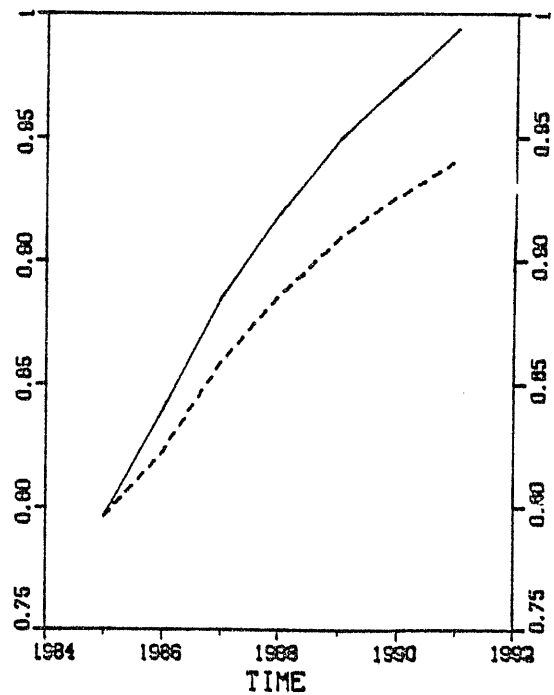
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



Higher Urban Income Tax

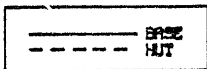
126. We first raise the urban income tax (Figure 21). This actually raises private consumption by increasing the amount that the government (and therefore the country) can borrow from foreigners permanently. This decreases government domestic financing needs, freeing up private sector funds for consumption and investment. The improved fiscal position lowers the need for investment to generate government revenue to safeguard creditworthiness. Investment as a result is reduced and there is a strong boost of private consumption despite the loss in disposable income caused by higher taxes. The real exchange rate appreciates, leading to a rise in real wages. Private sector welfare is increased overall.

127. Lower Tariff on Competitive Imports: A lower tariff on competitive imports, on the other hand, has opposite effects on the fiscal position (Figure 22). Lower tariff rates would, in the absence of the lending constraint, reduce distortions, generating positive effects on growth. With the lending constraint, however, the results are quite different. We simulate a reduction of the average tariff to ten percent from 16 percent. To maintain balance of payments equilibrium, the current account deficit is forced down to 1.1 percent of GDP (4.8 percent in the base); the shadow price of foreign exchange soars; tradeable exports must increase by 50 percent; investment jumps up by eight percent; and consumption plummets by over 20 percent. The loss in public revenue is 24 percent. This sharply increases the

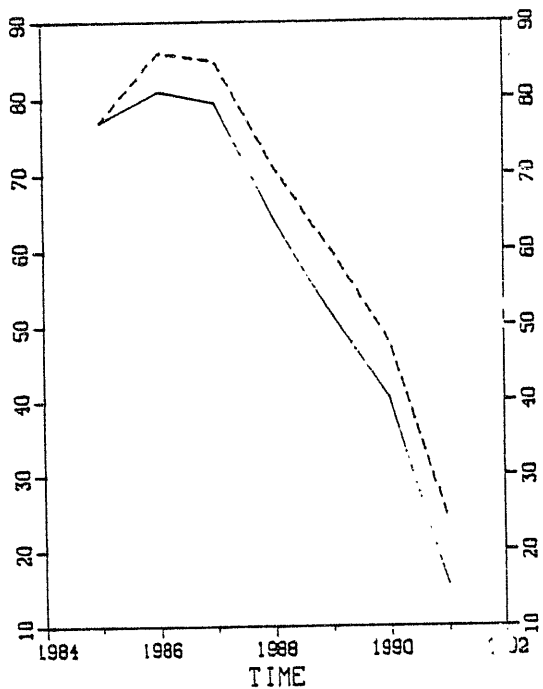
Figure 21

HIGHER URBAN INCOME TAX

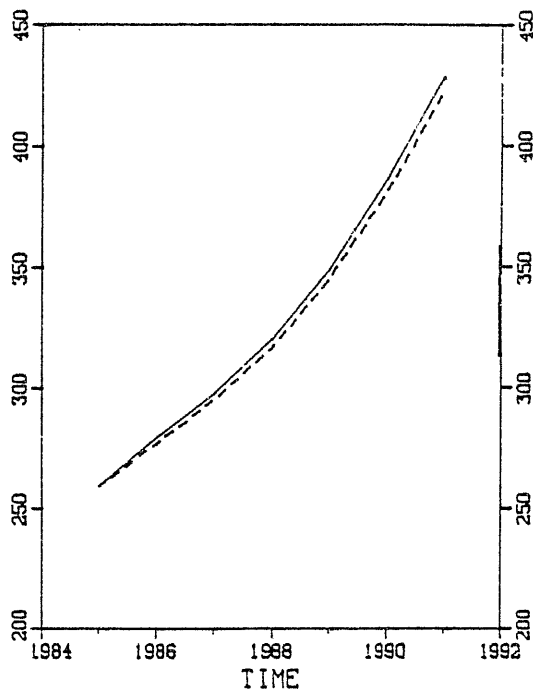
Real figures are in 1975 billion bahts



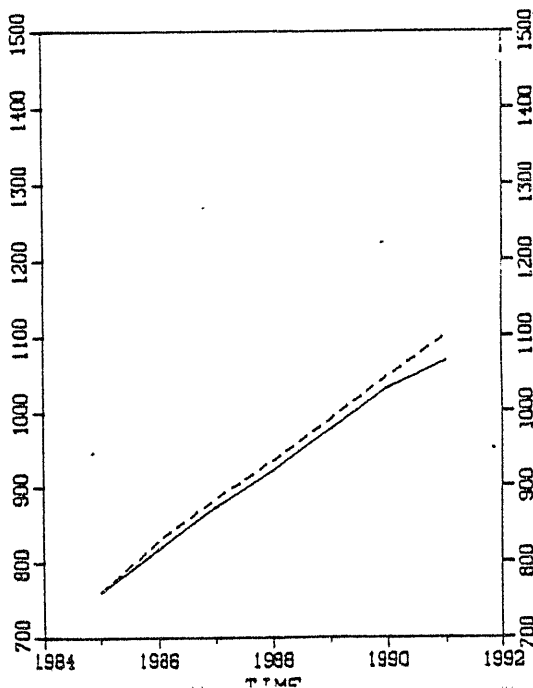
BORROWING



INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE

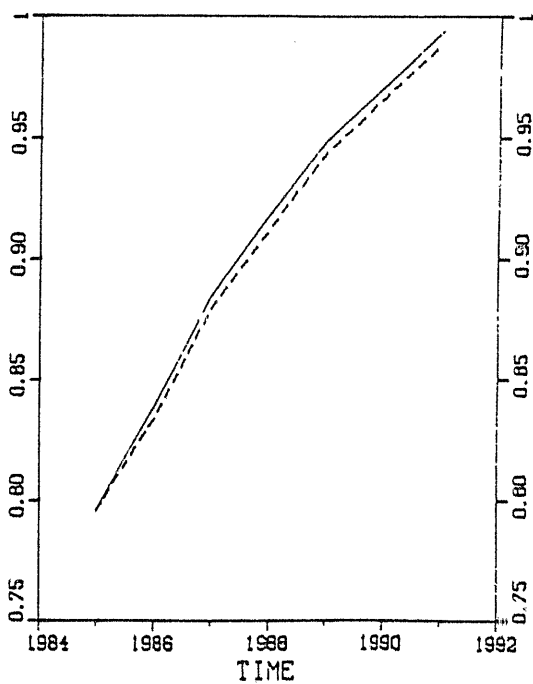
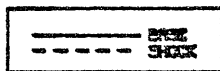


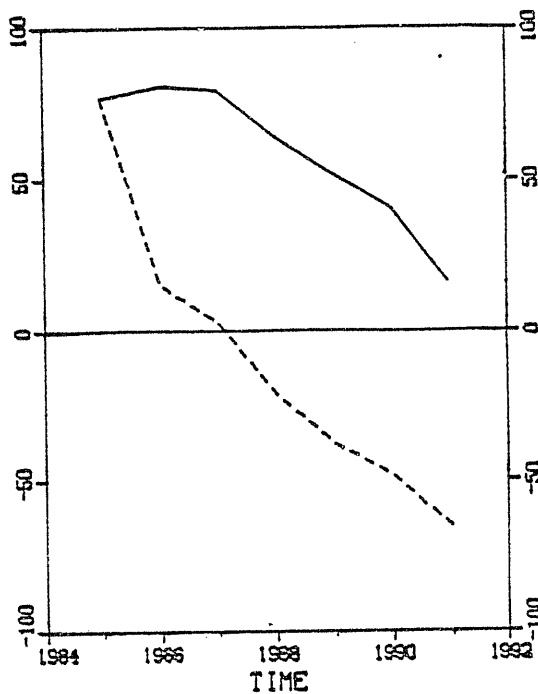
Figure 22

LOWER TARIFF RATE:

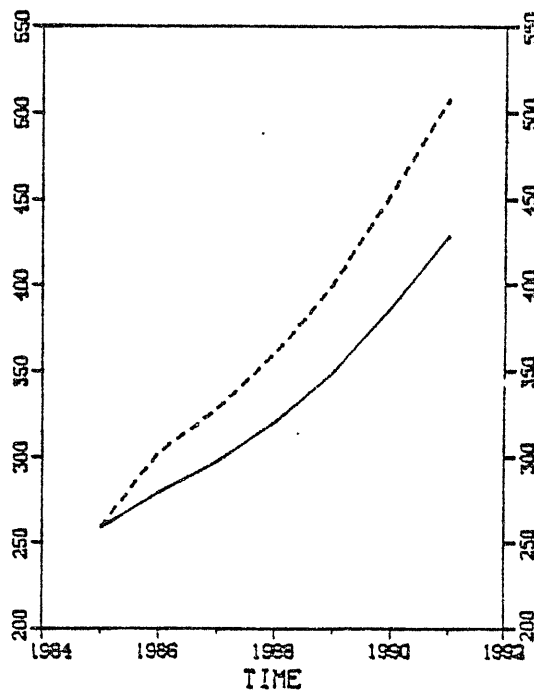
Real figures are in 1975 billion bahts



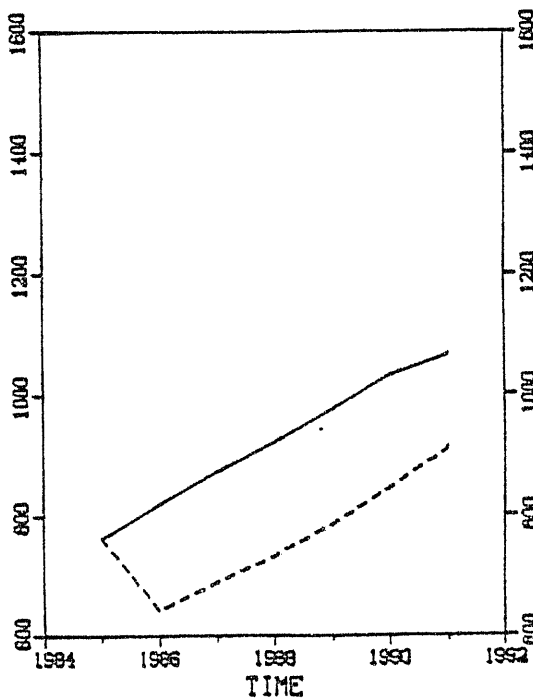
BORROWING



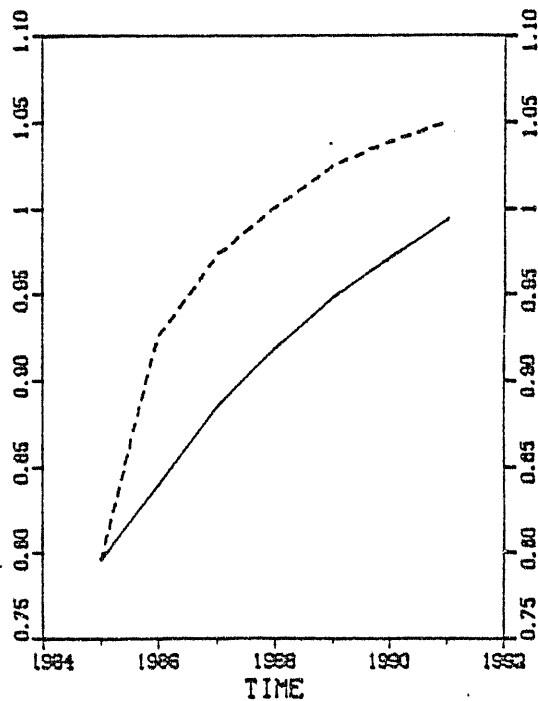
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



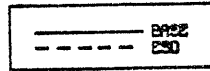
riskiness of public debt. Lenders cut back credit lines. Borrowing is only 18 percent of what is possible without the policy change.

128. Whether or not such immediate adjustments are possible is not the major concern here. The direction and magnitude of the required changes, however, suggests that policy makers would be well advised to phase major changes in a consistent package with other reforms. Even policy changes that increase efficiency in the medium- to long-run, can have adverse effects unless the negative impact on public resource mobilization is offset by other measures, such as higher taxes elsewhere or lower government consumption.

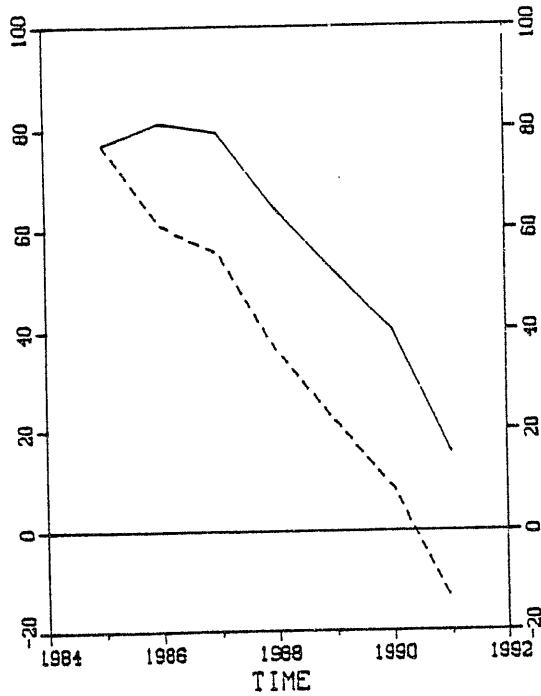
129. Eastern Seaboard Development: Assume that government investment in real terms is increased by 5-6 billion bahts, to finance the Eastern Seaboard Development for example (Figure 23). Assume also that technically these projects have the same high rate of return as other investments in Thailand, but that the government only recovers resources from its investment via the general growth in the economy that is stimulated. This may represent the long gestation period that is usually the case with such large scale investment. The simulation, therefore, highlights the trade-off between long-run growth and a balance in public finances.

130. We find the consequences of such public investment are enormous. Borrowing in 1986 falls by 26 percent. The exchange rate depreciates in real terms by 2.5 percent. Exports of tradeable goods jump by 13 percent to finance the decline in resource transfer from foreigners requiring a large nominal devaluation. Investment goes up by

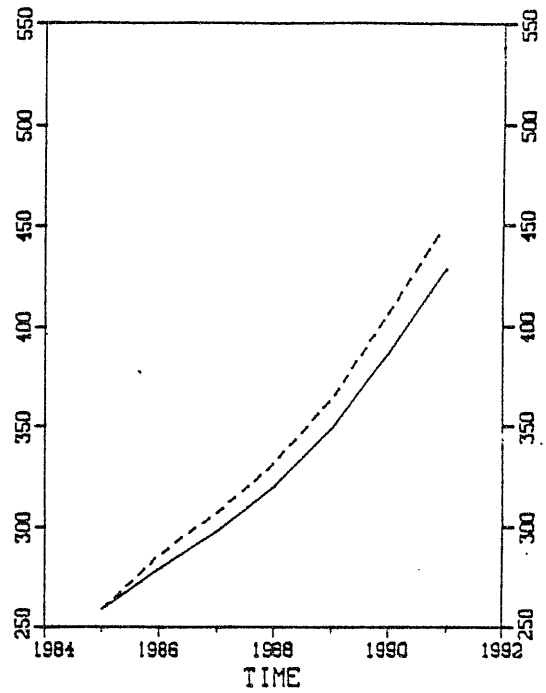
EASTERN SEABOARD DEVELOPMENT
Real figures are in 1975 billion bahts



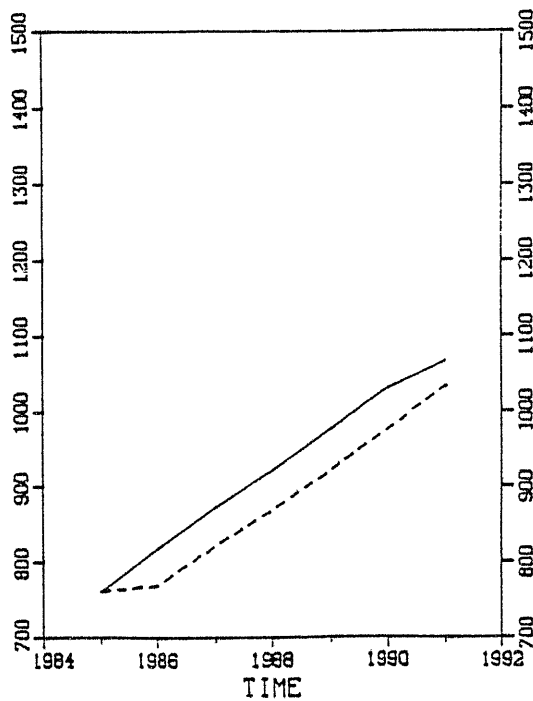
BORROWING



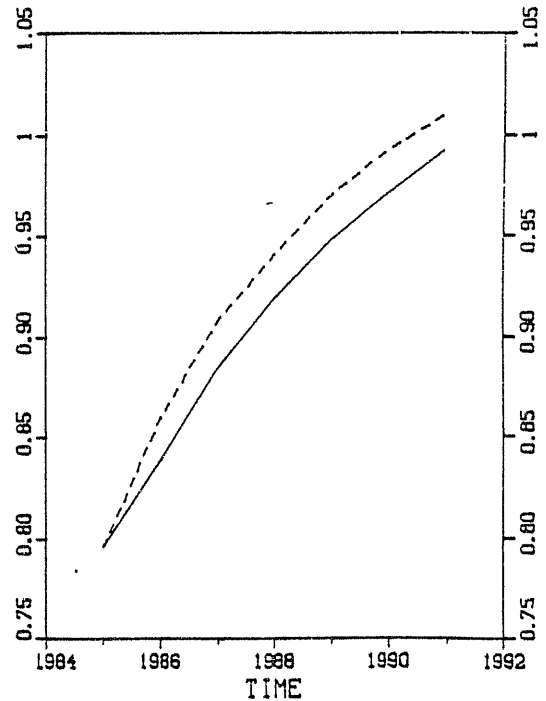
INVESTMENT



CONSUMPTION



REAL EXCHANGE RATE



2.2 percent. This exceeds the increase in public investment; private investment also goes up. Consumption declines, therefore, significantly throughout the simulation years, and although it ends on a higher growth path, the immediate costs outweigh future benefits. Overall welfare falls.

Future Summary

131. The base path derived for the medium-term (1985-92) evolution of the Thai economy illustrates certain important characteristics of any future foreign borrowing strategy. First, the high current account deficits of the recent past cannot continue over a medium-term horizon without jeopardizing creditworthiness. Although the deficit may reasonably stay as high as 5.3 percent of GDP in 1985, it must come down quickly towards two percent by 1989 and thereafter. Second, in order to sustain the capital inflows implied in such a transition path, investment must be high and directed towards tradeable production; export growth, especially in manufacturing, must be rapid. These would permit rapid GDP growth at 7.5 percent per year; a high rate by present standards but one that was exceeded in the past and that is achieved in other East Asian economies. Even so, a continued real depreciation of the exchange rate is necessary to promote the required structural adjustment of productive capacity towards foreign-exchange generating output. Net foreign exchange resource transfers from international borrowing must turn negative by 1989 to avoid an excessive debt build-up.

132. A key assumption behind this result is that active government intervention is desirable to reduce the risk of losing access to international credit lines. In the absence of such concerns, borrowing would be higher and investment lower. Consequently, domestic savings would also be low. We formalize this risk by introducing a lending constraint linked to the evolution of the balance of payments and the state of public finances. In the absence of domestic policy changes, government savings can only improve if there is higher growth in the economy (a higher tax base) or lower borrowing. Thus, our base case has more conservative borrowing and higher investment and domestic savings in the long-run than under a laissez-faire strategy.

133. We investigate how the economy would optimally respond as exogenous and policy parameters change. Table 12 reports the magnitudes of optimal responses of the key variables with respect to some of the shocks. Two general points emerge: the responses are quite varied in magnitude according to the type of shock or policy change; and the lending constraint has strong effects on the need for and desirability of adjustment. For the most part, borrowing and investment move in the same direction after a shock, although to differing degrees. In some cases, however, where the lending constraint is significantly affected, they move in opposite directions. A policy-induced improvement in

Table 12: Optimal Responses to Exogenous Shocks

(Percentages Change)

	Current Account/GDP <u>1/</u>		Borrowing		Investment		Consumption		P _{TR} /P _{NT}		(Memo) Debt-Export Ratio
	INI <u>2/</u>	BGS <u>3/</u>	INI <u>2/</u>	BGS <u>3/</u>	INI <u>2/</u>	BGS <u>3/</u>	INI <u>2/</u>	BGS <u>3/</u>	INI <u>2/</u>	BGS <u>3/</u>	BGS <u>3/</u>
Interest Rate <u>4/</u>	-1.6	-0.5	-40.7	-43.2	-6.7	-1.9	-2.9	0.01	3.1	-2.2	0.44
Rubber Exports <u>5/</u>	0.02	0	0.6	0.6	0.07	0.03	0.7	0.6	-0.04	0.06	0.72
World Demand <u>6/</u>											
Higher	2.0	0.7	55.0	50.0	6.6	2.0	4.5	3.0	-4.0	0.7	0.85
Lower	2.0	0.3	60.0	52.1	6.0	1.5	6.0	2.8	-4.4	1.1	0.65
Tariff <u>7/</u>	0.6	0.1	13.5	10.9	-1.4	-1.1	3.4	-0.2	-1.7	0.1	0.26
Income Tax <u>8/</u>	0.7	0.4	23.0	22.4	-2.0	-1.5	5.1	-0.6	-2.1	0	0.80
Technical Progress <u>9/</u>	0.2	0.1	6.0	8.3	-1.5	-0.5	2.4	2.1	-1.3	-1.8	
Gas <u>10/</u>	0.05	0.02	1.6	1.4	0.2	0.07	0.2	0.02	-0.7	0	0.87

1/ Percentage of point change2/ Value of the initial year of shock3/ Value of the balanced-growth state4/ One percentage point change in world interest rates of all types of borrowing5/ One percentage point change in growth rate of nominal revenue from rubber exports6/ One percentage point change in growth rate of the world manufacturing demand7/ One percentage point change in competitive import tariff rate8/ One percentage point change in urban income tax9/ One percentage point change in the rate of technical progress of the manufacturing sector10/ Ten percent change in nominal U.S. dollar value of natural gas output in the balanced-growth state

creditworthiness permits higher borrowing and lower investment at the same risk level, and vice-versa.

V. SUMMARY AND CONCLUSIONS

134. This paper addresses two issues that are central to the present policy debate in Thailand: how should the government establish medium-term borrowing and investment strategies and what factors should cause modifications in these strategies. These are general issues that revolve around how a society should allocate resources intertemporally. We present a methodology which permits a resolution of the problem, based on a simple specification of welfare and production functions. This approach focuses on the economic costs and benefits of foreign borrowing.

135. We have constructed and calibrated for simulation purposes a five-sector dynamic optimization model in order to shed more light on alternative foreign borrowing strategies for Thailand. The model maximizes the discounted sum of utilities over a given period of time with a terminal condition that implies balanced growth is reached after the transitional period is over. Aggregate levels of investment and foreign borrowing are the choice variables; the rest of the economy is assumed to function in a general equilibrium manner, i.e., all commodity and factor markets clear with endogenous prices.

136. The first-order conditions for optimization imply that the levels of borrowing and investment are chosen so that the real cost of foreign borrowing and the real rate of return on investment are equated with the real social discount rate. The latter is a function of the pure rate of time preference, the growth rate of consumption, and the degree with which marginal utility declines as consumption goes up. The pure rate of time preference is parametrically given and signifies the impatience of the population. The higher the growth rate of consumption, the higher is the social discount rate, because one values the present more knowing that higher consumption will be available in the future. Higher investment today means, ceteris paribus, lower consumption today and a higher consumption tomorrow; the real social discount rate thus increases with higher investment, whereas the real return on investment tends to go down. Higher borrowing would lower the growth rate of consumption by increasing today's consumption and reducing tomorrow's when debt service falls due. More borrowing would also increase the real cost of borrowing, not only because of the increasing cost of adjustment to new capital sources assumed in the model, but also because of changes generated in the time profile of relative prices. Borrowing lowers the price of tradeables relative to nontradeables, and debt repayment increases it. The borrowing, then is carried out when tradeables are cheap in terms of home goods, and repayment is made when tradeables are more expensive. The real cost of loans in the economy, therefore, in terms of consumption foregone, increases with this real depreciation.

137. This relative price ratio between tradeables and nontradeables, which we conveniently call the real exchange rate, is critical because it has a close association with the current account deficit by determining largely the excess demand for domestic tradeables. The ratio also dictates the allocation of new capital stock in the economy by shifting the relative profitability of the two key sectors, manufacturing and services, combined, these produce 72 percent of value added and use 81 percent of the total capital stock. A higher level of borrowing today, by providing imported goods, generates an excess demand for domestic tradeables and a consequent by lowering of this price ratio. The higher relative price of nontradeables would induce more investment to flow into this sector. With the assumption that capital is immobile after installment, this tends to make subsequent adjustment to balance of payments shocks more severe by requiring larger real exchange rate depreciation.

138. We have solved the model for the period 1975-1981 and compared the results with the historical experience. The major characteristics of this exercise are as follows:

- (1) the actual historical path Thailand took during 1975-1978 was close to the path projected by the model. (The model was solved twice sequentially starting from 1975 and 1978 in order to minimize the effects of terminal conditions). Actual investment was slightly below the optimal value between 1975-1978. However, actual borrowing and

consumption levels were much higher than the optimal solutions during the period 1979-1981;

- (2) the current account deficit-to-GDP ratio remained fairly constant in the model at around three percent, whereas actual historical values oscillated, reaching a record high of 7.7 percent in 1979;
- (3) reflecting the high level of investment earlier on, the model GDP grows 0.8 percent higher than actual history; and,
- (4) the real exchange rate in the model depreciates throughout relative to history.

139. In order to explain at least qualitatively the cause of the divergence between reality and the model results, several runs have been made under alternative specifications. Two alternative explanations for the historical evolution of the macroeconomy are presented. The first is that despite evidence that global conditions were deteriorating, Thai policy-makers failed to revise their expectations about the future, treating high interest rate and low world demand changes as temporary phenomena whereas they have proven to be of a medium term nature. However, while mistaken perceptions on the permanent or temporary nature of high interest rates would help to explain foreign borrowing and consumption behavior, they would also imply a greater divergence between simulated and actual investment. A similar inconsistency emerges in explanations of past behavior that focus on a perceived temporary slow-down in world demand. This can, therefore, only be part of the full explanation.

140. The alternative story suggests that non-economic factors, or nonoptimizing behavior, were important in this period. One feature of the desired adjustment path in several years (1978, 1980, 1981) without any expansion in per capita consumption. This may not have been possible to achieve politically. The imposition of an arbitrary constraint on adjustment that forces per capita utility to rise by at least 1.6 percent generates a solution with higher consumption, but without higher borrowing.

141. The difficulty in explaining the high levels of foreign borrowing in 1980 and 1981 partly suggests that market forces, on which our model behavior rests, were being distorted by government policy. Several features of this period stand out. The results clearly show that a desirable program of adjustment to the adverse world development should have included a depreciation of the real exchange-rate. The historical real exchange rate was overvalued by about ten percent. An official objective, however, was to retain the system of a fixed nominal parity of the baht against the dollar. When this system came under pressure, reflected in a run-down of reserves, the government failed to take adequate measures to reduce balance of payments pressure by a more austere fiscal stance. Instead, loose fiscal policy, and a growing overall public deficit, were supported by heavy public foreign borrowing especially by state enterprises. It was only when fears of the problems associated with rapidly rising indebtedness became acute that action was taken to devalue the baht and reduce public external borrowing. Thus,

foreign borrowing was not the result of a decision on least cost sources of finance in this period. The authorities did not internalize the rising cost of external borrowing into their decision-making, and failed to substitute these funds with lower cost domestic resources.

142. The base path derived for the medium-term (1985-92) evolution of the Thai economy illustrates certain important characteristics of any future foreign borrowing strategy. First, the high current account deficits of the recent past cannot continue over a medium-term horizon without jeopardizing creditworthiness. Although the deficit may reasonably stay as high as 5.3 percent of GDP in 1985, it must come down quickly towards two percent by 1989 and thereafter. Second, in order to sustain the capital inflows implied in such a transition path, investment must be high and directed towards tradeable production; export growth, especially in manufacturing, must be rapid. These would permit rapid GDP growth at 7.5 percent per year; a high rate by present standards but one that was exceeded in the past and that is achieved in other East Asian economies. Even so, a continued real depreciation of the exchange rate is necessary to promote the required structural adjustment of productive capacity towards foreign-exchange generating output. Net foreign exchange resource transfers from international borrowing must turn negative by 1989 to avoid an excessive debt build-up.

143. The future runs have an endogenous lending constraint that links lenders' willingness to lend and the government's capacity to mobilize domestic resources. This effectively constrains the present

value of the government expenditure not to exceed the present value of the government revenue in the long-run, after a transitional period. Due to the constraint, policy changes that increase the overall fiscal deficit are strongly welfare reducing. In general the optimal adjustment of the economy to different shocks/policy changes differ substantially according to the nature of the shock, the nature of the change in expectations about the future, the structure of the economy, especially in terms of the substitutability of factors between sectors, and the flexibility to react quickly to new conditions. For example, reducing import tariffs, or increasing expenditure in public investment (Eastern Seaboard Development) would impinge severely on the economy by reducing lenders' willingness to supply additional loans to Thailand.

144. Lower world demand growth would squeeze consumption much more when the lending constraint is binding than when it is not. This is because a lower growth rate of world trade slows down domestic economic growth, reducing government revenue; government expenditure, on the other hand, is relatively rigid. This loose fiscal stance of the government makes debt more risky and access to foreign capital potentially limited. Higher export growth does exactly the opposite until the lending constraint is no longer binding. The effects become much more moderate from then on. Increasing the income tax has similar effects; by expanding the availability of foreign capital, at a given risk level, such a policy may actually increase private consumption.

145. This analysis strongly suggests that robust foreign borrowing strategies should be based on an understanding of the following

components: the structure of the economy; the speed with which the structure can be adjusted as required; stable expectations of future events together with estimates of the volatility of some key variables. It is also critically important to understand lender behavior and the endogenous nature of the borrowing-investment interaction in a macroeconomic framework.

146. The structure of the economy obviously matters. To the extent that repayment of today's debt must be made by tomorrow's tradeable production, a relatively larger share of tradeable output in the economy is associated with more debt carrying capacity, ceteris paribus. Among the tradeables, the expansion of nontraditional manufacturing activities is imperative in maintaining creditworthiness. These activities tend to have more flexibility in their scope to expand exports as an adjustment to shocks than, say, monocultural crop export activities. The latter tend to suffer from inelastic demand, volatile world prices, and unresponsive production in the short-run. In the case of Thailand, the borrowing patterns suggested in the base case for the future are conditional on assumptions that world demand for Thai goods remain strong and that Thailand would be able to take advantage of such demand by expanding the nontraditional manufacturing sector.

147. We have also demonstrated the sensitivity of desired net new flows to changes in key parameters. This means that the ability of the economy to change its production patterns and use of outputs in a very limited amount of time is critical. Table 12 in section IV lists various elasticities that quantify the country's optimal response to

internal and external shocks. The elasticities suggest that ability to shift the labor force from one sector to another, the need to suppress consumption in order to increase investment and/or exports, and the real depreciation of the exchange rate necessary to change the destination of investment toward tradeables and to encourage exports are all key elements of a flexible adjustment package. Especially in the case of interest rate shocks and negative world demand shocks, the required adjustment is extensive and painful. When the economy does not have sufficient flexibility to undertake such far-reaching adjustment in a short span of time, borrowing policies should be much more conservative.

148. Expectations as to how the domestic and world environment will evolve in the future is another critical element in devising foreign borrowing strategies. From the private sector viewpoint, it is critically important to forecast how the real exchange rate will move over time. A successful borrowing strategy necessitates a real depreciation. Actual experience of the government's real exchange rate management, however, belies this. External shocks, as well as government policy, are important determinants of exchange rate and of real income. If wrongly optimistic forecasts of world interest rates or world demand for Thai goods are made, then later adjustment when realization of the error draws, is quite painful. Justifiable concerns should thus be raised, over the volatility of external conditions. In our model framework, even temporary shocks have permanent effects through the change in relative prices and hence the change in the destination of capital investment, and through the accumulation of debt.

149. Finally, knowledge of lender behavior is imperative. In many of the sensitivity runs, the burden of adjustment is made greater because of the lending constraint imposed. Especially in such cases as lower import tariffs and implementation of the Eastern Seaboard Development Program, the government investment-savings gap increases, while access to foreign borrowing is reduced. This in turn requires drastic increases in exports and investment immediately so that existing debt can be serviced throughout by exports, rather than by new borrowing. Consumption is naturally reduced substantially. The volatility of the international environment becomes even more critical with the endogenous lending constraint because of the procyclical behavior of lenders. When shocks do occur, the required adjustment is much more drastic than unconstrained cases. Similarly, underinvestment in constrained cases also has a high cost. If investment is kept at suboptimal levels, due to political or absorptive reasons, new borrowing will fall. Hence, exports must shoot up and consumption decline to balance the external accounts.

150. Foreign borrowing is a process that is closely linked with other macroeconomic variables. Around the optimum, the real cost of foreign borrowing is always equated with the real return on investment, and real social discount rate. All of these three indicators, however, are endogenous. It is highly important, in devising foreign borrowing strategies, to recognize this interdependence. Such recognition inevitably links foreign borrowing with other macroeconomic policies. Knowledge of the economic structure its flexibility and estimates of future variables are necessary to obtain target levels for aggregate

foreign borrowing and investment. Magnitudes of optimal responses to exogenous shocks are shown in Table 12 should be of some use in determining how such a path should be modified in the future. Rapid response to external shocks lowers the effective cost of borrowing. A proper mix of monetary, fiscal and commercial policies is essential to achieve this adjustment.

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Appendix 1

Equations of the Foreign Borrowing Model of Thailand

Objective Function:

$$\text{Max } \sum_{t=1}^{T-1} U_t / (1 + \delta)^t - 1 + U_T / ((\delta - gpc)(1 + \delta)^{T-2}) \quad (1)$$

where

$$U_t = \left(\frac{C(C_{Tt}, C_{Nt}, C_{At})}{L_t^U + L_t^R} \right)^{1-b} / (1-b) \quad \text{and } C = C_{Tt}^{a_1} C_{Nt}^{a_2} C_{At}^{1-a_1-a_2} \quad (2)$$

$t = 1, \dots, T$

S.t.

Urban Production:

$$Q_{it} = Q_{it}(K_{it}, L_{it}, Q_{it}) \quad (3)$$

$$= q_{it} K_{it}^{\alpha_{it}} L_{it}^{1-\alpha_{it}} \quad i = T, N, CO$$

Rural Production:

$$Q_{it} = Q_{it}(K_{it}, L_{it}, Z_{it}, q_{it}) \quad (4)$$

$$= q_{it} K_{it}^{\alpha_{it}} L_{it}^{\beta_{it}} Z_{it}^{1-\alpha_{it}-\beta_{it}} \quad i = E, A$$

Market Clearing Equations:

$$O_{Et} = X_{Et} + IM_{Et} \quad (5)$$

Equations of the Foreign Borrowing Model of Thailand

$$Q_{At} = r_{At} (C_{At} + GC_{At} + IM_{At}) + X_{At} \quad (6)$$

$$Q_{Tt} = r_{Tt} (C_{Tt} + GC_{Tt} + IM_{Tt}) + \alpha_k \left(1 + \frac{U_{Dt}}{2TK_t}\right) J_{Dt} + X_{Tt} \quad (7)$$

$$Q_{Nt} = C_{Nt} + GC_{Nt} + IM_{Nt} + X_{Nt} \quad (8)$$

$$Q_{COt} = (1 - \alpha_k) \left(1 + \frac{U_{Dt}}{2TK_t}\right) J_{Dt} + IM_{COt} \quad (9)$$

Exports:

$$P_{Et} \cdot X_{Et} = \bar{XV}_{Et} \quad (10)$$

$$P_{Nt} \cdot X_{Nt} = \bar{XV}_{Nt} \quad (11)$$

$$X_{At} = \alpha_A \zeta_A \left(\frac{P_{At}}{e_t \cdot FW_{At}}\right) \xi_A \quad (\text{or } = P_{At} X_{At} = \bar{XV}_{At}) \quad (12)$$

$$X_{Tt} = \alpha_T \zeta_T \left(\frac{P_{Tt}}{e_t \cdot FW_{Tt}}\right) \xi_T \quad (13)$$

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Imports:

$$M_{At} = \left(\frac{\epsilon_A}{1 - \epsilon_A} \right)^{\theta_A} \left(\frac{P_{At}}{e_t^{PW_{At}}} \right)^{\theta_A} TD_{At} \quad (14)$$

$$M_{Tt} = \left(\frac{\epsilon_T}{1 - \epsilon_T} \right)^{\theta_T} \left(\frac{P_{Tt}}{e_t^{PW_{Tt}}} \right)^{\theta_T} TD_{Tt} \quad (15)$$

Domestic production ratios:

$$r_{At} = Y_A^{\theta_A - 1} (1 - \epsilon_A)^{\theta_A} \left(\frac{PP_{At}}{P_{At}} \right)^{\theta_A} \quad (\text{or} = 1) \quad (16)$$

$$r_{Tt} = Y_T^{\theta_T - 1} (1 - \epsilon_T)^{\theta_T} \left(\frac{PP_{Tt}}{P_{Tt}} \right)^{\theta_T} \quad (17)$$

Purchasers' prices:

$$PP_{it} = \frac{1}{Y_i} \left(\epsilon_i^{\theta_i} ((1 + tr_i) e_t^{FW_{it}})^{1 - \theta_i} + (1 - \epsilon_i)^{\theta_i} P_{it}^{1 - \theta_i} \right)^{\frac{1}{1 - \theta_i}} \quad (18)$$

$i = t, A$

$$PP_{it} = P_{it} \quad i = E, N, CO \quad (19)$$

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Investment allocation:

$$K_{it+1} = K_{it} + \frac{\alpha_i \frac{\partial O_{it}}{\partial K_{it}} PV_{it} K_{it}}{\sum_j \alpha_j \frac{\partial Q_{jt}}{\partial K_{jt}} PV_{jt} K_{jt}} J_t \quad (20)$$

Labor force growth:

$$L_t^U + 1 = L_t^U (1 + n^U) + L_t^R S \left(\frac{w_t^U}{w_t^R} \right) \quad (21)$$

$$L_t^R + 1 = L_t^R (1 + n^R) - L_t^R S \left(\frac{w_t^U}{w_t^R} \right) \quad (22)$$

debt Accumulation:

$$D_{gt+1} = D_{gt} + B_{gt} \left(1 + \frac{v_b B_{gt}}{2 TD} \right) \quad (\text{or} = D_{gt} + B_{gt}) \quad (23)$$

$$D_{gpt+1} = D_{gpt} + B_{gpt} \left(1 + \frac{v_b B_{gpt}}{2 TD} \right) \quad (24)$$

$$D_{pt+1} = D_{pt} + B_{pt} \left(1 + \frac{v_b B_{pt}}{2 TD} \right) \quad (25)$$

$$B_{pt} = \bar{B}_{po} \exp \{g_{pd} t\} \quad (\text{or} = \bar{B}_{pt}) \quad (26)$$

Equations of the Foreign Borrowing Model of Thailand

Private savings constraint

$$\sum_t S_{pt} > 0 \quad (27)$$

Public savings constraint

$$S_T > \tau \quad (28)$$

Foreign exchange balancing equation

$$\begin{aligned} \sum_{j = E, A, T} P W_{jt} X_{jt} + B_{gt} + B_{pt} = \sum_{i = A, T} P W_{it} M_{it} \\ + i r_t (D_{pt} + D_{gt} + D_{gpt}) + P W_{Tt} m J_{Dt} \end{aligned} \quad (29)$$

Government sector balancing equation

$$\begin{aligned} \sum_{j = E, A, T} e_t t x_{jt} P W_{jt} X_{jt} + \sum_{i = A, T} e_t t r_{it} P W_{it} M_{it} \\ + t y \{ \sum_{i = T, N, CO} W_{it}^U L_{it} + \sum_{i = E, A} W_{it}^R L_{it} \} + t k \left(\sum_i P V_{it} \frac{\alpha_{it}}{\kappa_{it}} K_{it} \right) \end{aligned}$$

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Equations of the Foreign Borrowing Model of Thailand

$$PV_{it} = P_{it} (1 - t_{id}) - \sum_j PP_j A_{ji} \quad (33)$$

Urban labor first order conditions

$$\frac{\partial Q_{it}}{\partial L_{it}} = \frac{W_t^U}{PV_{it}} \quad i = T, N, CO \quad (34)$$

Rural labor first order conditions

$$\frac{\partial Q_{it}}{\partial L_{it}} = \frac{W_t^R}{PV_{it}} \quad i = E, A \quad (35)$$

Full employment of urban labor

$$\sum_i L_{it} = L_t^U \quad i = T, N, CO \quad (36)$$

Full employment of rural labor

Equations of the Foreign Borrowing Model of Thailand

$$\sum_{i=E, A} L_{it} = L_t^R \quad (37)$$

Terminal conditions

$$J_{D \cdot T + 1} + \dot{m} J_{D \cdot T + 1} = \sum_i \left\{ \left(\frac{1+g}{(1+\eta)^i} - \alpha_i \right) \frac{1}{i} - 1 \right\} K_{iT} \quad (38)$$

$$\text{where } g = \left(\frac{1+ir}{(1+\eta)(1+\pi)(1+\delta)} \right)^{\frac{1}{b}} (1+\eta) \quad (39)$$

$$B_{g \cdot T + 1} = (g + \pi) D_T - \bar{B}_{p \cdot T + 1} \quad (40)$$

Notation

U	Utility
Q	Products
C	Private consumption
GC	Government consumption
X	Exports
XV	Value of exports
IM	Intermediate inputs
J	Real investment (J_D = Domestic content of real investment)
I	Investment expenditure
M	Imports
P	Producers' price
PP	Purchaser's price
PV	Value-added price
PW	World price
e	Nominal exchange rate
r	ratio of domestic product to Armington aggregate
TD	Total domestic demand for domestically produced goods
WT	World trade
W^U	Urban wage rate
W^R	Rural wage rate
ir	Interest rate

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L	Labor
Z	Land
K	Capital
TK	Total capital stock
L ^u	Urban labor
L ^R	Rural labor
mJ _D	Import content of real investment
S(.)	Shift function of labor from rural to urban (given exogenously)
D	Debt outstanding
TD	Total debt outstanding
B	New net borrowing
S	Savings

Subscripts

Sectors	E	Exogenous export sector
	A	Agriculture
	T	Tradeable
	N	Nontradeable
	CO	Construction
p		Private
g		Public
(gp		Public borrowing from private sources)

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t	Time
Superscript	
U	Urban
R	Rural
Parameters	
u	Investment adjustment cost factor
u_b	Borrowing adjustment cost factor
ζ	Elasticity of export with respect to the world demand
ξ	Elasticity of export with respect to relative prices
α	Capital share in production
β	Labor share in rural production
α_k	Manufacturing share in capital formation
b	Inverse of intertemporal elasticity of consumption
substitution	
θ	Elasticity of substitution between domestic and imported
goods	
ϵ	Distribution parameter of imports function
γ	Scaling parameter of imports function
δ	Pure rate of time preference
tx	Export tax
tid	Indirect tax
tr	Tariff
ty	Income tax on labor income
t_k	Income tax on capital income

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g	Steady growth state aggregate growth rate
gpc	Steady growth state per capita growth rate
g_{pd}	Growth rate of private borrowing
n	Population growth rate
π	Rate of inflation
τ	Constraint of the government savings in the terminal period
q	Technical progress factor in production
a_1	Share of tradeable consumption
a_2	Share of nontradeable consumption

Terminal Conditions

1. We resort to the turnpike theorem in deriving the terminal conditions of the model. The theorem states that an economic system abstracted into a model obtains the highest efficiency when: ^{1/}

- (1) the system first changes its capital structure toward the von Neumann balanced-growth proportions;
- (2) when it is sufficiently close to this configuration, it spends most of the time growing at the balanced-growth-state maximal rate.
- (3) as the end of the time horizon nears, it bends away from the balanced-growth to satisfy the desired terminal conditions.

In other words, the welfare of an economic system is maximized when it quickly approaches the balanced-growth path growing at the maximum rate and stays on it insofar as it is possible to do so.

2. We assume that by the time the model reaches the terminal period, the system has already come close enough to the desired balanced-growth path, and therefore, we force the system to be in that state from then on. This assumption effectively gives us the terminal

^{1/} See for example, Burmeister and Dobell (1970) for exposition of this theorem. Samuelson (1960) and McKenzie (1963) prove the theorem when the production functions are nonlinear.

conditions by specifying the necessary amounts of borrowing and investment that support the balanced-growth path which, in turn, satisfies the first order conditions of the dynamic problem.

3. This assumption is attractive because it gives the important terminal conditions within the framework of optimal growth theory.

There are, however, drawbacks. First, the system may not have obtained enough proximity to the "turnpike" by the terminal period to warrant such terminal conditions. Our terminal conditions, then, assign too high a value to the terminal capital stock and too high a cost to the terminal debt stock, thereby biasing the results toward higher investment and lower borrowing toward the end of the simulation period. As discussed in para. 61 of the text, this divergence may be significant close to the terminal period.

4. Second, the growth rate derived through assumptions that all the first order conditions are satisfied may not be compatible with the von-Neumann balanced-growth growth rate. We have not examined this possibility or its implications. Future efforts are clearly needed. We do agree, however, that the terminal conditions may be interpreted as a reflection of the planner's preference or general expectation as to which direction the economy is moving, rather than as a reflection of the strict optimality conditions of infinite time horizon models.

Derivation

5. If the growth rate of all real variables is g , and labor force grows at n , utility per capita grows by $((1 + g)/(1 + n))^{1 - b}$. The discounted sum of per capita utility after T th period to infinity is

$$\frac{U_T}{(1 + \delta)^{T-1}} + \frac{(1 + g)^{1-b}}{(1 + \eta)} \frac{U_T}{(1 + \delta)^T} + \dots$$

$$= \frac{U_T}{(\delta - gpc)(1 + \delta)^{T-2}}$$

where

$$gpc = \left(\frac{1 + g}{1 + \eta} \right)^{1-b} - 1$$

This is the second term in the objective function.

6. Terminal period borrowing and investment are the amounts that allow such a steady growth state. The first order condition for optimization with respect to borrowing in a two sector (tradeable and nontradeable) economy facing a real interest rate of rr is

$$(1 + \delta) \left(\frac{C_{t+1}}{C_t} \right)^b = (1 + rr) \left(\frac{P_{Nt}/P_{Tt}}{P_{Nt+1}/P_{Tt+1}} \right)^{1-a}$$

when consumption aggregate C is the Cobb-Douglas function of sectoral consumption (See Glick and Kharas, 1984). With exogenous rates of population growth and inflation, the same relationship can be rewritten as

$$C_{t+1} = \frac{(1 + ir)(1 + \eta)^b}{(1 + \eta)(1 + \pi_T)(1 + \delta)} \left[\frac{1 + \pi_T}{1 + \pi_N} \right]^{1-a} \frac{1}{b} C_t$$

where ir is the nominal interest rate and

$$\pi_i = \frac{P_{it+1}}{P_{it}} - 1 \quad i = T, N$$

Assuming a constant real exchange rate, i.e., $\pi_T = \pi_N = \pi$ (at, say, the world inflation rate), g can be expressed as

$$1 + g = \left(\frac{1 + ir}{(1 + \eta)(1 + \pi)(1 + \delta)} \right)^{\frac{1}{b}} (1 + \eta)$$

and

$$1 + gpc = \left(\frac{1 + ir}{(1 + \eta)(1 + \pi)(1 + \delta)} \right)^{\frac{1-b}{b}}$$

The sectoral output also grows at g with labor force in each sector increasing at η . The capital stock in each sector has to grow at

$$\left(\frac{1 + g}{(1 + \eta)} \right)^{\frac{1}{1 - \alpha_i}}$$

for each sector, when α_i is the capital income share in sector i . The debt outstanding in real terms also grows at g . In nominal terms, it then grows at $g + \pi$.

Appendix 3

1. Foreign transfer F is defined here as consumption plus investment less total outputs.

$$\begin{aligned} F &= (P_c C + P_I I - P_y Y) \frac{1}{e} \\ &= \left(\frac{P_c C}{P_z Y} + \frac{P_I I}{P_T Y} - 1 \right) Y P_y \frac{1}{e} \end{aligned}$$

The differentiation of this and division by Y (GDP) gives us.

$$\begin{aligned} \frac{dF}{Y} &= (P_c dC + P_I dI) \frac{1}{e} + (dP_c C + dP_I I) \frac{1}{e} + (P_c C + P_I I - 1) \frac{dY}{eY} \\ &\quad + (P_c C + P_I I - 1) d\left(\frac{1}{e}\right) \end{aligned}$$

The terms on the RHS are from the first, structural change effects, price effects, growth effects and exchange-rate effects.