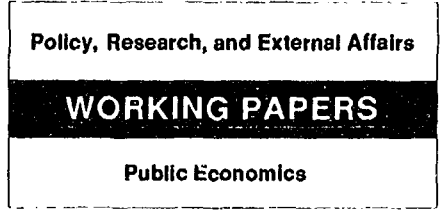


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External Shocks, Adjustment Policies, and Investment

Illustrations from a Forward-looking CGE Model of the Philippines

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The rapid increase in investment and external debt of middle-income countries like the Philippines during the 1970s was perfectly "rational" behavior, given existing policies. However, these countries could have done better with an appropriate mix of adjustment policies. The paper highlights the intertemporal tradeoffs of tariff reform, emphasizing the need for complementary measures to ease macro imbalances and short-term dislocations of the protected sector.

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This paper — a product of the Public Economics Division, Country Economics Department — is part of a larger effort in PRE to examine open-economy tax reform and adjustment policies in developing countries. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Ann Bhalla, room N10-059, extension 37699 (48 pages).

Go developed a model that integrates both temporal and forward-looking behavior in investment and consumption decisions in a multisectoral general equilibrium framework applicable to developing countries. It formulates and uses an infinite-horizon growth model to examine the adjustment, growth, and debt problems of a middle-income country, which Go illustrates using data for the Philippines.

The simulations illustrate the importance of rational, forward looking behavior in consumption and investment. They show how an import price shock could lead to an investment boom and rapid expansion of foreign debt, as happened in the mid-seventies to many developing countries.

The rapid expansion is hard to explain without investigating the dynamic competitive conditions between domestic and foreign goods economies in response to this shock. The increase in current account deficits and foreign debt after an import price shock, for example, is certainly greater than would be implied by just the increase in foreign prices. Go concludes, among other things, that:

... Expectation is a key factor. Contrary to the common suggestion that an economy should adjust and contract in response to a permanent import price shock, the behavior suggested in a model with rational expectations in investment decisions is that the opposite can be true. The expectations prevailing in the mid-seventies were that the energy crisis was permanent, the days of cheap oil were over, and petrodollars would continue to be available. But conditions soon changed. The actions of the high-debt developing countries appear "imprudent" viewed

from the perspective of the interest rate shock of 1979. The expectation that debts could be stacked indefinitely was clearly wrong and the interest rate shock after 1979 came as a surprise to many.

- The results demonstrate both the promise and danger of liberalization, an adjustment policy often recommended in the 1980s. Tariff reform shows the expected benefits in the primary sector and to some degree in exports. But it may easily lead to a contraction in the protected sector like manufacturing, a decline in tax revenues, more current account deficits, and more debt. Other measures are needed.

- In general, Go finds that a combination of policies is effective in maintaining growth and exports without a rapid accumulation of debts — even during a permanent import price shock. In fact, an import price shock is an attractive occasion for tariff reform, as it eases pressures on domestic prices, prevents exports from declining too much, and does not lead to an expansion of import demand that normally accompanies a tariff reduction.

Combined with other policies, tariff reform could rechannel investment and resources toward the more tradable sectors and exports can be emphasized and increased. If domestic resources are also mobilized through increased tax collection, the combined effect will be to reduce or slow the accumulation of foreign debt.

In other words, middle-income countries like the Philippines missed a golden opportunity for policy reform in the 1970s and found it harder to implement adjustment policies under less favorable circumstances in the 1980s.

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1 Introduction

The economic difficulties triggered by high oil prices during the brief Persian Gulf crisis underline the continuing importance of external developments and adjustment policies in shaping the economic performances of developing countries. It may be recalled that during the seventies, a number of middle-income and semi-industrial countries actually did well after the 1974 oil crisis but had difficulties after the 1979 oil and interest rate shocks. Hindsight tells us that many of these developing economies over-invested and over-borrowed in the mid-seventies but had to contract when faced with constraints in further borrowing after 1979.¹ The implementation of adjustment policies in the eighties has led to the problem of slower growth, characterized by a drop of investment as a ratio to GDP.² A key factor in these experiences is the behavior of investment and its sensitivity to price changes brought about by external shocks and policy changes. Why did investment in some middle-income countries rise so much in the seventies only to have severe debt problems later? Why did investment decline when adjustment policies, such as trade reform, are adopted? These policies, aimed primarily at making investment and growth more efficient and less dependent on foreign resources in the eighties, are constrained by their adverse impact on macro balances and investment activities in the short term. This study attempts to explore this type of investment and growth responses in a middle-income country like the Philippines by using a dynamic general equilibrium analysis.

¹These observations were made by several studies such as Balassa (1986) and Balassa and McCarthy (1984).

²See, for example, reviews of adjustment lending experiences of the World Bank which contain major concerns for the recovery of investment and its productivity in *Adjustment Lending - An Evaluation of Ten Years of Experience* (1988) and *Adjustment Lending Policies for Sustainable Growth* (1990).

1.1 General Framework

This study is distinguished from other research on developing issues by the integration of an intertemporal and forward-looking behavior in investment and consumption decisions in a computable general equilibrium (CGE) framework applicable to developing countries. It formulates and uses an infinite-horizon growth model to examine the adjustment, growth and debt problems of a middle-income country using Philippine data for illustrations. This growth model is multisectoral and intertemporal. It combines the intersectoral efficiency in the allocation of resources resulting from market clearing and endogenous prices of a general equilibrium model with the intertemporal efficiency generated from the dynamic optimization of the firm and the utility of an aggregate consumer.

This quantitative framework allows us to explore several issues about the growth and investment behavior of a middle-income country in a way not possible in models without expectations. While there is growing number of CGE applications to developing issues, for example, Devarajan and Sierra's examination of Thailand (December 1986) and Lewis' study of Turkey (July 1986), these CGE models are static in nature and are ill-suited for analyzing the dynamic processes of growth.³ In particular, the effects of external shocks and adjustment policies on investment and growth are inherently dynamic -- an import price shock or a tariff reform changes the expectation of profits permanently and hence the level and pattern of investment. In these previous CGE studies, an economy's movement in time is described by a series of static equilibria strung together by updates in the levels of factor endowments. These updates are *ad hoc* and exogenous to the tâtonnement. In relation

³The strengths and weaknesses of economy-wide models in analyzing development issues are discussed in Bell and Srinivasan (1984).

to the observed patterns of middle-income countries during the seventies, these previous CGE studies stop short of explaining why investments (hence debts) were high after the first oil shock in 1974 and low after the second shock in 1979. Investment levels were either exogenously fixed at their high levels or driven low by arbitrarily setting them equal to a lower level of domestic and foreign savings as required by the macro-closure of the model. One effect that these models were designed to measure - the intersectoral reallocation of resources caused by the market price shifts - was often swamped by exogenous changes in investments.⁴

To examine these dynamic issues, a forward-looking behavior in investment and consumption is embedded in a multisectoral and general equilibrium representation of a developing economy. Unlike the static case, the solution of the model is a dynamic competitive path in the sense that it is an intertemporal path along which the economy is always in general equilibrium. It is characterized by three key features - the simultaneity of investment and saving decisions, the intertemporal and forward-looking behavior, and a general equilibrium applicable to developing countries.⁵

First, savings and investment decisions are not only intertemporal but separate and simultaneous. Investment is neither fixed as in static CGE applications nor dynamically passive as in studies concerned mainly with optimal borrowing, for example, Kharas and Shishido's (1985) study of Thailand and Devarajan's (1986) examination of Korea. The

⁴While it is possible to set the various elasticities of substitution very low to have strong reallocation effects, convergence problems are often encountered first as the models become rigid and approach Leontief's fixed-coefficient world. The effects of relative price shocks in a static CGE generally run their course in a single period and have less impact on real income over time than changes in factor supplies.

⁵There are some recent studies that utilize intertemporal models with forward-looking investment behavior, but they are not applied to development problems. For examples, Bruno and Sachs (1985) and Summer (1985) have forward looking investment incorporated in very macro simulation models with applications to the OECD countries or the United States. Wilcoxon (1986) discusses forward looking investment in general equilibrium models and their numerical calculation using linearization. Goulder and Summer (1989) incorporates this type of investment behavior in a multisectoral general equilibrium model for the United States and examines tax incentive issues for investment.

solution is decentralized. At each point in time, consumption is an increasing function of wealth as in a choice-theoretic and life-cycle consumption model. Investment is an increasing function of Tobin's q , the ratio of the present value of profits to the cost of capital, and is subject to adjustment cost as in Hayashi (1982). The macro-closure and equality of savings and investments are brought about by an endogenous adjustment in the level of foreign borrowing, supplied at a given world interest rate. We assumed that a middle-income country have sufficient access to the world capital markets in the seventies. When foreign borrowing is constrained as in the eighties, we explore domestic sources of savings and examine the impact on debt accumulation.

Second, the model is dynamic and forward-looking. Consumption smoothing is carried out by the consumer in anticipation of changes in consumer prices. Similarly, capital accumulation is started by the firms in response to future prices of net output and the cost of capital. In this model, consumer and producer prices are determined by the prices of domestic and foreign goods that are imperfect substitutes. Hence, the dynamic paths of consumption and investment will depend on the changing competitive conditions between domestic and foreign goods. These conditions are reflected in the appropriate real exchange rates and their impact on the intertemporal rates of transformation for consumption and investment. Moreover, because of the adjustment cost, the new steady-state capital stocks are approached gradually over time. The speed of adjustment in the production sector is not instantaneous.

Third, it is a multisectoral and general equilibrium model with imperfect substitution. In addition to the Walrasian paradigm of price endogeneity and market clearing, a variety of imperfect substitution in the trade and labor markets are incorporated. Thus in each

period, changes in relative prices will affect resource allocation in the tradition of general equilibrium models applied to developing countries.

Finally, a middle income country is chosen because the higher per capita income reflects a more diversified economy with a more developed manufacturing sector capable of independent investment decisions. The analysis uses the Philippines as a case in point. Like other oil-importing and middle-income developing countries, the Philippines was hit hard by the four-fold oil price increase in 1974 and the world-wide inflation and stagnation after. Yet from 1974 to 1979, the Philippine economy grew by 6.5% annually which was higher than its long term growth of 5.5%. Much of this growth was financed by external borrowing. When foreign loans became costly in the eighties and adjustment policies were undertaken, the economy went through a serious financial crisis that was eventually marked by a 10% decline in GNP and widespread unemployment during 1983-85. As in many such instances, the repercussions went beyond the economic sphere and contributed to a popular civilian-military rebellion that brought down a 20-year strongman government in early 1986. The size of the foreign debt in the Philippines was a staggering \$26.2 billion in 1985. This was about 80% of its annual gross national product (GNP). Debt service required \$1,257.0 million or about 27% of its annual merchandise exports. In recent years, moderate economic growth has been restored but the country is still faced with serious questions about its long-term policies and prospects. Taking the Philippines as an example and using a dynamic simulation model, can we explain its economic and investment performance? What could have been done differently?

1.2 Organization of the Paper

The remaining sections of this paper are organized this way. Section 2 briefly describes the specification and implementation of the model. Section 3 examines the growth and investment behavior of a middle-income country in the seventies and early eighties by introducing an import price shock to the model. To examine whether the dynamic effects generated by the proposed framework add new insights to the observed responses of the middle-income countries, we compare the results with those a static CGE model. Section 4 investigates some of the policy options while section 5 summarizes the findings and conclusions.

2 Model

In this section, we briefly describe the framework with emphasis on the intertemporal consumption and investment.⁶ A list of equations and a glossary of terms are included in the appendix. A reference such as 'A20' means equation '20' in Appendix A.

2.1 Consumption

The representative consumer maximizes his expected utility or the present value of the utility of total consumption in each period which is expressed as follows:

$$\max \int_1^{\infty} \frac{1}{1-v} C_t^{1-v} e^{-\rho t} dt \quad (1)$$

This is a familiar homogeneous utility function which is additively separable and a case of constant elasticity of marginal utility v . This type of utility function has been used often by Ramsey, Frisch, Timbergen and others in the economic literature. Consumption

⁶Go (1988) provides a more detailed discussion, including the derivation and calibration of various equations in the model.

is discounted by the consumer's rate of time preference ρ . In order to maintain dynamic consistency as posed by Strotz (1955-56), we assume that ρ is fixed through time. At each point in time, the consumption bundle C is defined by a Cobb-Douglas aggregation of specific consumer goods C_i . This is akin to an intra-period utility function with fixed expenditure shares α_i (A2). The intertemporal condition for consumption determines the forward rate of growth of consumption in response to changes in the intertemporal rate r_{ct} by which current consumption is transformed into future consumption⁷ -

$$\frac{\dot{C}_t}{C_t} = \frac{r_{ct} - \rho_t}{v} \quad (3)$$

A large r_c makes future consumption cheaper and the rate of growth of consumption will increase, and vice-versa. The intertemporal rate r_t is determined by the opportunity cost of savings, the cost of foreign borrowing (A22). This depends on the world interest rate i^* and the real exchange rate e_{ct} by which import substitutes of domestic goods are traded to satisfy consumer demand.

Aggregate consumption is function of wealth and can be derived from the optimal conditions and the wealth constraint. In the solution strategy however, we take advantage of certain conditions in which a central planning formulation will give identical results as a decentralized CGE with a single infinitely-lived consumer. Furthermore, the consumer bud-

⁷The Hamiltonian for this problem is

$$H = e^{-\rho t} [U(C_t) + \gamma_t (YC_t + r_{ct}W_t - PC_t C_t)] \quad (2)$$

The optimality conditions from the maximum principle are as follows:

- a) $\frac{\partial H}{\partial C_t} = 0 \Rightarrow U_C = \gamma_t P C_t$
- b) $\frac{\partial H}{\partial C_{it}} = 0 \Rightarrow U_{C_i} = \gamma_t P_{it}$
- c) $\frac{\partial (e^{-\rho t} \gamma_t)}{\partial t} = -\frac{\partial H}{\partial W_t} \Rightarrow \frac{\dot{\gamma}_t}{\gamma_t} = (\rho_t - r_{ct})$
- d) $\lim_{t \rightarrow \infty} e^{-\rho t} \gamma_t = 0$

Condition a) and b) are the first order conditions for the consumption of aggregate and specific goods, respectively. The marginal rate of substitution between two goods is derived from b) and is equal to their price ratio in every period (A3).

Condition c) and d) are the intertemporal and transversality conditions, respectively. Noting that $U_C = C_t^{-v}$ and that $\dot{\gamma}_t/\gamma_t = \dot{U}_C/U_C$, the intertemporal condition for consumption is derived as equation (3).

get is effectively a 'national' budget. This is reflected in two ways. Wealth of the consumer includes the total capital stock of the economy and the capital formation needed to create this stock is the total savings available in the economy for each period.

2.2 Investment

Following pioneering work by Abel (1980), Hayashi (1982) and others, investment in each sector is a function of Tobin's q and the parameters of an adjustment cost function $\theta(\cdot)$ as in the expression found in Summers (1981)⁸ -

$$\begin{aligned} \frac{I_t}{K_t} &= h(Q_t^T) \\ &= \alpha + \frac{1}{\beta} Q_t \quad \text{where} \\ Q_t^T &= \left[\frac{q_t}{PK_t} - (1 - bb - tc - DPN_t) \right] / (1 - tk) \end{aligned} \quad (4)$$

where Q_t^T is the ratio of the shadow price of capital q_t and the replacement cost of capital PK_t , adjusted for various taxes, and, α and β are parameters of a quadratic adjustment cost function (A10). The various taxes in the investment equation include - DPN_t (A8), the present value of depreciation allowances on a unit of new investment; bb , the rate of current incentives given to new investment; tc is new tax credit on a unit of investment; and tk is the tax rate capital income. Favorable changes in tc or DPN_t is equivalent to a reduction in the acquisition cost of capital J_t (A6) for the firm.

⁸The exact form of the investment equation depends on the specification of the adjustment cost function $\theta(\cdot)$. It takes the quadratic form (equation A10) suggested in Summers (1981). This function is treated as external to the firm in this study while it internal in Summers (1981). If $\alpha = 0$, the adjustment cost function and investment equation reduce to a linear form used in Bruno and Sachs (1985).

The investment function is derived from the problem of a producer that maximizes the value of the firm. The Hamiltonian for the problem is

$$H(t) = \mu(t)[R(t) - q_t(I_t - \delta^R K_t)] \quad (5)$$

where $R(t)$ is net revenue less investment expenditures and $\mu(t)$ is the discount factor (equation A20) The optimality conditions from the maximum principle are as follows:

In this formulation, firms invest up to the amount until the marginal cost of investment is equal to the shadow price of capital or the present value of the future marginal revenue products of capital (equation 8).⁹ This approach has natural economic interpretation and is closely related to the concepts of economic project appraisals. In most project appraisals however, the shadow and future prices are obtained independently. Here, they are derived from the intra-period solution of the general equilibrium which in turn interact dynamically with the investment paths. An intertemporal equilibrium is attained when the expectations of future prices in investment decisions conform to the values eventually realized in the future. q_t is net of adjustment cost $\theta(\cdot)$, the presence of which reduces the shadow price and makes investment less attractive.

By Hayashi's identity, the shadow price of capital q_t is equivalent to the average q , the ratio of the value of the firm V_t and its capital stock K_t , adjusted for DPO_t (A9), the present

$$\begin{array}{ll}
 \text{a) } \frac{\partial H}{\partial L_t} = 0 & \Rightarrow (1 - tk)p_t F_L(t) = W_t \\
 \text{b) } \frac{\partial H}{\partial N_t} = 0 & \Rightarrow (1 - tk)p_t F_N(t) = PN_t \\
 \text{c) } \frac{\partial H}{\partial I_t} = 0 & \Rightarrow J'(I_t) = q_t \\
 & \text{or } PK_t(1 - bb - tc - DPN_t + [\theta(\cdot) + x_t \theta'(\cdot)]) = q_t \\
 \text{d) } \frac{\partial(\mu_t q_t)}{\partial t} = -\frac{\partial H}{\partial K_t} & \Rightarrow \dot{q}_t = (r_t + \delta)q_t - R_k(t) \\
 & \text{or } r_t q_t = R_k(t) + \dot{q}_t - \delta q_t \\
 \text{e) } \lim_{t \rightarrow \infty} \mu_t q_t K_t = 0 &
 \end{array}$$

where

$$R_k = (1 - tk)p_t F_k(t) - PK_t x_t^2 \theta'(x_t)$$

Condition (a) and (b) require that labor and material inputs are hired so that their marginal revenue products equal their market prices.

Condition (c) states that investment takes place until the marginal net cost of investing equals the shadow price of installed capital q_t . Since $\theta'(\cdot) > 0$, the equation can be inverted to derive an investment function with (I_t/K_t) as an increasing function of q_t .

$$I_t = h(q_t)K_t \quad (6)$$

The next condition (d) states that the required return of capital $r_t q_t$ is equal to the marginal revenue product of the added capital R_k plus capital gain \dot{q} net of depreciation loss δq_t . R_k is defined as

$$R_k = p_t F_k(t) - PK_t x_t^2 \theta'(x_t) \quad (7)$$

$x_t^2 \theta'(\cdot)$ is a reduction in the marginal revenue product of capital due to the adjustment costs. Equation (d) is a differential equation that can be solved subject to the transversality condition (e) to yield the equation for q_t (equation 8).

⁹See condition (d) in the previous footnote.

value of depreciation allowances allowed by tax laws on *existing* accounting capital stock.

$$\begin{aligned}
 q_t &= \int_t^{\infty} R_k \exp[-\int_t^{\infty} (r_t + \delta)dv]ds \\
 &\equiv \frac{V_t - DFO_t}{K_t}
 \end{aligned}
 \tag{8}$$

In a simple case without taxes, Q_t in the investment function becomes -

$$\begin{aligned}
 Q_t &= \frac{q_t^a}{PK_t} - 1 \\
 &= \frac{V_t}{PK_t K_t} - 1
 \end{aligned}
 \tag{9}$$

The first term on the right is simply's Tobin's q , the ratio between the value of the firm and the replacement cost of capital. Thus, if Tobin's q or the real shadow price of capital is greater than 1, investment will increase, and vice-versa if it less than 1.

2.3 The Intra-period CGE

The intertemporal investment and consumption are embedded in a computable general equilibrium model which incorporates many stylized features of a developing economy. Generally, these features follow the family of CGE models constructed for developing countries by Dervis, de Melo, and Robinson (1982).¹⁰ Production is a nested function of inputs. Output in each sector is a CES combination of value added and material input (A29-31). Material input is a fixed-coefficient aggregation of inputs (A35-6). Value added, on the other hand, is another CES composite of labor and installed capital (A32-4). Labor market is fragmented - labor in each sector is a Cobb-Douglas combination of urban and rural types (A37-9); but sectoral wages are fixed proportions of wages for each labor type, reflecting differences in productivity (A40).

¹⁰A survey of such CGE models is found in Robinson (1988).

Imperfect substitution characterizes the trade markets. This is reflected in the Armington function between domestic goods and imports (A46-9) and the constant elasticity of transformation (CET) between sales to the domestic market and sales to the export markets (A42-5). Moreover, reflecting the country's endowments, trade specialization, and past policies, the baskets of export goods and import goods are different. This dichotomy implies that the exchange rate in the demand side depends on prices of domestic goods and their import substitutes (A22) while the exchange rate in the supply side, r_p , relies on domestic and export prices (A21).

2.4 Equilibrium Conditions

To arrive at a dynamic solution, two sets of equilibrium conditions must be satisfied. First, expectations about future prices and variables are 'self-fulfilling' and conform to values eventually realized in the future. This is the intertemporal requirement for the forward-looking and perfect foresight. Second, given expectations about future prices, supplies must equal demands for a general equilibrium in each period.

After a policy change or external shock, the intertemporal conditions for consumption (A14) and investments (A15-6) will nudge the economy towards new steady state levels (A25-8) from which everything grows at a constant rate g . Given initial capital stocks, there is only one unique path that will lead capital accumulation to the steady state level I^*/K^* . Likewise, there is only one consumption path consistent with the consumer wealth generated by investment and labor earnings in each period. The lead variables in this path, consisting of the exchange rates affecting the intertemporal transformation rates (A21-24), guarantee that the future prices of domestic and foreign goods are fully anticipated. Because

the baskets of goods for exports and imports are different, the intertemporal transformation rates for consumption and investment in each period may diverge. Consumers face the costs of domestic goods and import substitutes in their decisions while producers look at the sale prices in the domestic and export markets. In the steady state however, a unique asset equilibrium is attained. All relative prices become stable and the exchange rates cease to change, $\dot{e} = 0$. At this point, all asset prices converge to the world interest rate (A28).

Given expectations of the lead prices, the equilibrium conditions in each period require that – (i) the demand for each labor types equals its supply (A61); (ii) the demand for goods equals the supply from each sector (A62); (iii) the balance in the external current account must be offset by flows in the capital account (A63); and, (iv) total savings must cover total investment (A64).

2.5 Solution Strategy

In the model, producers maximize profits and a single consumer maximizes its utility in an Arrow-Debreu CGE framework. We can solve this type of formulation as a master plan with a solution which will be identical to the competitive equilibrium.¹¹ That is, –

$$\max \int_s^{\infty} U(C_t)e^{-\rho t} dt \quad \text{subject to} \quad (10)$$

the investment and CGE equations

Moreover, by Walras' law one of the budget constraints is not independent and we choose to omit the complicated wealth constraint of the consumer, reducing the dimension of the problem.

¹¹Ginsburg and Waelbroeck (1981) prove an existence theorem that links and emphasizes the symmetry between the competitive model and certain planning models. The equivalence of the two approaches in an infinite-horizon macro-model is also discussed in Abel and Blanchard (1983).

<i>Sector</i>	σ_c	σ_t	σ_q	σ_v
Primary	2.00	3.00	0.75	1.25
Manufacturing	1.25	1.50	0.75	0.85
Services	0.60	1.00	0.75	1.25

Table 1: Trade and Production Elasticities

The model is calibrated to generate a reference steady state run with values that match the benchmark data of the Philippine economy. The derivation of these data and parameters are based on a 1979 social account matrix (SAM) and CGE model for the Philippines in Go (1986 and 1988). For this study, there are three production sectors – the primary sector, manufacturing, and services; two labor types – urban and labor; and, one representative household but four distinct institutions – urban labor, rural labor, firms, and government. The trade-related elasticities, σ_c for the Armington functions and σ_t for the CET functions, are generally higher in the commodity sectors than in the less-tradable service sector (see Table 1). In the nested production function, the elasticity of substitution σ_q between intermediate input and value-added is set at less than unity to allow for flexible and increasing shares of material costs in the event of an input price shock. The elasticity of substitution between labor and capital σ_v in value added is less in manufacturing than in other sectors, given the assumption that skill and training are required more in manufacturing. However, the σ_v 's in manufacturing are still close to unity.¹² The manufacturing sector is the most capital-intensive while the primary sector is the most labor-intensive. The balanced-growth rate, g , is specified at the long-term growth of the Philippine economy at 5.5% a year.

¹²This is consistent with the findings in other studies, Behrman (1982) which uses cross-country data and Estanislao (1980) which uses Philippine time series.

The parameters are tested to replicate historical paths of the Philippines during 1974-85.¹³ In general, we find that the values, $\alpha = 0$ and $\beta = 2$, are reasonable. These values imply a linear adjustment cost function similar to Bruno and Sachs (1985). They generally will add a 10.5% adjustment cost to investment expenditures at the steady-state. In the consumer utility function, we set $v = 0.90$ and calibrate p from the state-state condition (A27). Taken together, the parameters indicate a stronger intertemporal substitution in the supply side relative to consumption.

We follow the usual procedure in solving an infinite-horizon growth model by requiring that a steady-state is reached at some future terminal period. For as long as the transversality conditions (A18 and A19) in the maximization of the objective function and the value of the firm are satisfied, the sums of various infinite series (pertaining to the utility function, the value of the firm, the present value of depreciation allowances, and the shadow price of capital) will be finite and solvable. A sufficient condition is that the discount rate and the rate of time-preference are positive and greater than the balanced-growth rate.¹⁴

3 External Shocks

In this section, we examine the effects of an import price shocks in a middle-income country like the Philippines using simulations from the dynamic CGE model. We take the case in which foreign lending is not constrained and foreign debt is endogenous. The shocks to

¹³This step is implemented in Go (1988).

¹⁴The model is solved by using a high-level modeling language called General Modeling System (GAMS) with the Minos5 as the solution algorithm. See Brooke, Kendrick, and Meeraus (1988) for a full exposition. The version of GAMS used in this study will actually solve for 30 periods but the computing time will increase geometrically. For the purpose of this study, 20 periods are used most of time. This is not a serious constraint - given reasonable parameters in the adjustment cost function, most of the adjustments are exhausted within 10 to 15 years. Moreover, to prevent rounding errors and small data infeasibilities in the base-year from blowing up by exponential growth, the variables and solutions are detrended by the balanced-growth rate itself. Detrending also allows us to check if the model generates and replicates the base-year data in a steady-state solution.

the system are permanent in nature but initially unanticipated. The external disturbance is an *import price shock* involving a 50% increase in the import price of primary goods which include oil. This is a reasonable replication of the 1974 oil crisis since it causes an immediate worldwide inflation which raises the cost of imported raw materials everywhere. Another type of major disturbance is an interest rate shock much like in the late seventies. However, the effects of the latter, which is an outright shift in the intertemporal rate of transformation of resources, are straightforward and will lead to a decline in investment and a contraction in the economy as what happened to many middle-income countries after 1979.¹⁵ Hence, we consider only the import price shock.

Several questions are raised in this exercise. Do the simulation results illustrate the observed responses of middle-income countries in relation to the import price shocks during the 1970s? Does the introduction of forward-looking and dynamic behavior make any difference? There are several dimensions to this issue. In relation to a comparable static CGE model, what are the *qualitative* differences in behavior? Are there changes in the *signs* of the effects? Are the *magnitudes* of these differences large?

The results are presented in graphical form for easier interpretation. In each graph, a horizontal line equal to one along the vertical axis is taken as the reference balance growth run. Each deviation from this reference traces the effects on a key variable of a change in policy or the advent of an external shock.

¹⁵See Go (1988) for details of this simulation.

3.1 The Impact of an Import Price Increase

The dynamic effects of an import price shock in the primary sector are summarized in Figure 1 to 4. One immediately discernible effect is the increase in *real investment* ('Invest' in Figure 1). This is in fact what happened after the oil crisis in 1974 to many middle-income countries like the Philippines. In this simulation, total investment goes up to about 1.04 times the benchmark level and gradually settles at 1.03. For a shock comparable to the magnitude in 1974, the increase will be a lot more. There are several reasons for this increase.

First, the shock is a boost to the production of primary goods but causes a contraction in trade. The increase in import price will favor the demand of domestic variety of primary goods. It is also an input price shock that raises output prices, notably in the raw material intensive sector such as manufacturing. Because of the effects of demand substitution and the input price shock, domestic prices will rise unambiguously. With other world prices constant, the real price of exports relative to domestic prices ('PWE/PD' in Figure 1) will decline, causing a shift away from export supply. Overall, both imports and exports will decline. The import price shock works out like an increase in tariff protection with Stolper Samuelson-like effects (for specific factors) on the favored sector. The equivalent experience in the Philippines in the mid-seventies is the rapid rise in the supply of domestic energy, particularly in the areas of geothermal, hydro power, and non-traditional energy sources.¹⁶

Much of the dynamic impact depend on domestic prices and how they affect the rates of intertemporal substitution. For the consumer, the increase in domestic prices and import

¹⁶The episode indicates that the substitution elasticity in energy sources, although costly, is greater than zero.

prices will clearly raise consumer prices. This will reduce real wealth and decrease consumption below the benchmark levels. Moreover, domestic prices do not go up as much as the import price shock because of the imperfect substitution. As producers increase outputs, the rise in domestic prices also will slow down eventually. This implies a deteriorating depreciation of the real exchange rate and the rate of intertemporal substitution will increase, making future consumption goods cheaper. A process of consumption smoothing will occur in favor of postponing consumption. In time, consumption rises slightly from the initial drop but remains below the benchmark level ('Consum' in Figure 1).

For the producers, the increase in domestic prices raises the expectations of profits and value of the firm by causing an appreciation in the exchange rate and an immediate decline in the intertemporal rate of transformation. The shadow price of capital will thus go up. Tempered somewhat by the higher replacement cost of capital, the tax-adjusted Q^T 's still go up and sectoral investments are encouraged (Figure 3). Among the three sectors, investment in the primary industry jumps the highest in the first few periods as expected. In manufacturing, the increase in the costs of material inputs and replacement capital will discourage investment initially. Interestingly however, investment in the service sector goes up and stay above the benchmark levels. The contraction in foreign trade and the availability of foreign borrowing will in effect favor the least tradable sector in a *Dutch Disease* like phenomenon. The historical analogy in the Philippines is the boom in hotel and other real estate construction in the mid-seventies.

The presence of forward-looking investment behavior with adjustment costs amplifies the magnitudes of some effects in the early stages. With supplies adjusting slowly, domestic prices move rapidly to signal shortages and to create the appropriate expectations of net

income and their timing so that investments are made immediately. Over time, the process is reversed by changes in domestic prices brought about by investments and their impact on supplies. The production of domestic substitutes will slow the initial changes in prices and bring about a correction of the intertemporal transformation rates. As a result, investment in the primary sector will slowly decrease from its initial peak. In the manufacturing sector, the long-term conditions are more favorable with cheaper costs of materials and replacement capital becoming available. Its investment will eventually rise again and settle near the benchmark level. In the service sector, its investment will remain stable at higher than the benchmark levels. The switch away from foreign trade benefits this sector. In the primary good sector, the shock acts like a permanent protection. Its investment and output settle at higher levels than the other sectors (Figure 4). For the manufacturing sector, the input price shock reduces its output supply permanently. Since its capital stock returns to the benchmark level eventually, the shock leaves a permanent loss in the productivity of its capital.

Because of the investment activity, the current account deficits and the foreign debt also rise more steeply than would be the case. This is precisely the experience of some middle-income countries in the 1970s. Current account deficits ($M - E$) jump to 1.6 times the benchmark level at the start (Figure 2). They eventually stabilize at 1.18 as exports become more competitive when domestic prices start to soften. Foreign debt is about 1.15 times greater than the benchmark at the end.

3.2 Features in the Dynamic Behavior

In discussing the import price shock, three dynamic features of the model were implicitly emphasized - first, the simultaneity of investment and savings behavior; second, the intertemporal and dynamic character; and third, the forward-looking behavior of investment and consumption. To isolate these features, we compare the results from a static CGE model. The static version is the same model without the intertemporal consumption and investment. Consumption of each good is a fixed share of household income. The investment-saving identity is closed by either fixing sectoral investments or total savings through a constant level of foreign borrowing. In the latter case, sectoral investments are allocated on the basis of relative profitability.

3.2.1 The Simultaneity of Investment and Savings

One immediate difference is the closure of the savings-investment identity. In the static model, one component has to be fixed. We show the effects of the shock in each case (Figure 5-8) and identify the important differences.

1. *Fixing sectoral investments* (Figure 5-6) makes capital accumulation a trivial case. The import price shock still causes a contraction in trade as expected, more in imports than exports. Consumption also declines in response to higher prices. GNP declines slightly as a result. Because real investments are fixed, the current account deficits ($M - E$), foreign borrowing, and debt will increase only slightly.
2. *Fixing foreign borrowing* (Figure 7-8) makes the story in the balance-of-payments trivial. In addition to the contraction in trade, consumption, GNP, and investment

also will decline. Investments are now more costly and will decline in relation to a constant level of total savings. Among industries, the higher prices in the primary industry will raise its investment and capital stock while contractions are observed in manufacturing and services.

3. *Differences*: First, the *magnitudes* of the effects in a static model are small compared to the dynamic effects. The intersectoral effects are immediately exhausted in a static CGE model while these are amplified in the dynamic version. The magnitudes in the rise in investments, the current account deficits, the foreign borrowing and debts are nowhere near duplicated in the static results. This is true in either closure of the static case. Second, the *sign* of some effects are different. In the dynamic case, real GNP eventually rises above the balanced growth trend. Another obvious difference is the rise in investments in the service sector. The *Dutch disease*-like boom in the least tradable sector is simply missing. In the static model, investment in the service sector is either fixed or will contract.

3.2.2 The Intertemporal behavior

The shifts are one-time effects when investments are fixed. What appear as downward shifts in sectoral investments, GNP, consumption, exports and imports in the case of fixed foreign borrowing are not due to economic behavior. They are caused by the rising debt service payments as the external debt moves along the balanced growth trend. Since foreign lending is fixed, the portion of borrowing devoted to debt service payment rises and net foreign savings will decline in time. Hence, another difference is the rich story brought by the changes in relative levels of domestic prices and world prices. In an intertemporal

model, producers compete in both the domestic and export markets; the consumer chooses between imports and domestic goods and starts a consumption smoothing in response to changes in the exchange rate. These time-dependent patterns are simply missing.

It is also erroneous to think that the results of the static model are equivalent to the steady-state changes in the dynamic model. The magnitudes are different - note sectoral investments and balance-of-payments figures. Some of the signs in the steady-state are also different - note real GNP and sectoral investments of services and manufacturing.

3.2.3 The Forward-Looking behavior

The forward-looking feature is best illustrated by introducing the permanent import price shock in a future period rather than the first period. Using the sixth period as the cut-off point, we compare effects of a future import price shock in a static CGE model using a savings-driven closure (Figure 9) with the results in a dynamic CGE model (Figure 10-2). In the static case, all changes begin only in the sixth period when the shock occurs. The results are the same as those in Figure 7-8 but are moved forward as we would expect. In the dynamic case, the changes begin in the first period in spite of the delayed shock.

In fact, the dynamic responses of an anticipated permanent shock are different from those noted previously in Figure 1 to 4. Investment strategies change substantially. Investments in all sectors are now significantly above the benchmark levels in the first period. Investment in the primary sector rises more as the shock nears and peaks when the benefit is greatest at the time of the shock. What is interesting is in the manufacturing sector. Anticipating the adverse shock, producers invest immediately while the replacement cost of capital is not yet affected in the first few periods. The same is true in the service sector in which

the investment boom is now more amplified. After the shock, all the investment levels drop somewhat from the initial growth but remain way above the balanced-growth trend. Similarly, consumption increases immediately in anticipation to the higher future prices. After the shock, it shifts down below the long-term trend.

Because domestic prices are bid up much more initially, the real exchange rate for exports appreciates immediately. The initial rise in exports are no longer observed. In fact, total exports drops below the trend throughout. The impact on import demand is most illuminating. It changes signs before and after the shock. Before the shock, there is a very strong rise in imports while they are still cheap. After the shock, a big fall is registered.

This temporary stimulus in investment and consumption is a rational expectations behavior emphasized in Dornbush (1985). Because of the import contents of investment and consumption goods, the expectation of relatively higher import cost will lead to a higher real price of assets for the producers and a lower intertemporal rate for the consumer. This will promote a transitory investment boom, a temporary rise in consumption, and a very steep rise in import purchases immediately. Thus, the current account deficits, foreign borrowing and debts also increase immediately by several folds. They are maintained at high levels for the duration of the periods before the shock. Once the real depreciation in exchange rate of imports goods has occurred, investment will slow down. Consumption also will decrease.

These results suggest that the expectation of an accelerating foreign inflation will have greater impact than a one-time permanent shock. In the mid-seventies, the expectation was that the energy crisis was permanent and may even worsen. Moreover, it was expected that the inflation in the industrial countries would continue to make the cost of imports high. By these observations, the anticipation of a worsening situation is an important source of

variation in the investment and growth of middle-income economies.

4 Adjustment Policies

In this section, we analyze one adjustment policy often suggested for many developing countries in the eighties - a liberalization of the economy involving a tariff reform. Because there is a need to maintain credit worthiness, we study the dynamic effects of such a policy on the external debt and government revenues as well as the overall growth of the economy. A key question is whether it is possible to push exports and agriculture without incurring government deficits and heavy debts. To do this, a combination of other measures is introduced - export subsidies, removing incentive bias against agriculture, investment tax credits, and some amount of consumption tax. Then, looking at the mid-seventies in retrospect, we examine if a combination of these policies would have been effective in pushing exports and slowing the growth of debts in the face of a severe import price shock. This is an attempt to answer if the middle-income countries like the Philippines could have done better by implementing the 'right' policies.

Like many import-substituting developing countries, the policy incentives in the Philippine economy is biased against agriculture and exports. These are incorporated in the dynamic models two ways. First, the average tariff rate for manufacturing (23%) is more than twice the rate in the primary sector (10%). However, the difference in these rates are only small part of the incentive bias and are not high when compared to the magnitudes of the recent external shocks. More important, the bias is also reflected in the bb parameter in the investment equation.

The shadow price of capital vary with the amount of installed capital, the discount rate, and the investment levels in the base year. For a discount rate of 9.5%, the shadow price for the primary sector is about 2.10; 1.50 for manufacturing; and 1.20 for services. They are reasonable values for the Philippines.¹⁷ Their differences indicate some amount of over-investments in the service and manufacturing sectors when compared to the primary sector. The parameter *bb* is calibrated to generate the base year investment levels and the above shadow price of capital. In one policy experiment, we examine the effects of removing the incentive bias against agriculture by setting *bb* to a uniform value in all sectors.

4.1 Tariff Reform

We introduce a tariff reform by imposing a uniform 10% tariff rate. 17% is the average import duty in the base year. The results are shown in Figure 13 to 20. Note that foreign borrowing and debt will increase. A tariff reform makes imports cheaper and their demand will increase. Exports also increase but not as much as imports. Because tariffs are important revenue sources in developing countries, tax collection will fall ('Taxes' in Figure 13), foreign borrowing will have to increase to cover for increased imports and reduced government savings (Figure 14).

Who gains and losses? Note that a tariff reform will hurt the manufacturing sector. Its value-added will decline since it will face the most competition from cheaper imports. Its investment will fall while those in the primary and service sectors will increase. With full employment and wages in each sector tied to the market clearing levels in fixed proportions, we find wages to be relatively stable in the manufacturing sector. However, adjustments will

¹⁷See, for example, Bautista, Powell *et. al* (1979).

be carried out from the quantity side and a dislocation of employment in the manufacturing sector is registered (Figure 17). All told, aggregate labor income in the manufacturing will decline while it increases in the other two sectors. If the general equilibrium condition for full employment is not satisfied in the real world, unemployment may rise and wages may fall in the manufacturing sector. The rates of return also work against the manufacturing sector in the short-run. This is a restatement of Stolper-Samuelson theorem with specific factors. Its investment and capital income will all drop from the benchmark levels (Figure 18). Overtime however, the domestic supply of manufactured goods will shrink and the domestic prices of manufacturing will rise, making investment in manufacturing attractive again. If the reform can be financed and the initial resistance of the manufacturing sector overcome (which are two big if's), the long-run results of this model show and quantify the gains of such policy - a tariff reform will lead to a higher consumption, investment, and GDP (Figure 13 & 16).

Much of the effects of a tariff reform have been debated. Recent studies show that unifying tariff rates may not be efficient.¹⁸ This dynamic analysis confirms some additional fears - the short-term dislocation of the protected sector, the decline in tax revenues¹⁹, and the increase in foreign debts. To be fair, we have not examine the effects on the efficiency of production, whether tariff reform will lead to long-term increases in the efficiency of a more competitive production? This may mean using some form of embodied technical change as suggested by Solow (1988) or increasing returns in production which is not the scope of the present paper.

¹⁸For example, Dahl, Devarajan, and van Wijnbergen (1986) and Mitra (1987).

¹⁹We find that the decline in tax revenue, although less severe, is also true even in case of a tariff reform involving a uniform 0.17, the base-year average tariff rate.

4.2 Policies During an Import Price Shock

The results in the previous section demonstrate both the promise and danger of liberalization. A tariff reform shows the expected benefits on the primary sector and to some degree on exports. However, it also may lead to a contraction in manufacturing, a decline in tax revenues, more current account deficits and an accumulation of debts. A variety of complementary measures are needed to offset some of the less desirable effects. In general, it is possible within the same framework to introduce a reform of domestic taxes and incentive schemes to encourage further output of primary goods, more exports, and prevent a decline in manufacturing while offsetting potential revenue losses.²⁰ In this regard, an interesting question is as follows - will a combination of such policies work in response to an import price shock? Could a package of policies maintain growth, slow down the contraction in trade, rechannel investment towards more exports and prevent the rapid rise in debt? The answer from using this framework of analysis is yes, which we establish by demonstration.

Three experiments are conducted and presented in Figure 21-4. For simplicity, we concentrate on the dynamic effects on total investment, real GDP, foreign debt and exports. The label of each plot corresponds to the group of policy instruments that are applied and the definition of the experiment.²¹

1. PM - This corresponds to no policy and to the dynamic effects of an import price shock. The external shock is defined by a 2.3 times increase in the real price of primary imports. This is equivalent to the 1974 oil price shock in the Philippines. As before,

²⁰See Go (1988).

²¹Foreign debt remains endogenous to maintain comparability with the previous experiments. It is possible, however, to derive a time path of fiscal adjustment, ie. domestic tax changes or reduction in government expenditure, in order to generate the necessary domestic savings while keeping foreign borrowing fixed. Moreover, for simplicity, we assume that policy makers are able to implement these policies immediately right after the unanticipated shock occurs.

the results of the shock show a permanent increase in investment, an acceleration of economic growth (GDP), a contraction in exports, and an accumulation of foreign debt.

2. $PM+tm$ - In addition to the import price shock, a tariff reform is introduced and a uniform duty of 10% is implemented. This is a sizable tariff reduction for manufacturing from its original 23%. In addition, a temporary tax subsidy is given to exports in the manufacturing sector - 10% for the first 5 years, 5% the next 5 years, and zero thereafter. A 10% tax credit is also given to the manufacturing sector. To raise domestic resources, a 5% consumption tax is implemented while government consumption expenditures are reduced to 4% below the long-term trend. The reasons for the measures and their effects are as before. Except this time, a debt accumulation is prevented by the tariff reform and the various policies aimed at assisting manufacturing and its exports. Note that exports no longer decline as much. Investment responds positively to the temporary benefits but stays at near the benchmark levels after period 5. Real GDP is slightly below the long-term trend.

3. $PM+tm+bb$ - In addition to $PM + tm$, the incentive bias against agriculture is removed and kept at par with manufacturing, ie. a uniform bb parameter. To prevent the manufacturing sector from 'losing out' too much to agriculture, the 10% subsidies for manufactured exports are kept for 10 years and the consumption tax is raised to 10%. Except for an initial boom in investment, the net result is an economy growing at its long-term trend with high exports and a rapidly declining foreign debt level. While it takes some extreme policies to attain this growth pattern, the purpose is

simply to demonstrate that rapid debt accumulation is not necessarily the end result of an import price shock, given the right mix of policies.

In fact, the arrival of an import price shock is an attractive occasion for tariff reform since it eases the accompanying pressures on domestic prices; it will prevent exports from declining too much; and it does not lead to an expansion of import demand that normally accompanies a tariff reduction. Combined with other policies, the investment boom and *Dutch disease*-like effects on the service sector could be rechanneled towards the more tradable sectors and exports could be emphasized and increased. If a mobilization of domestic resources is also undertaken through increased tax collections, the combined effects will reduce or slow debt accumulation.

5 Conclusions

The simulations illustrate the importance of dynamic and forward-looking behavior in consumption and investment. It shows how an import price shock could lead to an investment boom and rapid expansion in foreign debt as what happened in the mid-seventies to many developing countries. This rapid expansion is hard to explain without investigating the dynamic competitive conditions between domestic and foreign goods over time in response to these shocks. For instance, the increase in current account deficits and foreign debt after an import price shock is certainly greater than would be implied by just the increase in foreign prices.

In looking at these dynamic effects, several points were emphasized:

- The intersectoral effects of a shock are amplified by the dynamic behavior. The

magnitudes of these effects were clearly large in relation to comparable results from a static CGE model. This is specially true at the early stages of the impact.

- In time, the supply of domestic goods and their prices react to the initial changes in investments. A reversal of the initial effects is usually triggered because of the changing competitive conditions between domestic and foreign goods. This phase corresponds to a slowing down of an expansion (or contraction) as the economy approaches a new steady state. A static CGE model would simply miss out this rich dynamic story.
- The signs of some of the effects are also different. For example, in response to an anticipated import price shock, the transitory boom in investment and increase in consumption demand will lead to a rapid increase in import demand, not a contraction as one would expect from a static intersectoral reallocation of resources. The increase in investment in the service sector would have not been registered.
- Expectation is a key factor in the results. Contrary to a common suggestion that an economy should adjust and contract in response to a permanent import price shock, the behavior suggested in a model with rational expectations in investment decisions is that the opposite can be true. Investment and output must expand in response to the dynamic competition with a more costly import substitute in the market place. Demand for a domestic alternative is sought and is slowly provided with increased investment. It is a 'rational' action based on the expectations that the shock is permanent and may worsened and that the interest rate of foreign borrowing will continue to be low. The kind of expectations prevailing in the mid-seventies were precisely of that kind – that the energy crisis was permanent, the days of cheap oil was

over, and the availability of petro-dollars was going to continue. But conditions soon changed. The actions of these high-debt developing countries are found 'imprudent' from the hindsight of the interest rate shock in the late 1970s.

Is there a failure of policy? The expectation that debts could be stacked indefinitely was clearly wrong and the interest rate shock after 1979 did come as a surprise to many. A more interesting issue is whether policy makers could have taken advantage of the easy credits to finance the needed reforms without the accumulation of debt. Searching for policy options, the results demonstrate both the promise and danger of liberalization, an adjustment policy often recommended in the eighties. A tariff reform shows the expected benefits on the primary sector and, to some degree, on exports. But it may easily lead to a contraction in manufacturing, a decline in tax revenues, more current account deficits and an accumulation of debts. A variety of other measures are needed. In general, we find that a combination of policies is effective in maintaining growth and exports without a rapid accumulation of debts even during a permanent import price shock. In fact, the arrival of an import price shock is an attractive occasion for tariff reform since it will prevent exports from declining too much; it eases the accompanying pressures on domestic prices; and it does not lead to an expansion of import demand that normally accompanies a tariff reduction. Combined with other policies, the investment boom and '*Dutch disease*' effects on the service sector could be rechanneled towards the more tradable sectors and exports can be emphasized and increased. If a mobilization of domestic resources is also undertaken through increased tax collections, the combined effects will reduce or slow the foreign debt accumulation. Based on this hindsight, we conclude that middle-income countries like the Philippines missed a golden opportunity for policy reforms during the seventies and found it harder in the

eighties to implement the adjustment policies under less favorable circumstances.

Figure 1
Dynamic Effects of an Import Price Shock in Primary Goods
On Some Macro-Variables
 (Flex. Borrowing Case, Balanced Growth Run = 1.00)

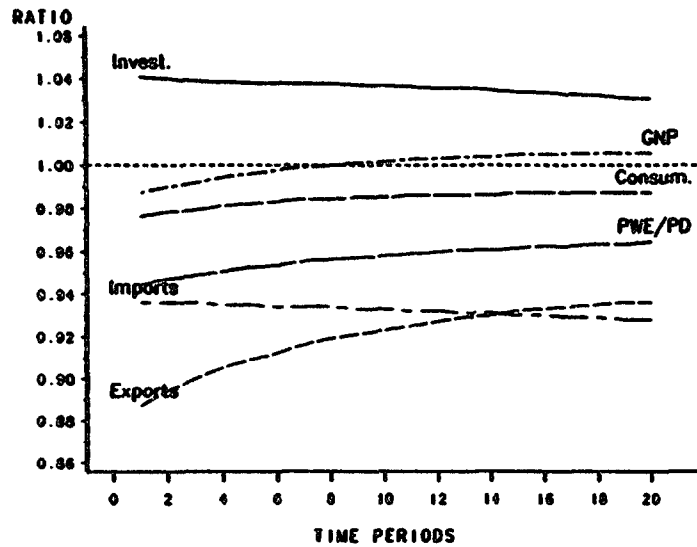


Figure 2
Dynamic Effects of an Import Price Shock in Primary Goods
On Foreign Debt
 (Flex. Borrowing Case, Balanced Growth Run = 1.00)

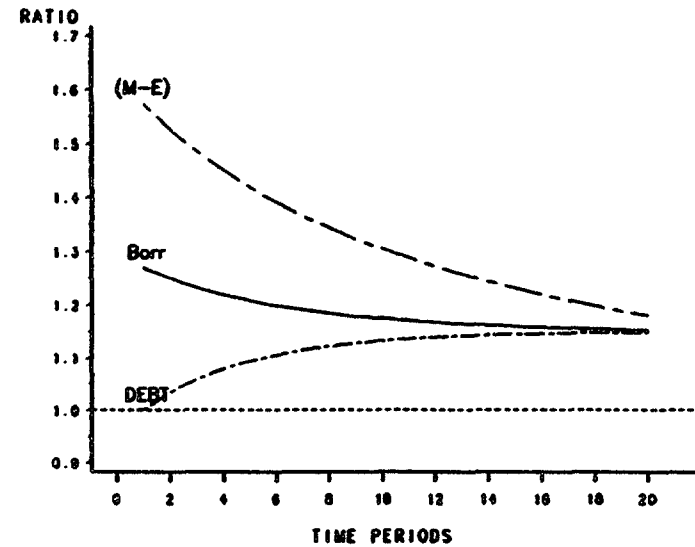


Figure 3
Dynamic Effects of an Import Price Shock in Primary Goods
On Sectoral Investment
 (Flex. Borrowing Case, Balanced Growth Run = 1.00)

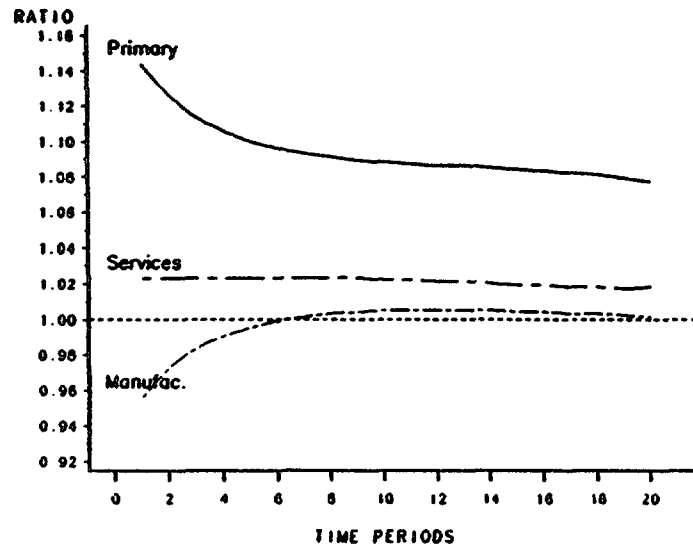


Figure 4
Dynamic Effects of an Import Price Shock in Primary Goods
On Sectoral Output
 (Flex. Borrowing Case, Balanced Growth Run = 1.00)

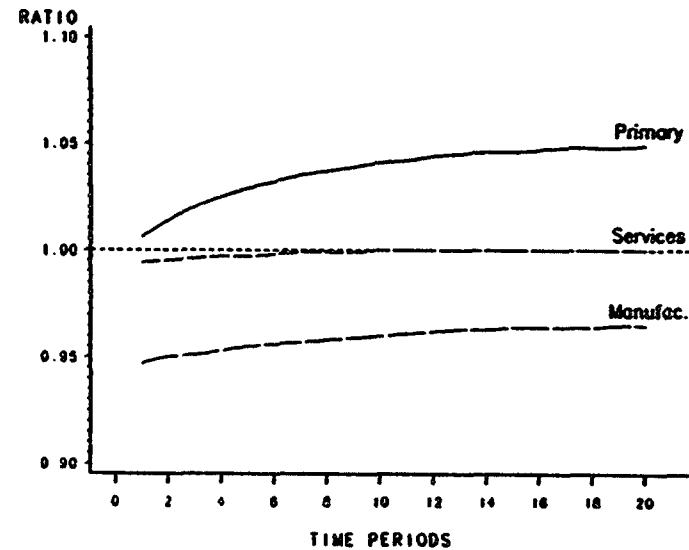


Figure 5
Effects of a Import Price Shock in Primary Goods, Static Case
On Some Macro-Variables
(Flex. B Case, Balanced Growth Run = 1.00)

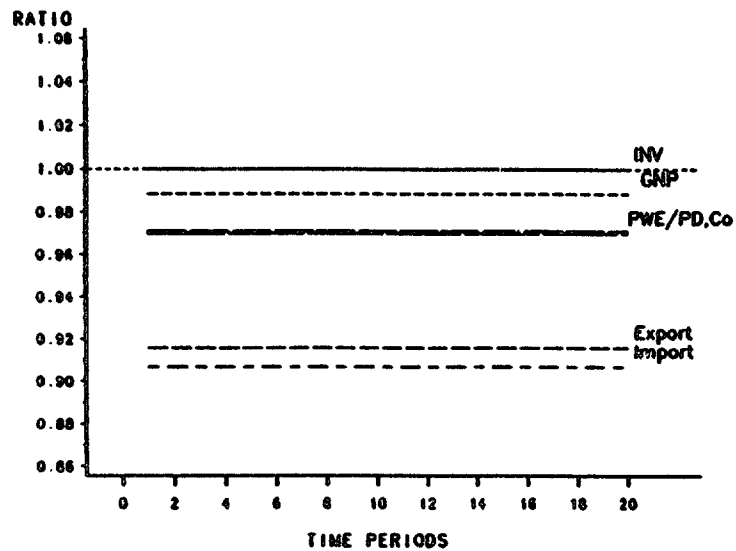


Figure 6
Effects of a Import Price Shock in Primary Goods, Static Case
On Foreign Debt
(Flex. B Case, Balanced Growth Run = 1.00)

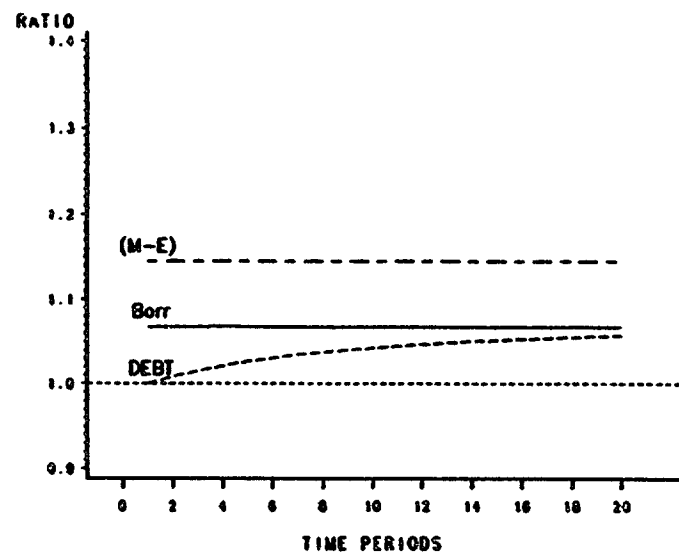


Figure 7
Effects of a Import Price Shock in Primary Goods, Static Case
On Some Macro-Variables
(Fixed B Case, Balanced Growth Run = 1.00)

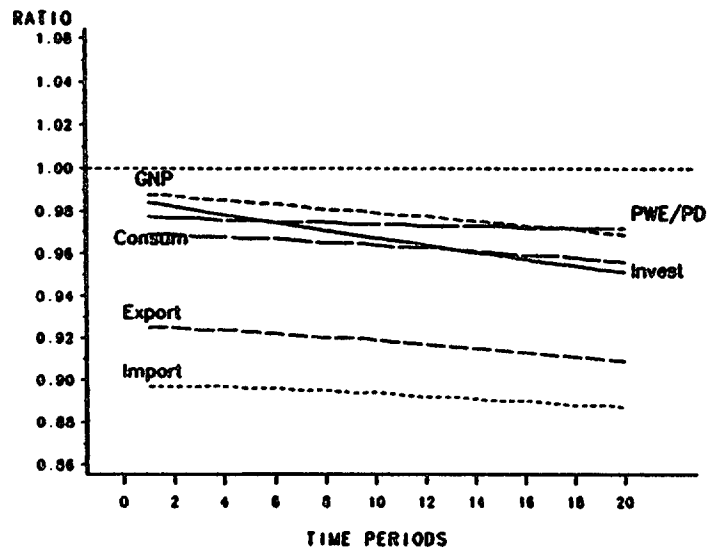


Figure 8
Effects of a Import Price Shock in Primary Goods, Static Case
On Sectoral Investment
(Fixed B Case, Balanced Growth Run = 1.00)

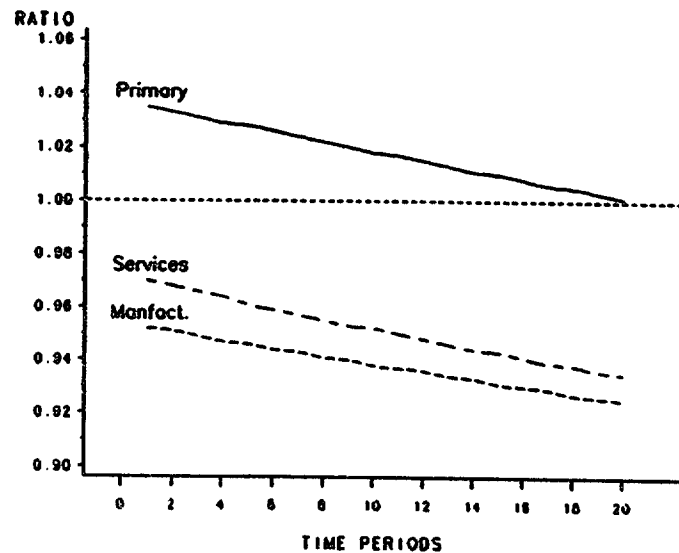


Fig. 9
Effects of a Future Import Price Shock in Primary Goods, Static Case
On Some Macro-Variables
 (Free B Case, Balanced Growth Run = 1.00)

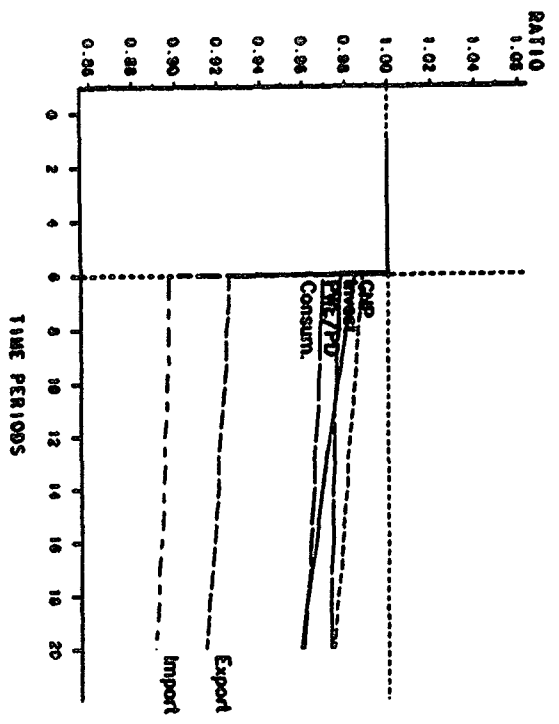


Fig. 10
Dynamic Effects of a Future Import Price Shock in Primary Goods
On Some Macro-Variables
 (Free B Case, Balanced Growth Run = 1.00)

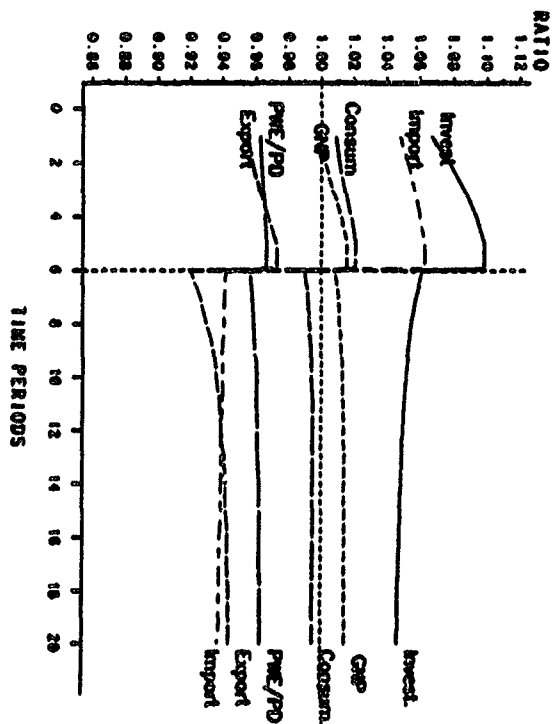


Fig. 11
Dynamic Effects of a Future Import Price Shock in Primary Goods
On Foreign Debt
 (Free B Case, Balanced Growth Run = 1.00)

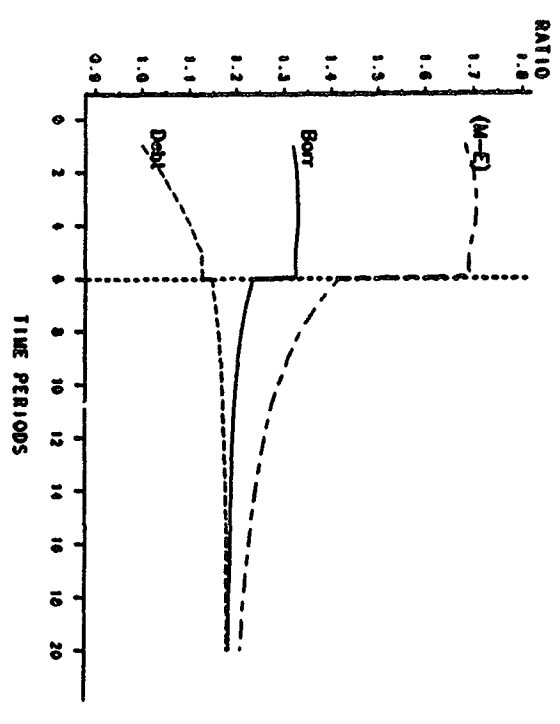


Fig. 12
Dynamic Effects of a Future Import Price Shock in Primary Goods
On Sectoral Investment
 (Free B Case, Balanced Growth Run = 1.00)

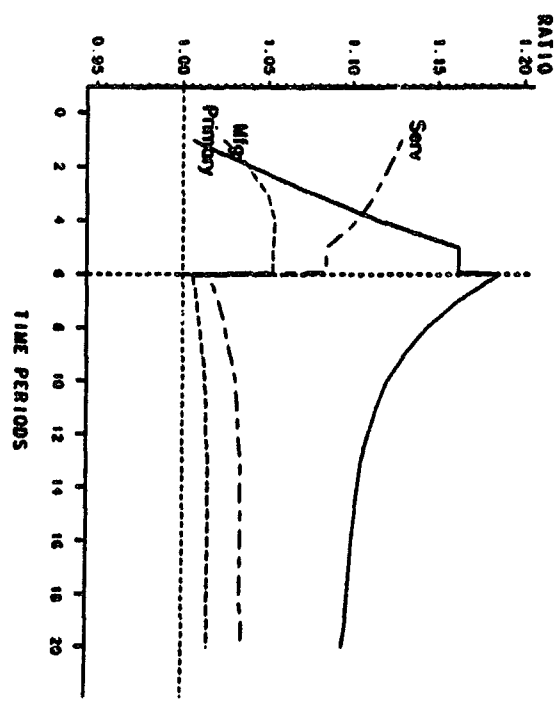


Figure 13
Dynamic Effects of Tariff Reform, $lm = 0.10$
On Some Macro-Variables

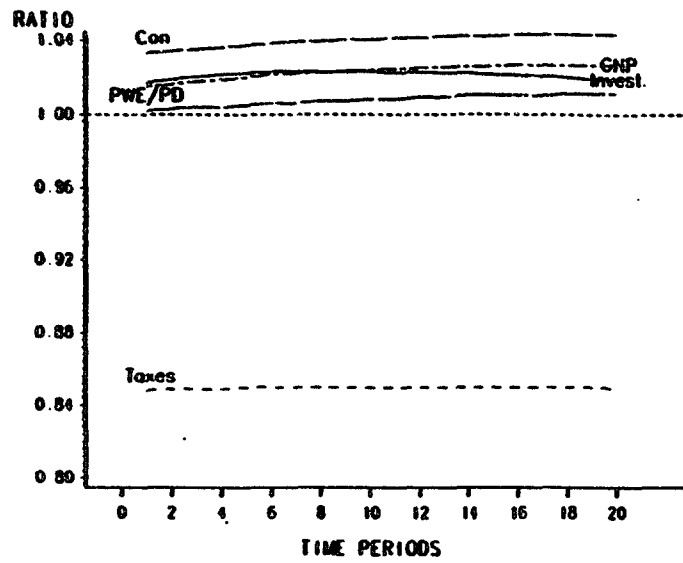


Figure 14
Dynamic Effects of Tariff Reform, $lm = 0.10$
On Foreign Debt

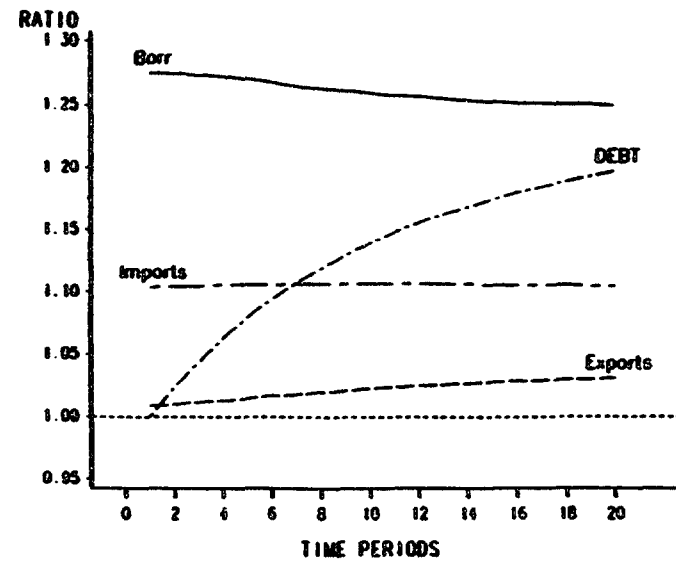


Figure 15
Dynamic Effects of Tariff Reform, $lm = 0.10$
On Sectoral Investment

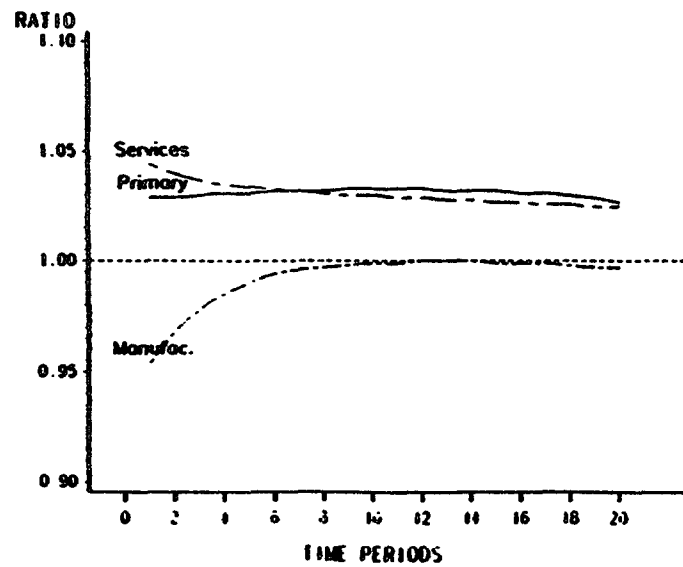


Figure 16
Dynamic Effects of Tariff Reform, $lm = 0.10$
On Value-Added

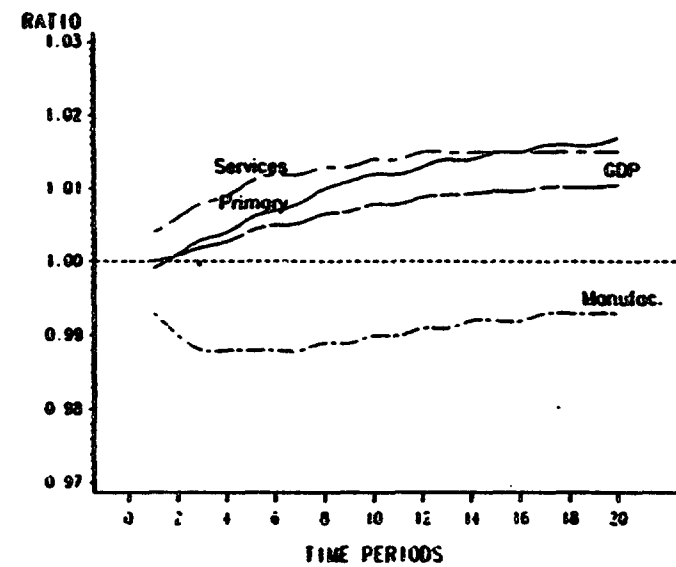


Figure 17
Dynamic Effects of Tariff Reform, $tm = 0.10$
On Employment

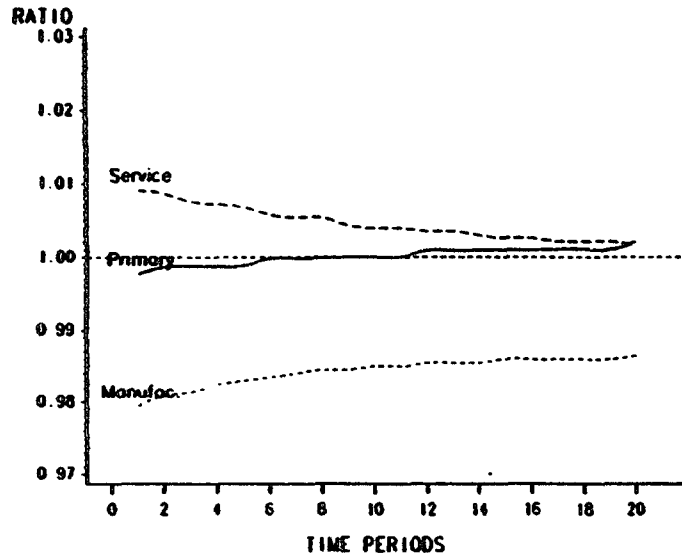


Figure 18
Dynamic Effects of Tariff Reform, $tm = 0.10$
On Capital Stocks

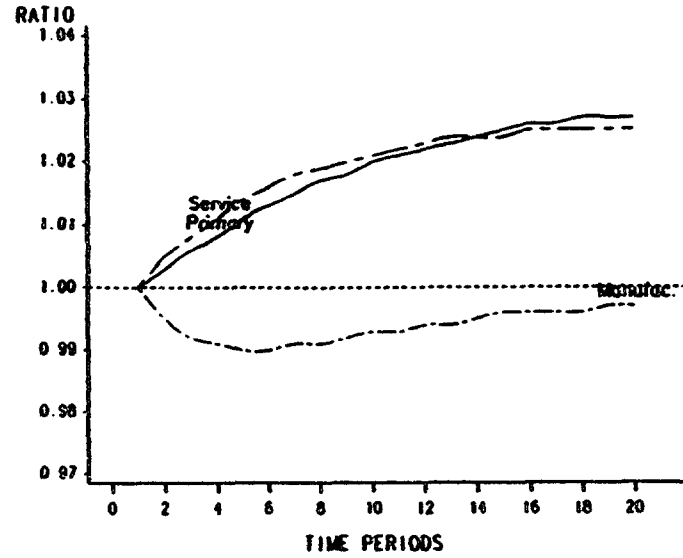


Figure 19
Dynamic Effects of Tariff Reform, $tm = 0.10$
On Labor Income

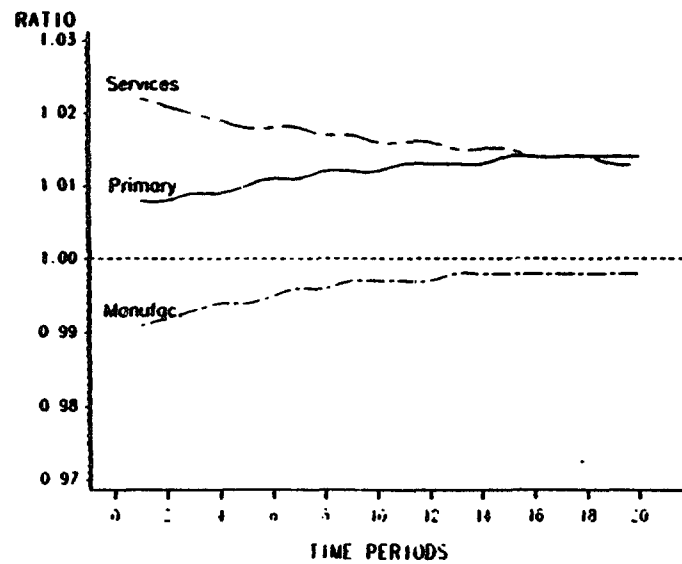


Figure 20
Dynamic Effects of Tariff Reform, $tm = 0.10$
On Capital Income

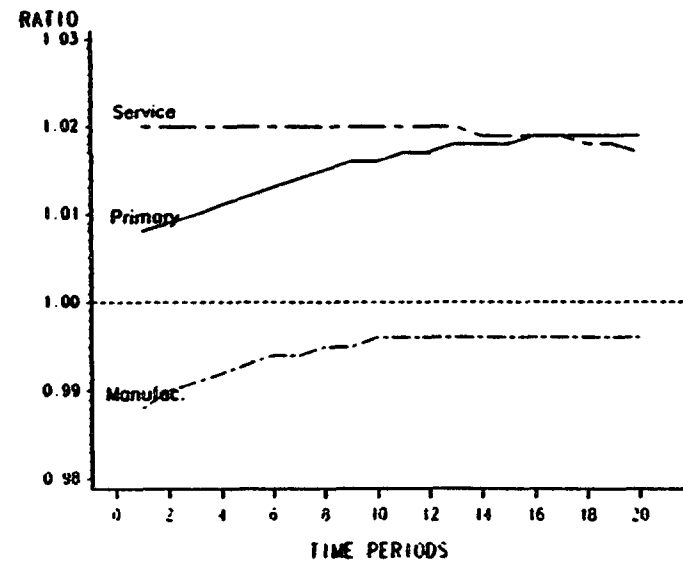


Figure 21
Policies for an Import Price Shock
On Total Investment

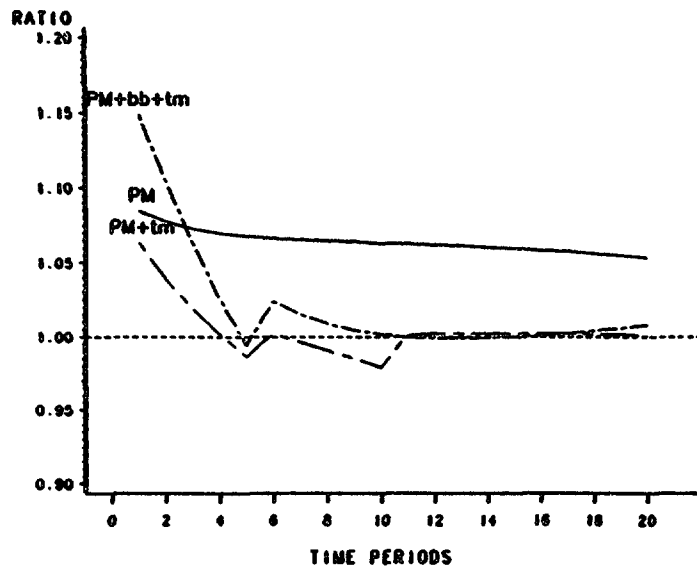


Figure 22
Policies for an Import Price Shock
On Real Gross Domestic Product

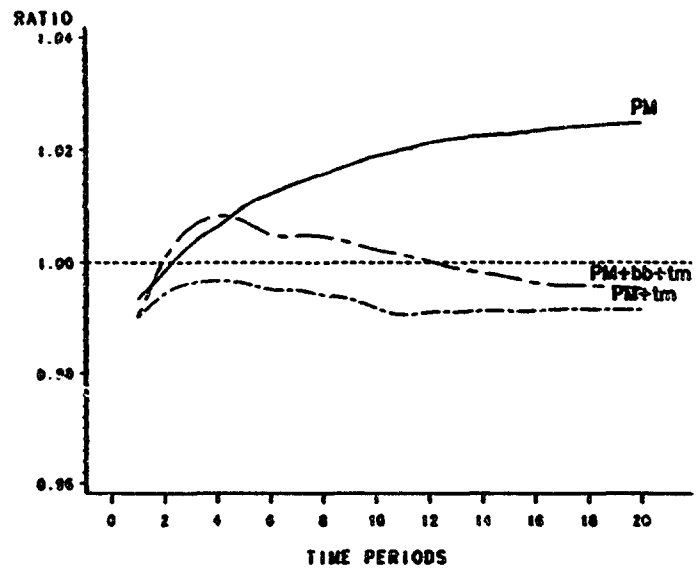


Figure 23
Policies for an Import Price Shock
On Foreign Debt

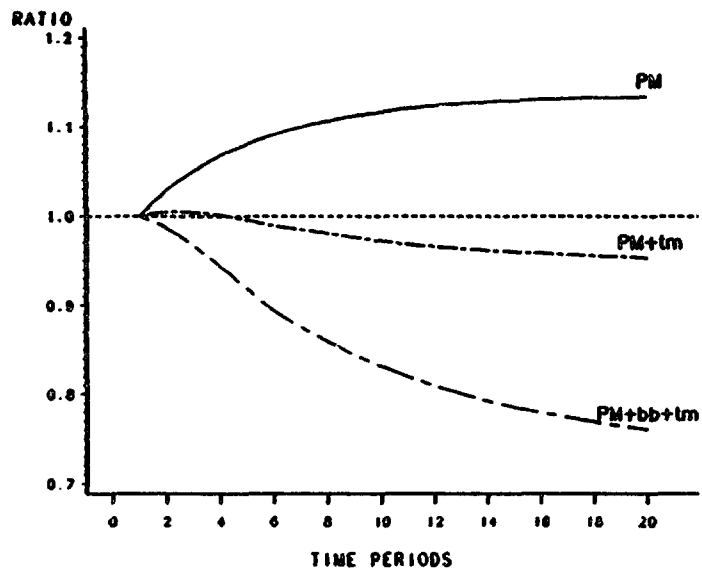
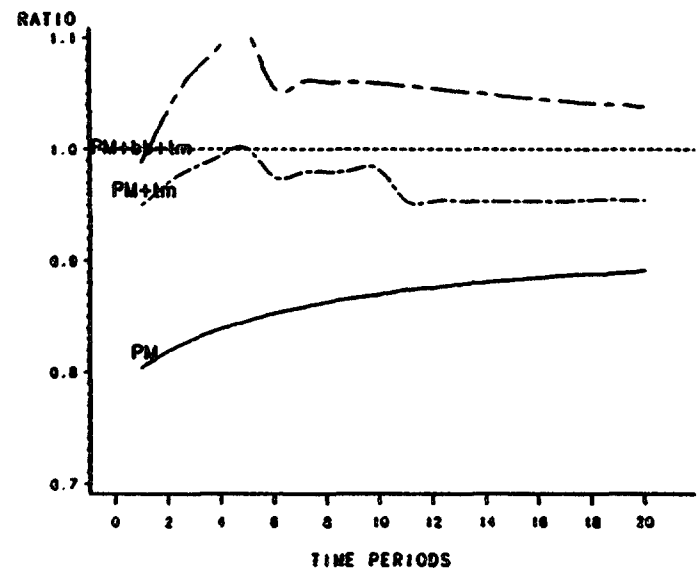


Figure 24
Policies for an Import Price Shock
On Total Exports



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A List of Equations

A.1 The Intertemporal Consumption and Investment

Subscripts for sectors are suppressed in this part for easy reading but the variables and parameters are defined for each sector unless otherwise indicated.

A.1.1 Objective Function

$$\max \int_1^{\infty} U(C_t) e^{-\rho t} dt \quad \text{where} \quad (1)$$

$$U(C_t) = \frac{1}{1-\nu} C_t^{1-\nu}$$

$$C = \prod_{i=1}^n C_i^{\alpha_i}, \quad \sum_{i=1}^n \alpha_i = 1 \quad (2)$$

$$\frac{dU}{dC_i} / \frac{dU}{dC_j} = \frac{P_i}{P_j} \quad (3)$$

A.1.2 Investment and Tobin's q

$$\frac{I_t}{K_t} = \alpha + \frac{1}{\beta} Q_t^T \quad (4)$$

$$Q_t^T = \left[\frac{q_t}{PK_t} - (1 - bb - tc - DPN_t) \right] / (1 - tk) \quad (5)$$

$$J_t(I_t) = [1 - bb - tc - DPN_t + \theta(x_t)] I_t PK_t \quad (6)$$

$$V_k t = \alpha_v^{-\rho_v} (1 - \delta_v) \left[\frac{V_t}{K_t} \right]^{1+\rho_v} \quad (7)$$

$$DPN_t = \int_s^{\infty} \frac{\mu_t}{\mu_s} tk_s \delta^T \exp[-\delta^T(t-s)] dt \quad (8)$$

$$DKO_t = \int_s^{\infty} \mu(t) tk_s(t) \delta^{\sigma T} K T_s \exp[-\delta^{\sigma T}(t-s)] ds \quad (9)$$

$$\theta(x_t) = \begin{cases} \left(\frac{\beta}{2}\right) \frac{(x_t - \alpha)^2}{x_t} & \text{if } (x_t - \alpha) \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad (10)$$

$$q_t \equiv \frac{V_t^* - DKO_t}{K_t} \quad (11)$$

$$x_t \equiv \frac{I_t}{K_t} \quad (12)$$

A.1.3 Dynamic Equations

$$L\dot{S}_{kt} = L\alpha_k e^{\rho t} \quad (13)$$

$$\frac{\dot{C}_t}{C_t} = \frac{r_{ct} - \rho}{v} \quad (14)$$

$$\dot{q}_t = q_t[r_t + \delta^R] - (1 - tk_t)FV_t V k_t + PK_t x_t^2 \theta'(x_t) \quad (15)$$

$$\dot{K}_t = I_t - \delta^R K_t \quad (16)$$

$$\dot{KT}_t = I_t - \delta^T KT_t \quad (17)$$

$$\lim_{t \rightarrow \infty} \mu_t q_t K_t = 0 \quad (18)$$

$$\lim_{t \rightarrow \infty} e^{-\rho t} \gamma_t = 0 \quad (19)$$

$$\mu(t) \equiv \exp\left[-\int_0^{\infty} r(s) ds\right] \quad (20)$$

$$r_{pt} = i_t^* + \frac{e_{pt} \dot{e}_{pt}}{e_{pt}} \quad (21)$$

$$r_{ct} = i_t^* + \frac{e_{ct} \dot{e}_{ct}}{e_{ct}} \quad (22)$$

$$e_{pt} = \frac{\sum_i \frac{PD_i(t)D_i(t)}{\sum_j D_j(t)}}{\sum_i \frac{pe_i^*(t)E_i(t)}{\sum_j E_j(t)}} \quad (23)$$

$$e_{ct} = \frac{\sum_i \frac{PD_i(t)D_i(t)}{\sum_j D_j(t)}}{\sum_i \frac{pm_i^*(t)M_i(t)}{\sum_j M_j(t)}} \quad (24)$$

A.1.4 Steady-State and Terminal Conditions

$$\frac{I_{ss}}{K_{ss}} = g + \delta^R \quad (25)$$

$$\frac{I_{ss}(1 + \theta_{ss})}{KT_{ss}} = g + \delta^T \quad (26)$$

$$\frac{\dot{C}_{ss}}{C_{ss}} = \frac{i^* - \rho}{v} \equiv g \quad (27)$$

$$r_c^{ss} = r_{pt}^{ss} = i^* \quad (28)$$

A.2 The Within-Period CGE Sub-Model

The time subscripts are suppressed in this part but are assumed to exist unless otherwise indicated.

A.2.1 Gross Output

$$Q_i = \alpha_{qi} [\delta_{qi} V_i^{-\rho_{qi}} + (1 - \delta_{qi}) N_i^{-\rho_{qi}}]^{-1/\rho_{qi}} \quad (29)$$

$$\frac{V_i}{N_i} = \left[\frac{\delta_{qi}}{(1 - \delta_{qi})} \frac{PN_i}{FV_i} \right]^{1/(1+\rho_{qi})} \quad (30)$$

$$FQ_i Q_i (1 - t_{si}) = PN_i N_i + FV_i V_i \quad (31)$$

A.2.2 Value Added

$$V_i = \alpha_{vi} [\delta_{vi} L_i^{-\rho_{vi}} + (1 - \delta_{vi}) \bar{K}_i^{-\rho_{vi}}]^{-1/\rho_{vi}} \quad (32)$$

$$\frac{L_i}{\bar{K}_i} = \left[\frac{\delta_{vi}}{(1 - \delta_{vi})} \frac{rk_i}{w_i} \right]^{1/(1+\rho_{vi})} \quad (33)$$

$$FV_i V_i (1 - t_{vi}) = w_i L_i + r_i \bar{K}_i \quad (34)$$

A.2.3 Material Inputs

$$N_i = \min \left(\frac{Q_{ji}}{a_{ji}} \right) \quad (35)$$

$$PN_i = \sum_{j=1}^n a_{ji} P_j \quad (36)$$

A.2.4 Labor Markets

$$L_i = \alpha_{li} \prod_{k=1}^{n_l} L_{ik}^{\beta_k} \quad (37)$$

$$w_i L_i = \sum_{k=1}^{n_l} w_{ik} L_{ik} \quad (38)$$

$$w_{ik} L_{ik} = \beta_k w_i L_i \quad (39)$$

$$w_{ik} = \omega_i w_k \quad (40)$$

$$LD_k = \sum_{i=1}^n L_{ik} \quad (41)$$

A.2.5 CET Sale of Domestic Output

$$PE_i = pe_i^* (1 + te_i) e_r \quad (42)$$

$$Q_i = \alpha_{di} [\delta_{di} E_i^{-\rho_{di}} + (1 - \delta_{di}) D_i^{-\rho_{di}}]^{-1/\rho_{di}} \quad (43)$$

$$\frac{E_i}{D_i} = \left[\frac{\delta_{di}}{(1 - \delta_{di})} \frac{PE_i}{PD_i} \right]^{1/(\rho_{di}-1)} \quad (44)$$

$$FQ_i Q_i = PD_i D_i + PE_i E_i \quad (45)$$

A.2.6 Armington Composite Good

$$PM_i = pm_i^* (1 + tm_i) er \quad (46)$$

$$X_i = \alpha_{ci} [\delta_{ci} M_i^{-\rho_{oi}} + (1 - \delta_{ci}) D_i^{-\rho_{oi}}]^{-1/\rho_{oi}} \quad (47)$$

$$\frac{M_i}{D_i} = \left[\frac{\delta_{ci}}{(1 - \delta_{ci})} \frac{PD_i}{PM_i} \right]^{1/(1+\rho_{oi})} \quad (48)$$

$$PX_i X_i = PD_i D_i + PM_i M_i \quad (49)$$

A.2.7 Income Flows and Taxes

$$\begin{aligned} YH &= \sum_{i=1}^n YL_i (1 - tl_i) \\ &+ TRNSer \\ &+ er REMIT \\ &+ \sum_{i=1}^n [(YK_i - \delta_i^T PK_i KT_i)(1 - tk_i - ks_i) - P_i DST_i] \end{aligned} \quad (50)$$

$$YL_i = \sum_{k=1}^{n_i} w_{ik} L_{ik} = w_i L_i \quad (51)$$

$$YK_i = PV_i V_i (1 - tv_i) - YL_i \quad (52)$$

$$\begin{aligned} GR &= \sum_{i=1}^n tm_i M_i pm_i^* er \\ &+ \sum_{i=1}^n ts_i PQ_i Q_i \\ &+ \sum_{i=1}^n tv_i PV_i V_i \\ &+ \sum_{i=1}^n tl_i YL_i \\ &+ \sum_{i=1}^n tk_i [YK_i - \delta_i^T PK_i KT_i] \\ &+ \sum_{h=1}^{nh} th_h YH_h \\ &- \sum_{i=1}^n te_i E_i pe_i^* er \\ &- TRNSer \end{aligned} \quad (53)$$

$$\begin{aligned} GR + er B_t &= \sum_{i=1}^n P_i GC_i \\ &+ i^* er DEBT \\ &+ GSAV \end{aligned} \quad (54)$$

A.2.8 Demand

$$INT_i = \sum_{j=1}^n a_{ij} N_j \quad (55)$$

$$DST_i = v_i XQ_i \quad (56)$$

$$GC_i = cg_i GCON \quad (57)$$

$$ID_i = rat \sum_{j=1}^n b_{ij} I_j (1 + \theta(x_i)) \quad (58)$$

A.2.9 Savings and Investments

$$INVEST = \sum_{i=1}^n PK_i I_i (1 + \theta(x_i)) \quad (59)$$

$$\begin{aligned} SAVINGS &= GSAV \quad (60) \\ &+ \sum_{h=1}^{nh} sh_h (1 - th_h) YH_h \\ &+ \sum_{i=1}^n \delta_i^T PK_i KT_i \\ &+ \sum_{i=1}^n ks_i (YK_i - \delta_i^T PK_i KT_i) \end{aligned}$$

A.2.10 Intratemporal Equilibrium Conditions

$$LD_k \equiv \bar{L}S_k \quad (61)$$

$$X_i \equiv INT_i + C_i + GC_i + ID_i + DST_i \quad (62)$$

$$\sum_{i=1}^n pm_i M_i + i^* DEBT \equiv \sum_{i=1}^n pe_i E_i + REMIT + B \quad (63)$$

$$SAVINGS \equiv rat INVEST \quad (64)$$

B Glossary**B.1 Parameters****B.1.1 Coefficients**

a_{ij} input-output coefficient

b_{ij} coefficient of the capital composition matrix

bb rate of existing incentives to investment

$blim$ foreign lending constraint

δ^R depreciation rate of real capital

δ^{oT} old depreciation rate of accounting capital

δ^T new depreciation rate of accounting capital

γ a parameter in the adjustment cost function

ch_{ih} distribution share of household consumption

cg_i distribution share of government consumption

er nominal exchange rate in the base year, price numeraire

g growth rate

ϕ a parameter in the adjustment cost function

ω_i wage proportionality factors

ρ rate of consumer time preference

v_i share of inventories in gross output

B.1.2 Shift and share parameters

α_{ll} shift parameter in the Cobb Douglas aggregation of labor

α_{qi} shift parameter in the CES function for Q

α_{ti} shift parameter in the CET function for Q

α_{vi} shift parameter in the CES function for V

β_h share parameter in the Cobb Douglas function for L

δ_{qi} share parameter in the CES function for Q

δ_{ti} share parameter in the CET function for Q

δ_{vi} share parameter in the CES function for V

ρ_{qi} exponent parameter in the CES function for Q

ρ_{ti} exponent parameter in the CET function for Q

ρ_{vi} exponent parameter in the CES function for V

B.1.3 Saving and tax rates

- ks_h** corporate saving rate
- sh_h** household saving rate
- tc_i** rate of new tax credits to investment
- te_i** export tax or subsidies rate
- th_i** household income tax rate
- tk_i** tax rate on capital income
- tl_i** social security taxes
- tm_i** import duty
- ts_i** indirect tax rate
- tv_i** value added tax rate

B.2 Variables**B.2.1 Quantities**

- C_t** aggregate consumption at time t
- C_i** private consumption of good i
- D_i** sales of domestic goods
- DST_i** changes in stocks (final demand)
- E_i** exports by sector
- GC_i** government consumption of good i
- I_i** investment by sector of destination
- ID_i** investment by sector of origin
- INT_i** sales of intermediate goods in good i
- K_i** capital stock in each sector
- KT_i** accounting capital in each sector
- L_i** aggregate labor in each sector
- LD_k** labor demand for each labor category
- Lo_k** base year labor supply for each labor category
- LS_k** labor supply for each labor category
- L_{ik}** labor by category k in each sector
- M_i** imports by sector
- N_i** aggregate material input in each sector
- Q_i** gross output in each sector
- V_i** value added in each sector
- Vk_t** marginal product of capital
- X_i** Armington aggregation of domestic and import goods

B.2.2 Prices

- pe_t^* world export price
 pm_t^* world import price
 P_t composite price of domestic and import goods
 PD_t price of domestic goods
 PE_t domestic price of exports
 PK_t price of capital
 PM_t domestic price of imports
 PN_t price of material input
 PQ_t price of gross output
 PR_t premium rationing rate
 PV_t price of value added
 e_t real exchange rate
 i_t^* world interest rate
 q_t shadow price of capital
 Q_t^T tax adjusted Tobin's q
 r_t rate of return of assets for asset equilibrium
 rat_t rationing rate in investment market
 rk_t gross rate of return
 μ_t discount factor
 w_t average wage rate in each sector
 w_{it} average wage of labor category k in each sector

B.2.3 Values

- B_t foreign borrowings or capital inflows
 $DEBT_t$ outstanding foreign debt at time t
 DPN_t present value of depreciation allowances on a peso of new investment
 DPO_t present value of depreciation allowances on existing accounting asset
 $FSAV$ foreign savings
 $GCON$ total government consumption
 GR government tax revenues less transfers
 $GSAV$ government savings
 $INVEST$ total fixed investment
 J_t total investment expenditures, including adjustment cost
 $REMIT$ foreign remittances
 $SAVINGS$ total savings net of change of stocks
 $\theta(x_t)$ adjustment cost function
 $TRNS$ government transfers to households
 YFH factor income
 YL_t wage bill in each sector
 YK_t gross capital income in each sector
 YL_t wage bill in each sector

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