# Dynamic Effects of Tariff Liberalization: An Intertemporal CGE Approach

by

**Christian KEUSCHNIGG***

**Wilhelm KOHLER***

Forschungsbericht /

Research Memorandum No. 315

February 1993

Christian Keuschnigg
Institute for Advanced Studies
Department of Economics
Stumpergasse 56
A–1060 Vienna, Austria

Phone: (1) 59991–147
Fax: (1) 59991–163
E-mail: chkeu@ihssv.wsr.ac.at

Wilhelm Kohler
University of Essen
Department of Economics
Universitaetsstrasse 12
D–4300 Essen, Germany

Phone: (0201) 183–3655

*We gratefully acknowledge financial support by the Austrian National Bank under grant no. 3327. Keuschnigg is also grateful for financial support received from Deutsche Forschungsgemeinschaft, Sonderforschungsbereich 303 at the University of Bonn. We presented the paper in seminars at Catholic University of Leuven, Erasmus University of Rotterdam and Universities of Konstanz and Linz. We are obliged to E.E. Leamer, S.B. Nielsen, T. Url as well as seminar participants for helpful comments.

**Abstract**

The paper presents an applied CGE trade model with overlapping generations facing life-time uncertainty. Investment and savings are derived from intertemporal optimization of agents under perfect foresight. We emphasize the features of a small open economy which takes prices for imports and the world interest rate as given. Downward sloping export demand functions make the terms-of-trade endogenous. The model intertemporally determines the current account and the accumulation of foreign assets. We calibrate the model to Austrian data and simulate the effects of trade liberalization as negotiated in the Tokyo-round as well as a complete tariff liberalization. Among the results, we find that unilateral tariff reductions are expansionary in the long-run, but are contractionary in the short-run if the commercial policy is anticipated. Foreign debt increases in the long-run forcing an improvement in the trade balance to service the additional debt. Welfare improves for some old generations at the expense of young and future generations. The utility loss of young generations is attributed partly to unfavorable terms of trade effects and partly to intergenerational redistribution from young to old. In the multilateral scenario, however, welfare improves for all generations. The terms-of-trade effect is reversed. The sensitivity analysis identifies the price elasticity of exports as a particularly important parameter. Furthermore, we find parameter configurations that produce non-monotonic adjustment of the current account.

Das Papier präsentiert ein angewandtes allgemeines Gleichgewichtsmodell einer kleinen offenen Volkswirtschaft mit überlappenden Generationen. Investitionen und Ersparnisse werden aus einem vorausschauenden intertemporalen Optimierungskalkül bestimmt. Heimische und importierte Güter sind unvollständige Substitute in der Nachfrage. Die Exportnachfrage ist in den Preisen der heimisch produzierten Güter geneigt und macht damit die Terms of Trade endogen. Das Modell ist auf österreichische Daten kalibriert. Die Simulation der Auswirkungen der Tokyo Zollsenkungsrunde ergibt, daß Zollsenkungen langfristig expansiv wirken. Kontraktive Wirkungen ergeben sich kurzfristig, wenn die Zollsenkung vorangekündigt wird. Die langfristig erhöhte Auslandsschuld erfordert einen größeren Handelsbilanzüberschuß, um den Schuldendienst zu finanzieren. Bei einer unilateralen Zollsenkung verschlechtert sich die Wohlfahrtsposition zukünftiger Generationen hauptsächlich aufgrund einer Verschlechterung der Terms of Trade. Dieser Wohlfahrtseffekt reagiert allerdings sensitiv auf eine Änderung der Exportelastizität. Eine multilaterale Zollsenkung zeitigt Wohlfahrtsverbesserungen für alle Generationen. Außerdem sind bei bestimmten Parameterkonstellationen – entgegen den Erwartungen aus der theoretischen Literatur – nicht monotone Anpassungen der Leistungsbilanz möglich.

# Contents

# 1 Introduction

Recent events have once again revealed both the difficulties and the importance of removing international trade barriers. Observers uniformly expect the performance of the world economy to crucially depend on the outcome of trade liberalization efforts such as presently under way in the so called Uruguay-round negotiations of the GATT. While it is more or less universally accepted that dismantling trade barriers will entail significant gains for the world economy at large, policy makers nevertheless sometimes anticipate painful adjustments for their economies. This is witnessed by severe political obstacles towards more speedy trade libaralization as well as occasional resurgence of protectionist proposals. Hence, there is certainly a keen interest in what the *adjustment path* might look like that an economy will follow as a result of certain trade liberalization scenarios.

Economists have responded to this interest by developing large scale computable general equilibrium (CGE) models, thus pursuing general equilibrium trade theory in an applied direction. Arguably, the "first generation" of CGE models has earned great merits in approaching reallocation, redistribution and aggregate welfare effects of trade liberalization from a numerical, yet general equilibrium perspective.[1] However, these early models were largely static in nature, thus necessarily failing to address several key aspects of adjustment.[2] First, the results obtained did not involve any notion of adjustment in the sense of an economy approaching its new equilibrium position *through time*. Second, the models were unable to capture the difference between transitory and permanent, and anticipated and surprising policies. Third, macroeconomic effects such as those on the current account and foreign indebtedness have typically been ignored which contrasts with the high level of attention that these effects enjoy in public discussions. Fourth, related to the previous point, early models did not feature international mobility of capital which has become such an important feature of the world economy. Finally, many models also did not allow for capital accumulation, thus precluding trade policy to have any growth effects that policy makers very often are concerned with.

In one way or another, all these shortages can be traced back to the absence of intertemporal decision making in the model economies. The models did not extend their behavioral paradigm (optimization) to investment and savings flows which are inherently intertemporal in nature. Meanwhile, a number of analytical models have appeared that explore some of the above mentioned aspects of adjustment to structural policies by treating investment and savings decisions in an intertemporal optimization framework.[3] These studies have revealed the importance of intertemporal effects of commercial policy, in addition to the temporal distortionary effects emphasized by previous analytical literature and the "first generation" of CGE models. However, these studies are highly stylized and we argue that a natural next

[1] A convenient presentation of "first generation" CGE trade models is contained in Srinivasan and Whalley (1986).

[2] Bovenberg and Goulder (1992) contains a similar discussion.

[3] See Matsuyama (1988), Brock (1988), Sen and Turnovsky (1989), Engel and Kletzer (1990), and Gavin (1990, 1991), among others.

step is to incorporate intertemporal decision making into large scale CGE models for numerical policy analysis, and this is what we attempt to do in the present paper.

We present an intertemporal CGE model with considerable industry disaggregation which we have calibrated to Austrian data, and we use this model to simulate the dynamic effects of tariff liberalization scenarios. Systematic investigations of the economic effects of trade liberalization for the case of Austria are relatively few in number, and all of them suffer from the above mentioned limitations.[4] The intertemporal features of our model allow us to focus an various aspects of adjustment that have been neglected in previous studies. Indeed, we present complete adjustment paths not only of the current account but also of sectoral variables such as capital stocks and firm values. Moreover, we are able to distinguish between the paths that emerge from surprising and anticipated liberalization policies, respectively.

We restrict ourselves to two liberalization scenarios, one being historic and the other hypothetical. As our benchmerk data set includes pre-Tokyo-round tariff rates, a natural scenario to analyze was the tariff reduction agreed upon in the Tokyo- round of the GATT. The other is a complete unilateral removal of pre-Tokyo-round tariffs. Although our model is a single country one, we have also attempted to mimic the multilateral nature of these trade liberalization scenarios. Indeed, it turns out that multilateral liberalization has very different effects from unilateral liberalization. It is certainly true that the relationship between these scenarios and the issues presently on the liberalization agenda is somewhat tenous. No explicit reference is made to specific proposals that are actually negotiated upon. Moreover, as is well known, present liberalization efforts are increasingly addressing issues related to non-tariff trade barriers in addition to tariffs. However, we nevertheless hope that our results are indicative of the type of adjustment paths that economies like Austria will take as a result of trade liberalization. Moreover, given that large scale intertemporal CGE models have only recently begun to emerge, the paper will be of interest from a pure modeling perspective as well.[5]

The paper proceeds as follows. Section two presents the macroeconomic core of our model. Savings are determined by overlapping generations with uncertain life-times maximizing expected utility while investment behaviour is governed by maximization of firm values subject to installation costs for new capital. Section three then gives an overview of the disaggregate, sectoral structure of our model. We briefly discuss the relationships between certain key balances and related stock variables, in particular as relating to the public sector and the foreign sector. After stating the equilibrium conditions we briefly characterize how we have empirically implemented the model. In section 4 we first describe the policy scenarios and then present what we believe to be the most interesting results. We separately discuss the steady state effects and the adjustment dynamics. In doing so, we place significant emphasis on relating our results to those obtained in the analytical literature. In particular, we point out certain ambiguities of analytical models that should provide additional motivation for the simulation approach that we pursue in this paper. Section 5 contains a sensitivity analysis. We contrast the results from the base case unilateral

[4] Breuss and Tesche (1991) simulate various tariff liberalization scenarios within a static 7-sector model. Kohler (1991a) uses a static specific factors model with 48 sectors to investigate income distribution and employment effects of pre- and post-Tokyo- round tariff protection, and Kohler (1991b) uses the Michigan Model of World Production and Trade developed by Deardorff and Stern (1986) to simulate certain multilateral liberalization scenarios.

[5] Recent efforts towards intertemporal CGE models are surveyed in Bovenberg and Goulder (1992).

scenario with those obtaining under multilateral liberalization, and we consider alternative budgetary arrangements to make up for the loss in tariff revenues. Finally, we test the robustness of our results with respect to key behavioral parameters. Section 6 concludes with a few summary remarks.

# 2 The Macroeconomic Core

In its emphasis on intertemporal decision making, our paper is close in spirit to the work of Goulder and Eichengreen (1989a, 1989b), henceforth called GE. There are, however, some important differences which open new channels for policy effects. While GE model a two country world, our model represents a small open economy with foreign commodity prices and the foreign real interest rate given exogenously. On the export side, we assume downward sloping export demand functions making the terms of trade endogenous. Unlike GE, our model allows for endogenous labor supply which constitutes an important channel for expansionary or contractionary policy effects. Furthermore, GE assume an infinitely lived representative agent to determine aggregate consumption and savings while we assume that the economy is populated by overlapping generations with life-time uncertainty. Hence, we allow for conflicting intergenerational interests concerning policy changes.

The basic analytical model of overlapping generations with life-time uncertainty was pioneered by Blanchard (1985) who assumed identical birth and death rates and therefore a constant population. Weil (1989) extended the model to the case of a zero death rate. In Weil's model, new infinitely lived families enter the economy at each instant but they are disconnected to existing generations. Buiter (1988) synthesized the two types of overlapping generations models. Engel and Kletzer (1990) studied some effects of trade policy while Obstfeld (1989) considered crowding-out from public debt in the world economy. Our paper also builds on the overlapping generations model with life-time uncertainty, but presents a more complex simulation model which is meant to capture the basic empirical features of the Austrian economy. It is a model in discrete time as in Frenkel and Razin (1987) but it additionally features endogenous labor supply, short-run specificity of capital, a larger number of traded and non-traded commodities, government and foreign debt accumulation and a detailed account of the tax system (especially tariffs, excise taxes, value added taxes and taxes on factor income). The following presentation of the model structure is as brief as possible since more details are presented elsewhere.[6]

## 2.1 Savings Decisions

The economy is populated by individuals of different ages. In each period, individuals choose some action and face a risk $\theta$ of dying thereafter. For tractability, this probability is assumed constant and independent of age. In maximizing expected life-time utility subject to life-time resources, agents born at date $t-a$ choose at date $t$ consumption bundles for dates $s$, denoted by $v_{t-a,s}$. If no ambiguity arises, we write

[6] Keuschnigg and Kohler (1992) plus an associated appendix which is available upon request. Our previous paper also contains calibration details as well as some steady state results of an illustrative application to a unilateral tariff liberalization.

$v_{.s} = v_{t-a,s}$ for short. To simplify intertemporal consumption choice, we assume time separable life-time utility with exponential discounting, linearly homogeneous periodic felicity, and a constant intertemporal elasticity of substitution. Consumption is then determined by maximizing

$$\max \quad \sum_{s=t}^{\infty}[(1-\theta)\beta]^{s-t}u(v_{t-a,s}). \tag{1}$$

where $u(\cdot)$ is denotes felicity which, in turn, is linearly homogeneous and strictly quasi-concave in consumption $C$ and leisure $1-L^s$: $u(v) = u(v[C, 1-L^s])$. Moreover, $u(\cdot)$ features a constant elasticity of intertemporal substitution. At this stage, consumption $C$ must be thought of as a quantity index of all commodities consumed. Time endowment is normalized to unity. Since we allow for wage increasing productivity growth, we must further have a unitary elasticity of substitution between commodity consumption and leisure.[7] The homogeneity assumption allows to treat the intraperiod allocation of expenditures separately from the intertemporal problem of allocating expenditures over time. Specifically, a given consumption aggregate $v_{.s}$ is assumed to be obtained at minimum cost, and this implies that we may use the unit expenditure function as the exact price index for the consumption-leisure bundle. Denoting this price index by $p^v_s$ and given a net of tax wage rate $w^n$, we arrive at expenditures $p^v v = p^c C + w^n(1-L^s)$. Given a price index $p^c$, spending on commodity consumption $p^c C$ is allocated to different commodities according to the same principles. Since $v$ is detrended from productivity growth, the discount factor $\beta$ includes a term due to trend growth at rate $x$ in addition to the subjective discount rate $\rho$. Life-time uncertainty further increases the effective rate of individual discounting.

Given a path of future disposable wage incomes $y_{.s}$ consisting of the values of time endowments plus lump-sum income components, agents may shift consumption across periods by borrowing or lending in a perfectly competitive international capital market at the real interest rate $i^*$. The interest rate is expressed in import goods which are assumed to be available at constant prices. Denominating financial wealth $A$ in some foreign commodity[8], it evolves according to

$$A_{.} = \frac{1+i^*}{1-\theta}\frac{A_{.-1}}{1+x} + y_{.} - p^v v_{.}. \tag{2}$$

The presence of life-time uncertainty increases the effective interest paid on assets. This provides the key link between individual uncertainty and deterministic behavior of aggregate wealth. Frenkel and Razin (1987) and Blanchard and Fischer (1989), for example, give an institutional interpretation. Financial wealth is composed of government debt, equities and foreign bonds which are assumed to be perfect substitutes in private portfolios.

The maximization of expected life-time utility (1) subject to (2) and an appropriately specified solvency constraint may be solved via a Lagrangean approach [see appendix for details]. The necessary

[7] It is convenient to express all variables in efficiency units (except leisure, labor supply and labor demand which are per capita) making them stationary in a steady state.

[8] Alternatively, one could denominate financial wealth in terms of some home commodity available at an endogenously determined price. In this case, an interest parity condition ties the domestic real interest rate to the world interest rate. When assets are denominated in foreign commodities, the interest parity condition holds implicitly.

conditions show how consumption is allocated across periods to derive maximum utility,

$$u'(v_{.}) = \beta u'(v_{.+1})\left[\frac{1+i^*_{+1}}{1+x}\frac{p^v}{p^v_{+1}}\right]. \tag{3}$$

The left hand side gives the cost in terms of utility of forgoing one unit of full consumption this period. Given price changes and the interest on savings, the consumer can buy a quantity of full consumption equal to the square bracket next period which yields a marginal utility gain $u'(v_{.+1})$ per unit. Hence, the Euler equation compares the marginal utility cost with the discounted utility gain from transferring a unit of consumption from this to the next period. Note that it does not depend on the risk term $\theta$. Repeated application of the Euler equation shows how the consumer trades off the gains and losses from shifting consumption between any arbitrary two periods.

The Euler equation fixes the slope of the consumption profile. The level of present and future spending is restricted by the consumer's intertemporal budget constraint: the present value of full consumption expenditures must not exceed life-time wealth $\mathcal{W}_{.}$. The constant elasticity specification of utility then yields an explicit solution for current consumption expenditures $p^v_t v_{.t} = \Omega_t^{-1}\mathcal{W}_{.t}$. This "consumption function" relates expenditures on present full consumption to life-time wealth $\mathcal{W}$. The factor $\Omega^{-1}$ is the marginal propensity to consume out of total wealth and depends on the price of present relative to future consumption. Total wealth consists of financial and human wealth where the latter is the present value of disposable non-capital income $y$.

We assume that age cohorts are populated by a large number of identical individuals with independent risks of life. By the law of large numbers, the constant individual probability of dying $\theta$ is identical to the fraction of the cohort which dies at each date. Given the gross birth rate $n+\theta$, the total population grows deterministically over time with the net birth rate $n$. **Aggregate per efficiency unit** quantities $v_t$, are obtained by summing over cohort specific variables and by deviding through the overall population size to detrend from population growth: $v_t = \sum_{a=1}^{\infty} \omega_a v_{t-a,t}$. The population weights $\omega_a$ sum to unity and are time-autonomous implying that the age distribution of the population remains constant. Aggregation uses the fact that market prices as well as price indices are the same for all agents. Furthermore, we assume for simplicity that disposable non-capital income $y_{t-a,t} = y_t$ is age-independent which requires specifically that government transfers to individuals are age-independent. Therefore we have by definition that aggregate human wealth is equal to human wealth of each individual cohort, $H_{t-a,t} = H_t$. Human wealth is the same for all generations because they receive equal disposable incomes $\{y_s\}_{s\geq t}$, have the same time horizon over the rest of their lives and identical discount factors.[9] For similar reasons the marginal propensity to consume out of total wealth $\Omega^{-1}$ is identical across generations.

Realizing that all agents face identical prices irrespective of their age, we obtain aggregate expenditures on the consumption leisure bundle $v$ in efficiency units:

$$p^v v = \Omega^{-1}\mathcal{W}, \qquad \mathcal{W} = (1+i^*)\frac{A_{-1}}{1+\bar{g}} + y + H. \tag{4}$$

[9] This is very much different from life-cycle OLG models where agents face a fixed finite life-time and death is certain to occur after $T$ periods. In these models the marginal propensity to consume increases with age while human wealth declines with age. See Auerbach and Kotlikoff (1987) and Keuschnigg (1991b). For more details on aggregation over age cohorts, see Keuschnigg and Kohler (1992) and the associated appendix.

The overall growth rate amounts to $(1+\bar{g}) = (1+x)(1+n)$ in case of both population and productivity increases. Financial wealth must obey the following law of motion:

$$A = (1+i^*)\frac{A_{-1}}{1+\bar{g}} + y - p^v v, \tag{5}$$

with individual components evolving as in (2). The laws of motion for human wealth and marginal propensity to consume are obtained by writing their present value definitions in first differences.

## 2.2 Investment Decisions

Domestic production units are owned by resident consumers. In the absence of uncertainty, consumers simply choose those assets in their portfolios that yield the highest real rates of return. Given perfect capital markets, equities in firms must therefore earn a rate of return exactly equal to the market real interest that is available on alternative assets such as government bonds and foreign assets. With equities denominated in some foreign commodity, the no-arbitrage condition requires[10]

$$i^* \frac{V_{-1}}{1+\bar{g}} = \chi + \left(V - \frac{V_{-1}}{1+\bar{g}}\right). \tag{6}$$

Firm value $V$ as well as dividends $\chi$ are per efficiency units. The return on equity consists of dividend payments and capital gains. While the no-arbitrage condition gives the slope of the time profile of firm values, their levels are determined by value maximization. The no-arbitrage condition must hold in all future periods, and its forward solution gives the ex-dividend firm value. In doing so, we impose a transversality condition that excludes eternal speculative bubbles and gives the fundamental value of the firm equal to the present value of dividend payments,

$$V_t = \sum_{s=t+1}^{\infty} \chi_s \prod_{u=t+1}^{s} \frac{1+\bar{g}}{1+i_u^*}. \tag{7}$$

Net of tax dividend payments after internal investment finance are defined as

$$\begin{aligned} &(a) \quad \chi = (1-t_y)[\tilde{p}(F-\Phi) - w^g L^d] - (1-et_y)p^I I, \\ &(b) \quad F = F\left(\frac{K_{-1}}{1+\bar{g}}, L^d\right); \qquad \Phi = \Phi\left(\frac{K_{-1}}{1+\bar{g}}, I\right). \end{aligned} \tag{8}$$

The capital stock $K_{-1}$ in the previous period is expressed in efficiency units of the current period, and labor input is per capita. Technology is represented by a value added production function $F$ and an installation cost function $\Phi$ which are both assumed linearly homogeneous in their arguments. Installation of new capital absorbs own output reducing value added net of adjustment costs to $F-\Phi$. The installation technology is decreasing in capital and strictly convex in investment. Hence, physical capital is sector specific in the short-run and may be reallocated only through net investment. By way of contrast, labor is completely mobile across sectors. The value added product $F$ sells at a price $\tilde{p}$ which will be defined

[10] In presenting the core model we abstain from using sector and commodity indices.

below. Firms pay a wage rate $w^g$ (gross of factor taxes), and $I$ is gross investment. The latter may be thought of as demand for a composite capital good available at a price $p^I$. Details on $\tilde{p}$, $I$, and $p^I$ will follow in a subsequent chapter presenting the temporal, disaggregate structure of the model. Profits are taxed at a proportional rate $t_y$ but a fraction $e$ of investment expenditures is allowed as a deduction from the tax base.[11]

Labor input is an atemporal choice that must satisfy the familiar optimality condition of equality between the marginal value product of labor and the nominal gross wage rate: $\tilde{p}F_L = w^g$. Given that the capital stock in each period is predetermined, this defines a short-run labor demand function $L^d = L^d(\tilde{p}, w^g, K_{-1})$. The gross wage rate is tied to the market wage by $w^g = w(1+t_l)$ where $t_l$ is a sector specific indirect tax rate on wage payments. Capital depreciates at a geometric rate $\delta$. Therefore, the stock accumulates according to

$$K = (1-\delta)\frac{K_{-1}}{1+\bar{g}} + I. \tag{9}$$

The basic problem in organizing production over time is to accumulate capital stocks so as to maximize the cum-dividend value $(\chi + V)$ of the firm. Optimal investment can be determined by Lagrangean methods. The necessary conditions for an intertemporal production optimum imply

$$q_t = p_t^I(1 - e_t t_{y,t}) + (1 - t_{y,t})\tilde{p}_t \Phi_{I,t}. \tag{10}$$

The marginal shadow value of the capital stock $q_t$ is equal to the present value of incremental future net income streams that would be created by an additional unit of capital, including the effect of an increased capital stock on future adjustment costs. Hence, investment is determined by the simple rule that the present value of incremental future profits induced by a new project must cover at least the effective acquisition cost given in (10). In the light of the homogeneity assumptions on technology, we may invoke Hayashi's (1982) theorem which equates firm value to the shadow value of new capital: $V = qK$. Upon inserting this relation to eliminate marginal $q$ in (10), one obtains

$$\Phi_I\left(\frac{K_{-1}}{1+\bar{g}}, I\right) = \left[\frac{V}{K} - p^I(1 - et_y)\right]\frac{1}{(1-t_y)\tilde{p}}. \tag{11}$$

Assuming a functional form for the installation function and substituting from (9) for $K$, optimal investment is explained as a function of current prices, predetermined capital stock and expected firm value: $I = I(\vec{p}, K_{-1}, V)$. The vector of commodity prices $\vec{p}$ determines all price indices used in (11). Given predetermined capital stocks and a forward looking investment choice, all actions of the firm such as short-run labor demand and dividend payments are determined.

[11] Our modeling of capital taxation is rather simplistic and is primarily dictated by data restrictions. For example, it does not capture the double taxation feature of a separate corporate tax in addition to a personal income tax. See Keuschnigg (1991b) for a more elaborate modeling of capital taxation.

## 3 The Complete Disaggregate Model

### 3.1 Sectoral and Commodity Disaggregation

In the preceding discussion of the intertemporal part of the model, we interpreted the quantities $C$ and $I$ as commodity bundles. We shall now be somewhat more specific about these bundles.[12] Within each sector, commodities are available in a domestically produced and an imported variant. We thus follow the familiar Armington (1969) approach in assuming domestic and imported commodities to be imperfect substitutes. Any demand for commodity $i$, wherever it may originate, should be thought of as demand for a sector specific aggregate composed of a home produced and an imported commodity, denoted by superscripts $h$ and $m$, respectively. These sector specific aggregates enter a second level of aggregation leading to the consumption aggregate $C$ and the capital good $I$ mentioned above. Consumers, government and investors generate domestic final demand whereas producers demand intermediate inputs. In addition, there is export demand for domestic commodities by foreign agents. We capture this in our single country model by means of downward sloping, constant elasticity export demand functions $E_i[p_i^h(1+t_i^f)]$, where $p_i^h$ is the market price for home good $i$, and $t_i^f$ is an ad–valorem foreign tariff. In effect, we assume that home produced goods are differentiated making the home economy large in its export markets and capable of influencing its terms-of-trade.

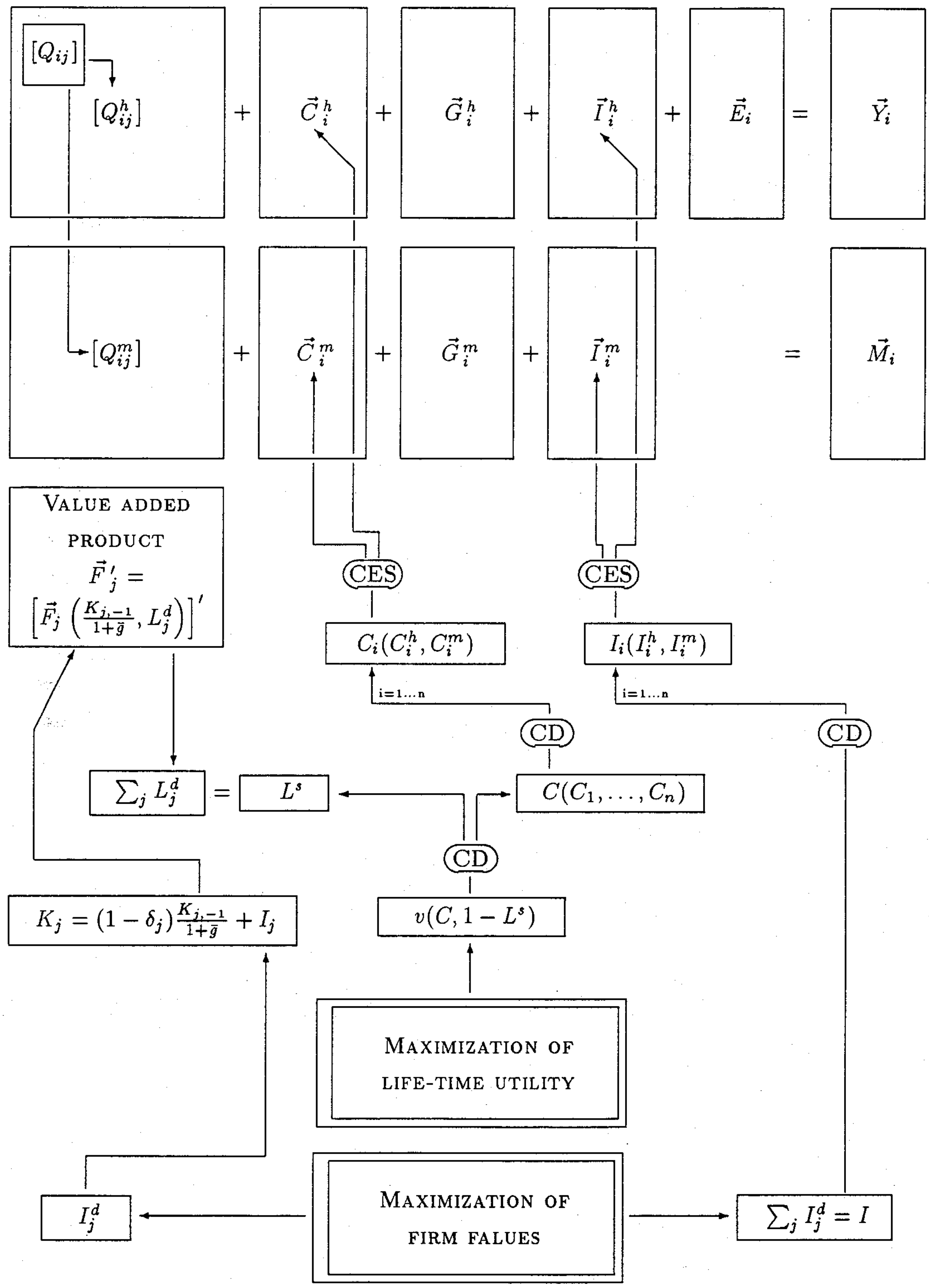
To take account of commodity disaggregation in consumption, the felicity function finally reads as $u\big[v\{C[C_1(C_1^h, C_1^m), \ldots, C_n(C_n^h, C_n^m)], 1-L^s\}\big]$ with linearly homogeneous and strictly quasi-concave sub-utility functions. Analogously, the capital good aggregate decided upon through intertemporal optimization is now interpreted as $I\big[I_1(I_1^h, I_1^m), \ldots, I_n(I_n^h, I_n^m)\big]$. This is like a capital good construction technology which we assume to be the same across all sectors. This type of nesting allows us to translate aggregate quantities resulting from intertemporal optimization into individual commodity demands by applying the principle of multi-stage budgeting. Expenditure minimization generates unit demand functions as well as exact price indices for every step of aggregation. Figure 1 gives an overview of how the intertemporal part of our model, dealing only with aggregate quantities, is linked to the sectoral level.[13]. As to government procurement, we assume a fixed coefficient upper level utility. This is meant to reflect the fact, albeit in a stylized way, that government procurement is to a large extent fixed by legal commitments. The lower utility nest, however, allows for cost-minimizing substitution between imported and home goods.

Production features separability between intermediate inputs and a value added product. This was already implicit in the use of the value added production function and its effective price above. In line with much of the literature we assume fixed input-output coefficients for intermediate inputs and the value added product. At the next lower level, cost minimizing substitution is possible between value added production factors and also between home produced and imported intermediates. As with final

[12]We shall, however, be very brief since the disaggregate structure of our model is more standard and we have outlined it in more detail in Keuschnigg and Kohler (1992).

[13]Square brackets indicate a matrix array, whereas arrows indicate column vectors. The algebraic operations should be thought of as element-by-element. $\mathcal{CES}$ denotes a Constant-Elasticity-of-Substitution aggregate and $\mathcal{CD}$ denotes a Cobb-Douglas aggregate.

**Figure 1: Overview of the model structure**



demand, we use the unit expenditure function as an exact price index for the input aggregate and the price of the value added product then follows along the lines of the effective protection literature.

In addition to the taxes appearing in the investment problem above, we allow for three types of sector specific, ad valorem commodity taxes: a value added tax, an excise tax, and an import tariff. These taxes drive wedges between buyer's and seller's prices. We normalize all prices net of these taxes to unity in the benchmark equilibrium. World prices for imported goods remain so by assumption in the counterfactual analysis.

### 3.2 Public Sector Balance and the Current Account

The government spends on commodities and on transfers to the household sector. It finances its budget by raising taxes and accumulating debt. Although the government may temporarily run deficits or surpluses, it must keep its liabilities within sustainable levels. If not otherwise indicated we assume that the government follows a prespecified path of debt and lets transfers adjust endogenously to satisfy the budget constraint. Alternative budgetary policies for stabilizing public debt are considered in section 5.1 as part of the sensitivity analysis. The following laws of motion tie primary balances to the accumulation of associated stocks:

$$\begin{aligned} (a) \quad & D^G = (1+i^*)\frac{D^G_{-1}}{1+\bar{g}} + S^G, \\ (b) \quad & D^F = (1+i^*)\frac{D^F_{-1}}{1+\bar{g}} + S^F, \\ (c) \quad & A \;\, = (1+i^*)\frac{A_{-1}}{1+\bar{g}} + S^H. \end{aligned} \tag{12}$$

The stock of government bonds, $D^G$, is denominated in foreign commodities. The primary government deficit amounts to $S^G = z + p^G G - T$ with $z$ denoting transfers to households. Spending for government procurement is $p^G G$ while $T$ denotes total tax revenues. $D^F$ indicates the stock of net foreign assets, and $S^F$ is the trade surplus. The third equation gives the aggregate flow constraint for the accumulation of household sector financial wealth with $S^H$ denoting savings out of disposable non-capital income equal to $S^H = y - p^v v = w^n + t_y d + z - (p^c C + w^n(1 - L^s)) = w^n L^s + t_y d + z - p^c C$. We denote by $t_y d$ the savings from a general income tax deduction. Solving these equations forward in time one obtains the intertemporal budget constraints which restrict the present value of future excess spending to the amount of existing wealth.

### 3.3 Equilibrium Conditions

All actions chosen during a certain period are conditional on previously determined, "historic" variables, $\mathcal{K} = \{K_1, \ldots, K_n, D^G, D^F\}$, and on expectations about the future as embodied in the forward looking variables $\mathcal{E} = \{V_1, \ldots, V_n, \Omega, H\}$. Temporary equilibrium requires that agents satisfy their budget constraints, that the spot markets for commodities and labor clear, and that the desired changes in asset positions are mutually consistent to yield equilibrium in the capital market. The temporary excess demand system $\zeta(\vec{p}, \mathcal{K}_{-1}, \mathcal{E}) = 0$ is given by[14]

$$\begin{aligned}
&(a) \quad \zeta_i^C \equiv C_i^h + G_i^h + \sum\nolimits_j I_{ij}^h + E_i + \sum\nolimits_j a_{ij}^h Y_i - Y_i, \qquad i,j = 1 \dots n, \\
&(b) \quad \zeta^L \equiv \sum\nolimits_j L_j^d - L^s, \\
&(c) \quad \zeta^G \equiv \bar{D}^G - (1+i^*)\tfrac{\bar{D}_{-1}^G}{1+\bar{g}} - S^G, \\
&(d) \quad \zeta^K \equiv \left[S^H + i^* \left(\tfrac{D_{-1}^G + D_{-1}^F}{1+\bar{g}}\right) + \sum\nolimits_j \chi_j\right] + R - p^I I - \nabla D^G - \nabla D^F.
\end{aligned} \tag{13}$$

The capital market condition may be stated equivalently in flow form as in (d) or in stock form $\sum_j V_j + D^G + D^F = A$. The flow condition is obtained from the portfolio identity by substituting the corresponding laws of motion and using the fact that the portfolio condition is identically satisfied for the preperiod. We have used $R = p^I I$ to denote retained earnings which, by assumption, equals investment expenditures. Moreover, $\nabla D \equiv D - D_{-1}/(1+\bar{g})$ denotes changes in asset positions, expressed per efficiency unit. The square bracket in (d) equals total household sector savings, i.e. savings out of non-capital income augmented by capital income. Adding retained earnings gives private sector savings which must match investment expenditures plus government deficit plus current account. In equation (c), we require the government deficit to be consistent with a prespecified path of government debt, denoted by $\bar{D}^G$.

Temporary equilibrium requires the excess demand system to be zero, $\zeta(\vec{p}, \mathcal{K}_{-1}, \mathcal{E}) = 0$. When computing temporary equilibria it suffices to solve equations (a) through (c) only since the system satisfies Walras' Law: $\sum_i p_i^h \zeta_i^C + w\zeta^L + \zeta^G + \zeta^K = 0$. To compute equilibria, we actually iterate on domestic producer prices, the wage rate and a government policy parameter such as transfers, $\vec{p} \equiv \{p_1^h, \dots, p_n^h, w, z\}$. Successive temporary equilibria are interconnected in two ways. First, all "backward-looking" stock variables are predetermined from previous equilibria. Second, future equilibria determine, via perfect foresight, the current values of the "forward-looking", expected variables. The terminal values of the dynamic variables are generated by an independent computation of the final steady state where all stocks and flows satisfy the steady state versions of the relevant equations of motion.[15]

### 3.4 Empirical Implementation

The most recent input output tables for Austria date back to 1976 which is unfortunate but beyond our control. Hence, the model is empirically implemented by means of calibration to a 1976 data set for the Austrian economy. While calibration of the static submodel is more or less standard, it is more difficult to find appropriate parameters for the intertemporal model elements. We are presently forced, more than we would like, to use informed guesses for some of these. Since we provide all details on calibration methods and choice of exogenous parameters in Keuschnigg and Kohler (1992) we can be

[14] We denote the *endogenous* input-output coefficient for home produced inputs by $a_{ij}^h$.

[15] Keuschnigg (1991a) gives details of the iterative procedure due to Wilcoxen (1989) that we follow to compute perfect foresight equilibria.

very brief at this stage. Table 1 gives base case values for some parameters that importantly determine the dynamic properties of the model. Bold face values are calibrated while the others are specified using extraneous information. The share parameter $\alpha$ denotes the weight of consumption in the top utility nest of households. The adjustment cost parameter $\psi$ governs the sensitivity of investment demand per unit of capital with respect to Tobin's marginal $q$, and its' value is implied by Summers' (1981) estimates. We have attempted to retain a reasonable level of disaggregation, and the present version of our model covers as many as 19 sectors. Table 2 provides information on the sector and commodity classification of our model. The column $VA$ identifies the important sectors of the Austrian economy in terms of the sectoral shares in total value added while the elasticities $\mu_i$ in table 4 indicate their flexibility in primary factor substitution, as evident from the econometrics literature. The column $\sigma_i^m$ in table 5 measures the degree of substitutability between home and import goods, and the same elasticity values apply to intermediate demands as well as to all categories of final demand. Again these values are adopted from existing econometric estimates.

The base case solution of the model reproduces the data set as a balanced growth equilibrium. Needless to say that interpreting a given historical situation as a steady state, which is what we do when calibrating the model, is a rather delicate issue. The extent to which models like the present one can claim to be empirical models is somewhat limited. In our view, they take a position somewhere inbetween stylized analytical models and empirical work. They incorporate much detail which would inevitably be missing if analytical tractability were to be retained, and they take recourse to empirical information. Yet, the results obtained are not, in our view, anything like econometric forecasts. Perhaps most importantly, the model as such remains untested. Calibration gives us a somewhat enriched neoclassical model that is capable of reproducing the long-term growth properties of a real world economy as a steady state.

# 4 Effects from Tariff Liberalization

## 4.1 Policy Scenarios

Given the detailed account of the effective tariff rates on all categories of demand, the model is suitable to an evaluation of the macroeconomic and interindustry effects of commercial policies. The first policy scenario concerns the reduction of tariff rates from their 1976 levels to post-Tokyo-round levels, while the second features a transition to a free trade regime with zero tariffs. Since we do not directly observe post-Tokyo-round tariff rates on a disaggregate level, we make use of the fact that the Tokyo-round negotiations featured an overall tariff-cutting formula instead of a tabling of item-by-item tariff cuts. Denoting pre- and post-Tokyo-round tariff rates $t_{m,i}$ by superscripts 0 and 1, respectively, the formula relevant for EC countries was[16]

$$t_{m,i}^1 \cdot 100 = \frac{1600 \cdot t_{m,i}^0}{16 + t_{m,i}^0 \cdot 100}, \tag{14}$$

[16]The assumption is that Austria followed the EC block in the negotiations even though she is not a member of the EC.

Our first scenario applies this formula to the effective tariff rates for all categories of demand appearing in our model. Quite naturally, this formula was not applied without exceptions, but it is nevertheless a useful guide in the present context.[17] The average pre- and post-Tokyo-round tariff rates and the implied average percentage reduction can be found in table 2.

The Tokyo-round negotiations were completed in 1979 and the tariff cuts agreed upon were gradually phased in over a period of seven years. This is a typical feature of commercial policy, and our model allows to capture the intertemporal effects that such an anticipated, gradual implementation will have. Accordingly, we contrast the effects of instantaneous tariff cuts with a more gradual implementation. The gradual policy scenario has the tariff cuts spread out over seven years in equal absolute steps, and the policy is announced four years in advance of its' actual implementation. These definitions also apply for the second scenario featuring a complete elimination of tariff rates.

Throughout the paper, the base case scenarios will always be unilateral tariff reductions. These will be compared with multilateral liberalization scenarios in section 5 below.

## 4.2 Analytical Results and Ambiguities

It may be useful to briefly indicate the various channels through which analytical models have found commercial policy to have intertemporal effects. At the outset, we should perhaps point out that an unanticipated and permanent change in import barriers in and of itself does not change intertemporal prices unless consumer preferences exhibit some form of intertemporal nonhomotheticity [on this point, see Razin and Svensson (1983)]. Hence, one might be inclined to think that commercial policy is devoid of any interesting intertemporal effects. Recent literature, however, has shown otherwise. For instance, current account adjustment dynamics and according changes in foreign indebtedness may result from sluggish supply reactions of domestic producers to the new environment created by a trade policy change. This has been emphasized in different model setups by O'Rourke (1989), Sen and Turnovsky (1989), and Gavin (1991), among others. O'Rourke and Gavin establish in models without any capital accumulation that short-run capital specificity combined with long-run mobility will generate adjustment paths characterized by a short-run deterioration of the current account as a result of trade liberalization.[18] The reason may either be that reallocation costs imply a higher long-run than short-run increase of income as a result of removing a production distortion, or that the implied higher long-run than short-run supply elasticities will cause the real exchange rate (relative price of the non-traded good) to rise along the adjustment path, thereby changing the consumption based real interest rate. In both cases intertemporal optimization by households will imply a temporary deterioration of the current account. It may, however, be questioned whether reallocation of existing physical capital is an important channel of adjustment. Arguably, capital reallocation is much more likely to occur through net investment rather than intersectoral movements of existing physical capital. Moreover, the significance of non-tradables may similarly be questioned on

[17] See the appendix in Kohler (1991a) for a discussion of this problem.

[18] O'Rourke (1989) uses a two-period model while Gavin (1991) uses the infinite horizon setup pioneered by Mussa (1978). Gavin (1990) offers a similar analysis of terms-of-trade shocks.

the grounds that trade in services has become an important part of international economic relations.[19] If all goods are traded and the economy is large, the relevant price variable influencing the dynamics of adjustment will be the terms-of-trade. Finally, if home produced goods and import goods are imperfect substitutes, tariffs do not entail any production distortion, hence there is also no potential for a direct production gain through tariff reductions which might otherwise be argued to be larger in the long-run than in the short-run.[20] As is evident from previous sections, our model departs in all of these respects (apart from incorporating more institutional and industry detail) from the basic assumptions of O'Rourke and Gavin. Hence, these studies can only provide limited guidance for interpreting our empirical findings.

The analytical study coming closest to our simulation model is Sen and Turnovsky (1989). They focus on capital accumulation of a completely specialized economy. The dynamics in their model is importantly driven by the endogeneity of labor supply, in addition to the endogeneity of the terms-of-trade, both of which are also key elements of our model structure. Tariff liberalization leads to an increase in labor supply and, via a given real interest rate, also to a long-run increase in the capital stock. One would perhaps be inclined to conclude that intertemporal consumption smoothing will cause a temporary worsening of the current account along the lines of the previous argument. However, that argument is now partially offset by a change in the terms-of-trade and, as Sen and Turnovsky show, the net effect on the current account as well as consumption of the two goods is theoretically ambiguous, even in the long-run. Additional ambiguities arise in the short-run analysis. Although clearly rising in the long-run, the relative price of the import good may either rise or fall on impact as a result of trade liberalization.[21] These ambiguities arising even in highly stylized analytical models, in our view, provide a strong case for pursuing simulation studies like the present one. This is further strengthened by the sectoral and institutional details that may be incorporated in a simulation model. Thus, incorporating as many as 19 sectors, our model allows for the above mentioned capital reallocation through differential net investment, and a natural question to ask is whether the overall increase of the capital stock, to be expected from Sen and Turnovsky, will unambiguously hold on the sectoral level. Moreover, while the Sen Turnovsky model indentifies the capital good with the home good, our capital good also incorporates imported goods which must be expected to importantly influence the adjustment path.

A final and important fundamental difference between our model and the Sen Turnovsky setup lies in household behavior where we assume overlapping generations instead of an infinitely lived representative household. Recent contributions by Matsuyama (1988) and Engel and Kletzer (1990) have highlighted intertemporal effects of commercial policy deriving from overlapping generations. Put most simply, the basic point is that wage and non-wage income do not enter the determination of wealth (and hence consumption and savings) on an equal footing if the household sector is populated by overlapping generations. If commercial policy changes income distribution through factor price changes, this will also imply an intergenerational redistribution of wealth. For instance, if in the long-run trade liberalization were to

[19] Our data reveal trade in all but one (the public sector) of the 19 sectors of our empirical model.

[20] There are, however, indirect production gains through cheaper imported intermediate inputs.

[21] It can be shown, however, that the terms-of-trade cannot 'overshoot' in the Sen Turnovsky framework. See Sen and Turnovsky (1989, p.827). On the other hand, 'overshooting' of the real exchange rate is a key aspect of adjustment in Gavin (1991).

lower the real wage rate and to increase dividend payments without affecting aggregate efficiency, this would in effect redistribute wealth from future to presently living generations. The latter would save less and the current account would accordingly deteriorate. The reason for all this is that future increases in dividends are capitalized to a greater extent than future losses in labor income which will be shared by individuals not yet born.[22] Whether or not trade liberalization will entail a temporary deterioration or improvement of the current account will thus also be determined by its real wage effect. This, however, is well known to be ambiguous even in static models with sector specific capital (neoclassical ambiguity) – a futher motivation for our simulation study.

### 4.3 Long-Run Steady State Effects

We first briefly discuss the long–run steady state effects before turning to the more interesting adjustment dynamics. The results are most easily understood if one first concentrates on the various income and substitution effects operating under notionally constant dynamic variables (wealth and capital stocks). As we have detailed in our previous paper, our preference structure featuring multi–level utility nesting implies that the bottom level price effects of tariff reductions feed into upper level price indices. Moreover, upper level substitution effects are equivalent to income effects if view from the bottom level. Thus, cheaper imports will first cause a reduction in the overall price index $p^v$ leading to substitution away from leasure towards commodity consumption. On the sectoral level, substitution effects will switch demand towards the sectors with the most pronounced tariff cuts, and on the commodity level there will be substitution towards imported goods. Bottom level substitution effects and the top level quasi–income effect will reinforce each other for imported goods, while they tend to offset each other for home goods where the net effect is a priori unclear. Similar reasoning applies to other categories of demand. Notice, however, that for the multilateral scenario these effects will be complemented by an increase in export demand as a result of foreign tariff reductions. Our results indicate that for unilateral cuts substitution effect would dominate to give lower demand for home goods.

On the supply side, tariff cuts will have an initial expansionary effect on labor demand due to cheaper imported intermediates and, therefore, higher value added prices. Given the increase in labor supply, the direct impact on the wage rate is not clear cut. We would, however, expect some potential for a depressing effect on producer prices.

We next turn to a brief discussion of changes in dynamic variables that we observe in the long–run. Steady state sectoral capital stocks are determined by the following equation

$$\frac{F_K - \Phi_K}{i^* + \delta} = \frac{(1 - t_y e)}{(1 - t_y)} \frac{p^I}{\bar{p}} + \Phi_I. \tag{15}$$

While the marginal productivity of capital depends on the capital labor ratio only, the derivatives of the adjustment cost technology hinges on the investment to capital ratio which must approach $\delta + \bar{g}$ in the long-run [see (9)]. Hence, $\Phi_I$, $\Phi_K$ are fixed across steady states. Holding the tax parameters constant,

[22] Engel and Kletzer (1990) demonstrate that the usual lump-sum redistribution of tariff revenue will also exhibit this type of non-neutrality.

the capital labor ratio must decline in each sector as the price of the investment commodity increases relative to value added prices [see tables 3 and 4].[23] The higher the elasticity of factor substitution, the more the capital labor ratio will decline. This is most apparent in sectors 4, 14, 17, and 19 which employ more labor but use less capital [see table 4]. Indeed, these are sectors which table 4 shows to be relatively flexible in factor substitution. We note an important difference to Sen and Turnovsky (1989) where the capital labor ratio remains constant across steady states. The reason is that investment demand in our case is demand for a commodity aggregate (including imports), instead of the respective sector's own output as in the Sen–Turnovsky model. This provides for a relative price effect ($p^I/\tilde{p}_i$ which in the present case leads to a long-run fall in capital labor ratios. But since we have increased labor demand, lower capital labor ratios are compatible with most capital stocks actually increasing. We do, however, observe some sectors running down their capital stocks as a result of tariff reductions. Firm values, $V_j = q_j K_j$, decline mostly because of the depressing effect of lower domestic prices on the profitabilty of capital as reflected in marginal and average $q$. It should be noticed, however, that firm values invariably fall by less than the price indices $p^v$ and $p^c$ (see tables 4 and 5). Since, on average, the economy builds up capital stocks, demand for the aggregate investment commodity increases which is felt on the sectoral level as increased demand for home and import goods required to construct capital.

The demand side of the model hinges fundamentally on the change in real disposable wage income. The initial partial equilibrium response to tariff reductions was to increase supply as well as demand for labor. In long-run general equilibrium we observe a lower wage rate together with a lower consumer price index with the latter effect dominating. Note that the top level government consumption aggregate as well as government debt are held constant in our base case scenarios. From the government budget, the loss in tariff (and other tax) revenues has apparently more than compensated lower prices on the expenditure side, and therefore feeds into lower transfers to households. The overall effect on disposable wage income of the household sector is negative as reported in table 3.[24] This causes second round effects on consumption and labor supply. To trace these effects which are essentially wealth effects, we once more turn to the consumption function and the different components of wealth. In a steady state, human wealth changes proportionally with disposable wage income, and so does the budget for full consumption. The reason is essentially that the interest rate as well as the marginal propensity to consume are constant across steady states. Now we find the stationary solution of (5),

$$A = \frac{1+\bar{g}}{\bar{g}-i^*}(y - M^v), \tag{16}$$

which finally tells us that financial wealth also changes proportionally with real disposable income. As our model satisfies the condition for a dynamically efficient equilibrium, $i^* > \bar{g}$, the first multiplicative term is negative. Also, the full consumption budget exceeds disposable wage income giving positive financial wealth in the initial equilibrium. Hence, we have established an important link across steady states that makes financial wealth and the top budget ultimately change in proportion with disposable wage income.

[23] With some explicit exceptions, tables 3-7 give changes of variables in percent of their initial values which is indicated by the hat notation. Hence, $\widehat{K_i/L_i} = \hat{K}_i - \hat{L}_i$.

[24] We shall see below that the multilateral liberalization scenario has a positive effect on disposable income.

The reduction of disposable wage income and its' proportional effect on the budget for full consumption leads to second-round effects on labor supply and commodity demands. Lower demand for the aggregate commodity bundle, $\hat{v} = \hat{M}^v - \hat{p}^v < 0$, amounts to a quasi-income effect which reduces per se the demand for lower level commodities and makes the demand for home goods more likely to fall. Therefore, the second-round consumption effects aggravate the excess supply of domestic goods but run counter to the initially observed substitution effect in favor of imports. Furthermore, the depressing general equilibrium effect of import liberalization on domestic prices, too, weakens the initial substitution effect of the tariff reduction. Table 5 indeed shows that demand for some of the imported commodities falls. As regards labor supply, the reduced demand for the top level consumption basket amounts to a negative income effect on the demand for leasure. Hence, the second-round effects reinforce the initial increase in labor supply.

How do the savings-investment flows of our model economy respond to tariff reductions? Consider the portfolio identity of the household sector: $A = \sum_i V_i + D^f + D^g$. We have already observed that the steady state effects of tariff reductions give both lower firm values as well as lower financial wealth. Note that the policy experiment featured a constant level of government debt. By assumption, domestic residents own the entire domestic capital stock and domestic government debt. Therefore, they absorb all of the changes in firm values. The excess of household sector wealth over the value of domestically issued assets is invested in foreign issued bonds[25]. The erosion of household sector financial wealth dominates the reduction of firm values according to tables 3 and 4. Households run down the stock of foreign assets to absorb all of the domestic equities. Hence, the portfolio identity implies a lower value of foreign wealth, or equivalently, a higher level of foreign debt. In a steady state, flows are tied to stocks by a constant growth factor. Hence, we observe in table 3 a deterioration in the current account. Since the economy is dynamically efficient, $i^* > \bar{g}$, foreign debt requires a trade balance surplus in the steady state to keep the level of debt constant [see (12b)]. Therefore, the tariff reductions necessitate a higher trade balance surplus to service higher foreign debt.[26]

Finally, we discuss how tariff liberalization affects welfare of new generations as compared to the initial steady state. The discussion of welfare effects on old generations and generations living during the transition is postponed to the next section. We measure the welfare changes separately for each generation by the equivalent variation in life-time wealth which is based on the intertemporal expenditure function $e(\mathcal{P}, EU)$ where $\mathcal{P}$ denotes an intertemporal price factor and $EU$ is indirect life-time expected utility [see the appendix which is available upon request]. The welfare change is, then,

$$EV = 100 \times \frac{e(\mathcal{P}^0, EU^1) - \mathcal{W}^0}{\mathcal{W}^0}. \tag{17}$$

For a new generation, life-time wealth consists of human wealth only since agents start their life with zero financial wealth. Indirect utility depends on the intertemporal price factor $\mathcal{P} = \Omega^{1/\gamma}(p^v)^{(1-\gamma)/\gamma}$

[25] Since assets are assumed to be perfect substitutes, the portfolio composition is irrelevant in the long-run. The portfolio composition is important only when new information becomes available, for example, when the government announces a new policy. The new equilibrium prices are capitalized in firm values which confers initial windfall gains or losses according to the initial ownership distribution.

[26] We may note at this stage that the *assumption* made by Sen and Turnovsky concerning the relationship between capital accumulation and changes in the level foreign indebtedness is supported by our simulation results.

and on life-time wealth. It increases in wealth but declines in the price factor [see appendix and note that we chose an intertemporal elasticity of substitution smaller than one]. According to table 3, human wealth declines and so does the price factor since the top level price index declines. While the two factors contribute in opposite directions, the human wealth effect dominates in our simulation to inflict welfare losses on future generations. Several explanations are possible: First, the policy may have an inherent tendency to redistribute intergenerationally at the cost of future generations and to the benefit of presently living old generations. Such a tendency will become evident upon consideration of the transition paths. Second, our specification of export demand gives domestic producers market power in their export markets. However, tariff liberalization depresses relative prices of domestically produced commodities which reduces the earnings of the home economy not only from marginal exports but also on inframarginal exports. Depending on the elasticity of the export demand schedule and the size of the initial tariff, an export tax may be optimal to exploit the market power of domestic producers in foreign markets[27]. A tariff can be shown to achieve the same objectives. Therefore, the detrimental effect of tariff liberalization on welfare of future generations may partly be due to this unfavorable terms-of-trade effect. Finally, our initial equilibrium is distorted in many ways by various direct and indirect taxes. In principle, tariffs might play a role in offsetting the distortions introduced by other taxes explaining why tariff liberalization might be harmful in our framework. Such second best arguments, however, are difficult to evaluate.

### 4.4 Short-Run and Transitional Effects

The findings from intertemporal CGE models most relevant for policy evaluation are the short-run and transitional effects from policy shocks. Most of the standard trade policy analyzes using comparative static techniques suffer from somewhat arbitrary and extreme factor mobility assumptions with no explicit role for adjustment costs. This contrasts with the fact that policy makers do apparently attach significant importance to adjustment costs, as evidenced by their preference for gradualism in the introduction of such policy changes as trade liberalization. Our computational model provides for an explicit role of adjustment costs and, thus, allows a comparison between transition paths generated by gradual and instantaneous policy implementation, respectively. Whether gradualism is in fact a preferable way to implement a given policy change must be judged by weighing the associated welfare effects on present and future generations. We may note here that the analytical literature is largely agnostic as to whether gradualism is superior to instantaneous policy changes in cases where tariffs are not the only distortions [see Mussa (1986)]. Hence, our calculated adjustment paths including age specific welfare measures should be interesting from this perspective.

¿From an applied viewpoint, several important issues arise in a dynamic equilibrium model such as ours. Are adjustment paths to long-run equilibria monotonic? Are short-run effects qualitatively different from long-run effects? Is the policy a welfare improvement for present or future generations, or for all of them? We confine our study of dynamic adjustment to the Tokyo-round tariff reductions and

[27] See Helpman and Krugman (1989) for such an argument.

distinguish between a gradual and an instantaneous policy implementation, as defined above. Figure 2 gives percentage deviations of firm values and capital stocks from their initial values for a selection of sectors. Agricultural goods and food & textiles are the most highly protected sectors while chemicals are an intermediate case and the transport industry is representative of the service sectors with no initial tariffs. Figure 3 depicts important variables characterizing the household sector, and figure 4 demonstrates the evolution of the current account and the trade balance.

As a general result, we observe that the dynamic effects of our policy scenarios are rather small quantitatively producing changes of less than one percentage point in most cases. While much of the adjustment in capital stocks and firm values is completed in the first twenty periods, the household sector takes much longer to approach the long-run equilibrium as can be seen, for example, from the path of labor supply. With households slowly adjusting their levels of financial wealth, foreign debt and the trade balance also approach their long-run levels only very gradually.[28]The evidence from the figures suggests that adjustment paths are in most cases monotonic for instantaneous and permanent tariff reductions.

The four sectors depicted in figure 2 exhibit very different adjustment paths for firm values and capital stocks. The preceding section explained the decline in firm values over the long-run essentially as a consequence of lower acquisition costs of capital relative to value added prices (via a fall in the capital-labor ratio and hence the marginal physical productivity of capital). According to table 4, firm values fall even in the expanding sectors. Whether firm values fall more or less in the short-run than in the long-run depends on the underlying adjustment speed. Thus, figure 2 suggests that the shadow value of capital in agriculture (no. 1) falls quite rapidly on impact, much more so than acquisition costs (gross of installation costs). The subsequent decumulation of the capital stock and increase in the shadow value more or less balance each other. As a result, firm values pretty much jump to their new long run equilibrium values with only little dynamics along the adjutment path, except for a slight 'overshooting'. A roughly similar adjustment path, though without any 'overshooting', is observed for the food industry (no. 3). A wholly different picture emerges for the chemicals sector (no. 7). We know from table 4 that this sector will expand its capital stock significantly, so that firm values will fall by only a negligible amount in the long run. We might expect that the shadow value of capital would increase on impact so as to initiate capital accumulation. But in our model an impact fall in firm values is entirely consistent with a subsequent increase in the capital stock. The reason simply is that the policy considered will also change acquisition costs, and our results indicate that they do so by a much larger amount than does the shadow value of capital in the chemical industry. The subsequent capital accumulation is quite rapid in this sector, so that firm values increase sharply in the first periods, giving rise to a pronounced 'overshooting' pattern. Finally, the bottom panel of figure 2 reveals that, due to general equilibrium repercussions, liberalization will also affect sectors which do not directly loose any protection because they had none to start with.

Table 3 shows that the overall economy accumulates capital which, together with lower value added prices, depresses the wage rate. The reduction in human wealth documented in figure 3 reflects declining wages as well as declining lump-sum income from the government. Inspite of lower wages, labor supply

[28]We have actually solved for as many as 250 periods to eliminate any sensitivity of the short-run solution with respect to terminal conditions.

slowly increases over time as consumer prices decline even more than wages, and leisure therefore becomes relatively more expensive. Furthermore, households gradually decumulate financial wealth, and they do so in an amount that exceeds the erosion in equity wealth. Hence, the economy increases its foreign indebtedness which is evidenced in figure 4. The flows that generate this increase in foreign indebtedness are displayed in the bottom half of figure 4 where the trade balance and the current account are expressed as percentages of benchmark aggregate value added.[29] Although it is hardly discernible in the graphs, the home economy runs a current account deficit which is large on impact, becomes less negative for some transitory subsequent periods, and deteriorates again in the more distant future.

Scenario two which features a preannounced and gradual reduction of tariffs, gives rise to more interesting adjustment patterns. Intertemporal optimizing models produce anticipation effects of preannounced policy changes which are clearly reflected in the graphs. When firms want to reduce capital in the long-run, they run down the stocks more quickly when acquisition costs are high, rather than in the future when costs are low. The chemicals industry (no. 7) which requires more capital in the long-run, wants to acquire capital in the future when the tariff cuts are in effect and acquisition prices are low, rather than in the present. Such intertemporal substitution effects may give rise to non-monotonic adjustment. The food industry (no. 3), for example, reduces capital stocks rapidly in anticipation of lower future costs. In doing so, it undershoots the long-run equilibrium values, and capital rises again in period 10 when the tariff cuts are completed. Capital stocks 'overshoot' a second time giving a too high value in period 20 which must be decumulated to approach the long-run level. In typical cases, firm values decline less than in the first policy scenario which is entirely consistent with the more rapid decumulation of capital. Since tariffs are reduced only later, acquisition costs decline less significantly in the early periods and even a relatively moderate reduction in firm values provides powerful incentives to disinvest. Later, when acquisition costs are low, firm values don't need to decline much further since the capital stocks are already very low then and don't need to be reduced that much more. The chemicals sector, however, experiences a more dramatic devaluation in order to slow down the rate of accumulation as compared to the instantaneous policy scenario.

Because agents tend to postpone consumption and investment activities until tariff cuts become effective, demand is depressed in the periods preceding the tariff cuts. Hence, domestic prices and price indices typically decline upon announcement of the future tariff cuts. As the tariff cuts approach, agents start to increase their consumption and investment activities which makes prices slowly increase from this lower level. Prices fall again when the tariff cuts become effective in period four as lower tariffs translate into lower unit costs for the desired commodity bundles. Such changes in price indices produces characteristic intertemporal substitution effects on the part of households. Depending on the magnitude of the intertemporal elasticity of substitution, consumption demand tends to be low when prices are relatively high and vice versa. Evaluating the Euler equation (3) shows that agents smooth the consumption index for $\gamma \rightarrow 0$ while they smooth expenditures in case of $\gamma = 1$. In the latter case, a decline of the price index is offset by an increase in consumption to give constant expenditures. In

[29] It should be noted that the current account is not zero in the steady state. The reason is that our model economy exhibits an exogenous increas in efficiency units. This implies that a stationary stock of net foreign assets *per efficiency unit* requires a non-zero current account.

our case, this parameter is nearer to unity, and we observe relatively smooth adjustment of expenditures while the adjustment of prices and quantities demanded is more erratic over time reflecting intertemporal substitution.

The preannounced policy scenario gives interesting dynamics in the foreign accounts. With rather smooth expenditures but higher non-capital income in the early years as compared to the alternative policy scenario [see human wealth in figure 3], households may temporarily increase their financial wealth or decumulate it more slowly in the early years. Given the less dramatic devaluation of equity capital in the gradual policy scenario, households reduce their foreign indebtedness before they increase foreign liabilities again to give higher long-run foreign debt. Therefore, figure 4 shows the current account to improve first but to become worse later on. Furthermore, the trade balance improves in the early years because agents postpone demand and imports while exports increase due to depressed domestic prices relative to world prices. When the tariff cuts are completed, the trade balance is negative since postponed demand is unleashed and imports rise. Eventually, the home economy generates a trade balance surplus again which is required to service a higher foreign debt in the long-run.

Although not the only factors in determining welfare, wealth effects seem to be largely responsible for the general shape of the time path of equivalent variations per generation. Since the ultimate argument of felicity is the available stream of the top level consumption aggregate, one needs to consider 'real' wealth in units of this consumption basket which is done by subtracting the percentage change in the price index from the percentage change in wealth. The price index and human wealth are given in figure 3 while figure 4 reproduces the change in firm values of all sectors lumped together. The form of figure 3 suggests that the tariff policy, besides its efficiency effect, may largely consist of intergenerational redistribution from future to present generations. Human wealth in 'real' terms declines over all of the transition path putting young and future generations at a disadvantage. Since new generations start their life with zero financial wealth, they perceive no other wealth effects. Our equivalent variation measure takes full account of the wealth effects on the initially living old generations due to a revaluation of financial assets. From figures 3 and 4 it is evident that firm values increase in 'real' terms in case of the instantaneous policy conferring windfall gains to old generations who own the domestic capital stock. However, firm values tend to fall in 'real' terms in case of the gradual policy scenario. Depending on the share of equities in the households' portfolios, this capitalization effect reduces the average return on financial wealth and, therefore, explains why welfare of old generations changes less favorably under the second scenario.

# 5 Sensitivity Analysis

## 5.1 Alternative Budgetary Policies

The base case scenario featured unilateral tariff cuts according to the Tokyo round formula and assumed that the revenue losses are financed by adjusting lump-sum taxes to keep government debt constant in units of foreign commodities. Recent literature has emphasized that this type of policy is non-neutral with respect to intergenerational redistribution.[30] Do demonstrate this, we simulate an alternative policy 1 which has lump-sum taxes adjust to keep constant the 'real' level of government debt, $D^g/p^v$. Since unilateral tariff cuts tend to reduce domestic prices, the policy requires a percentage reduction of government debt (as denominated in foreign commodities) equal to the percentage reduction of the top level price index $p^v$ to keep debt constant in units of the overall consumption basket including goods and leisure. In accordance with the typical crowding out effects of government debt in overlapping generations models, the policy package makes the home economy build up higher capital stocks [see table 6]. Labor supply, however, expands less than in the base case. As compared to the base case effects, the relative gains for future generations are available only at a loss to current old generations [see figure 5]. The loss to currently living generations is mainly explained by the fact that the government must generate a large one time tax financed budget surplus to reduce (foreign denominated) public debt to a permanently lower level. In following periods when the main part of the debt reduction is completed, the tax burden and the primary budget surpluses can be reduced again to more normal levels. Foreign indebtedness increases less than in the base case as the government absorbs less of household assets.

Financing tariff cuts with lump-sum taxes avoids that the distortionary effects of changing other taxes mix with the relative price effects from tariff cuts. Lump-sum taxes are, however, of little significance in actual policy making. Table 6 therefore contrasts the base case scenario with some alternative budgetary arrangements such as higher consumption or income taxes to make up for dwindling tariff revenues. Policy 2 scales up value added and excise taxes to substitute for lower tariff revenues while policy 3 adjusts income taxes, social security contributions and factor taxes on labor. Both scenarios reverse some of the important base case results. Both aggregate labor supply and the economy wide capital stock decline making the tax financed tariff cuts more contractionary in the long-run. Higher consumption taxes make commodities more expensive while higher income taxes reduce the consumers' net wages. Hence, both taxes make the price of leisure decline relative to that of the commodity bundle and induce agents to substitute leisure for consumption. Policy 3 introduces additional intertemporal distortions and is, therefore, more harmful in terms of capital accumulation. Hence, tariff cuts are most contractionary and most detrimental in terms of welfare of future generations if they are financed by increasing direct taxes. Figure 5 shows that tariff cuts financed by consumption and income taxes, respectively, make all generations lose.

Contrary to the base case scenario, policies 2 and 3 improve the net foreign asset position. Hence, the effects on the trade balance and the current account are also reversed in the long-run. Part of it is explained by the fact that government aborbs less of overall financial wealth since it reduces foreign denominated debt to keep it constant in real terms. The rest stems from the differential impacts on private sector savings and firm values. The model implements the source principle of international interest taxation which makes the net interest rate exogenous. Under the alternative residence principle which fixes the gross interest rate, an income tax increase would reduce the domestic net interest rate and provide further disincentives for savings.

[30] See, for instance, Engel and Kletzer (1990).

## 5.2 Multilateral Tariff Liberalization

The reciprocity principle underlying the GATT means that tariff cutting formulas are implemented simultaneously by all countries taking part in the negotiations. Besides making imports cheaper, the benefits from tariff liberalization will therefore depend importantly on the foreigners' cooperation in putting less of a tariff burden on Austria's exports. Worldwide tariff cuts cause supply and demand reactions in all countries which will eventually give rise to new equilibrium prices for all commodities. Contrary to our model assumption, one must thus conclude that world prices of the home country's imports will have changed as a result of global tariff cuts. In a world economy with many countries and many commodities, no theoretical presumption for the direction of these price changes can be established. Nor can we compute them with the aid of our single country model. Extending the demand structure of our model, one may think of imports as an aggregate of different varieties distinguished by country of origin. In evaluating multilateral tariff liberalization with our single country model, we must crudely assume on the import side that the multiple price changes occurring in different foreign countries offset each other to give a constant price index for the import aggregate.

On the export side, two channels can be identified through which multilateral trade liberalization will affect the home country's exports: changes in home prices plus changes in the tariff rates subject to which foreigners can buy the home country's export commodities. Denote the foreign tariff rate by $t_i^f$. The percentage change of exports will then be $\hat{E}_i = -\theta_i(\hat{p}_i^h + \hat{t}_i^f \frac{t_i^f}{1+t_i^f})$ where $\theta_i$ denotes sectoral price elasticities of export demand, $\hat{p}_i^h$ is the proportional change in the equilibrium home price, and $\hat{t}_i^f$ is the relative change of the foreign tariff rate implied by the Tokyo-round formula. This latter channel was absent in the base case scenario of unilateral tariff liberalization. The empirical implementation of initial foreign tariff protection $t_i^{0,f}$ uses the industrial countries' average pre-Tokyo-round tariff rates reported by Deardorff and Stern (1986). The resulting foreign tariff rates are somewhat lower than Austria's effective tariff rates reported in table 2. Hence, the pre-Tokyo-round figures portray Austria as being a relatively high tariff country.

Table 7 contrasts the expected long-run consequences of multilateral tariff cuts with the unilateral case. The most dramatic change as compared to the base case is that multilateral tariff cuts turn out to be beneficial for the home country in terms of welfare. On impact, lower foreign tariffs increase demand for domestically produced commodities. Indeed, domestic prices increase in general equilibrium and the terms-of-trade improve. The top level price indices decrease only moderately since higher domestic prices erode the savings from lower import costs. The full consumption budget increases proportionally with disposable non-capital income. Given a lower top level price index, the overall consumption index $v$ clearly increases. The latter effect produces a positive quasi income effect on demand for leisure and for derived commodities which is opposite to the effect observed in the base case. Hence, labor supply increases less than in the base case while commodity demands are now increasing instead of decreasing. Compared to unilateral tariff cuts, multilateral liberalization turns out to be much more expansionary in terms of capital accumulation and sectoral outputs even though labor supply increases less. As previously explained, household sector financial wealth increases now in line with disposable wage income. Even though the value of equities in private portfolios rises due to higher domestic prices, foreign indebtedness is less negatively affected which is attributed to the increase in financial wealth. The solution for the transition path reveals that multilateral tariff liberalization yields more welfare for all domestic agents irrespective of their date of birth. The specific form of generational welfare changes as shown in figure 6 is mainly due to wealth effects. Existing old generations benefit from capital gains on their previously acquired equity shares and also from higher discounted wage earnings. New generations start with zero financial wealth, but benefit from wage increases.

## 5.3 Price Elasticity of Exports

In the base case scenario, unilateral tariff liberalization was shown to reduce welfare for new generations. We attributed this result mainly to an unfavorable terms-of-trade effect. Making the price elasticity of the export demand schedules very high effectively fixes domestic prices to the world prices of imports and, thus, erodes the ability of the home country to influence its terms-of-trade. For a high enough value of the export elasticity, the welfare losses due to tariff liberalization should be reversed to give welfare gains. Figure 7 demonstrates the sensitivity of the welfare effects with respect to this parameter. The line marked with solid squares corresponds to the base case value of the export elasticity [see table 4]. It depicts the welfare changes across steady states when the initial effective tariff rates are scaled by the factors listed on the horizontal axis. A scale factor equal to unity gives the initial protection reported in table 2. Hence, the line marked with solid squares demonstrates the base case welfare result that an increase in tariffs is required to improve steady state utility of new generations. If we calibrate the model with an export elasticity two times larger than in the base configuration, a unilateral increase in tariff protection would still give more utility. However, if the initial tariff levels were five times larger than indicated by our data giving tariff rates ranging from 6 to 34 % instead of 1.3 to 6.8 %, a further increase in tariffs would eventually reduce utility. If the export elasticities were three times as high as in the base case, tariff increases would reduce utility of new generations even when starting from a position of free trade. Interestingly enough, trippling export demand elasticities would imply, roughly, that the pre-Tokyo-round *level* of Austrian tariffs would have been optimal.

## 5.4 Other Parameters

Table 7 investigates whether the comparative steady state effects of the Tokyo-round tariff reductions are robust with respect to alternative parameterizations of the model. The first column reproduces the base case and coincides with the results reported in table 3. The column entitled 'Par.1' computes the effects from tariff liberalization under fixed labor supply. As argued in section 4.3, the induced price changes require lower capital labor ratios. Combined with fixed labor supply, the economy wide capital stock is reduced. Tariff cuts become contractionary in the majority of sectors. In line with the arguments of Sen and Turnovsky (1989) we conclude that flexible labor supply is important in our model too for tariff cuts to be expansionary.[31] Column 'Par.2' considers the case of an increased elasticity of substitution between

[31] Sen and Turnovsky state that the capital stock would remain unchanged if labor were fixed exogenously. In our model this is not true because of the change in acquisition costs relative to 'effective' prices.

home and import goods in all categories of demand. The base case values are scaled by a factor of two. Upon a tariff cut, agents more heavily substitute imports for home goods. Hence, domestic prices decline somewhat more. Less capital is accumulated on average, and output therefore expands slightly less than in the base case. Otherwise, the results are not particularly sensitive to a variation in this parameter. As expected from the previous subsection, however, sectoral export elasticities are important. Setting these elasticities at half their base case values [see column 'Par.4'] makes the prices of home produced goods decline quite considerably in response to the initial substitution effects towards imports. Since a given reduction of domestic prices generates less exports than in the base case, domestic prices must decline by more to restore equilibrium in the markets for home goods. Employment increases but the economy accumulates less capital. In terms of sectoral outputs, tariff cuts turn out to be contractionary in a number of sectors.

A tariff cut makes the economy accumulate more foreign debt.[32] Changing only one parameter at a time, we could not reverse the model's prediction for net foreign indebtedness. Column 'Par.6', however, considers a configuration with several parameters changed simultaneously which reverses the effect on foreign indebtedness. The elasticity of substitution in value added production is increased by a factor of 1.5 while the export elasticity is half its base case value. Furthermore, depreciation rates are reduced and the tax deductions for investment are eliminated entirely. The lower value for the export elasticity makes domestic prices decline sharply while the higher elasticity in factor substitution makes the capital labor ratio decline by more than in the base case. As a result, firm values fall by even more than financial wealth of households allowing for lower net foreign indebtedness. Note that in calibrating the model to these new parameters we also change the productivity growth rate to reproduce the investment and capital income data [see the last line in table 7]. Although this parameter constellation is not entirely realistic, it does show that the effects of tariff cuts on foreign indebtedness as well as the stationary current account and trade balances are, in principle, ambiguous.

The steady state effects do not depend on the intertemporal elasticity of substitution $\gamma$ and the mortality rate $\theta$. Given internationally fixed interest rates, the marginal propensity to consume is invariant across steady states. However, these parameters importantly determine the speed with which agents accumulate financial wealth. Essentially the same holds for the adjustment cost parameter $\psi$. Alternative values importantly affect the adjustment speed but influence only slightly the steady state effects. Figure 8 corresponds to column 'Par.6' in table 7 and shows that even for an instantaneous and permanent tariff reduction the model can generate non-monotonic paths for the current account and the trade balance. The home economy incurs more foreign debt in the short-run which is opposite to the long-run improvement in the net foreign asset position. Depending on the non-monotonicity of foreign debt, the trade balance exhibits even more complicated dynamic behavior. In the pre tariff cutting equilibrium, the home economy runs a trade balance surplus to fulfill the interest obligations on its foreign debt. In some initial periods when the country incurs more debt, the trade balance surplus shrinks. Over a long intermediate period, the home economy runs a surplus higher than initially to improve its net foreign asset position. Eventually, an improved net foreign asset position allows again for lower trade balance

[32] However, if deflated by the consumer price index $p^c$ and measured in units of the corresponding consumption basket, foreign indebtedness declines.

surpluses than initially. Figure 8 also suggests that the non-monotonicities in foreign debt are associated with high values for the intertemporal elasticity of substitution $\gamma$ while the reduction in foreign debt is monotonic in the low elasticity case. The main difference is that agents tend to smooth expenditures $p^v v$ for values of $\gamma$ near unity while they smooth their demand for the consumption aggregate $v$ for low values of $\gamma$.

# 6 Conclusions

We have used the Tokyo–round tariff reductions as an *example* for piecemeal trade liberalization attempting to harmonize the tariff structure, and we have applied an intertemporal CGE model to gain insights into the kind of *adjustment path* that a small open economy like Austria will follow as a result of such a tariff reform. In doing so, we have attempted to distinguish, as carefully as possible, a unilateral from a multilateral tariff cut. The insights to be drawn from the above simulation exercise may now be summarized as follows.

Perhaps the most important finding is that the unfavorable terms-of-trade effects of unilateral tariff cuts inflict welfare losses on new generations while conferring welfare gains on old generations, whereas a multilateral tariff cut leads to an improvement of the terms-of-trade and an unambiguous welfare increase for all generations. As expected, the welfare losses in the unilateral scenario are sensitive to export demand elasticities, but they would only be reversed at elasticity values well above those reported in the econometric literature.

The unilateral scenario reveals an expansionary effect on the capital stock in some cases (mainly driven by endogenous labor supply), but this result was shown to be non-robust with respect to changes in the parameterization of the model. The expansionary effect was, however, much more pronounced in the multilateral scenario. Tariff liberalization increases foreign indebtedness of our model economy, and this effect, although ambiguous from the analytical literature, is pretty robust with respect to parameter changes. Whereas analytical studies invariably portray monotonic adjustment of the level of foreign assets, we have identified parameter constellations under which adjustment is non-monotonic, with the elasticity of intertemporal substitution in consumption being of crucial importance in this respect.

Another important insight is that the effects of commercial policy in an intertemporal model are highly sensitive to the fiscal policy pursued in attempting to accomodate revenue changes. While this has, in principle, already been emphasized in some of the analytical literature focusing on overlapping generations, a few surprising details have emerged from our counterfactual analysis. The expansionary effect of tariff cuts on the overall capital stock emerging under the usual lump-sum transfer policy is reversed if lower tariff revenues are compensated by higher distortionary (direct or indirect) taxes. The same holds true for labor supply. While tariff cuts raise the long-run level of foreign debt under lump-sum transfers, they reduce foreign indebtedness under compensating distortionary taxes. Thus, the assumption of lump-sum transfers, almost universally employed in the analytical literature, is not only far-fetched but also critical for the results obtained in an intertemporal framework.

A further feature of our results is the variety of dynamics on the sectoral level. First, even if the overall capital stock and employment increase, individual sectors may decumulate their capital stocks. Second, while some sectors exhibit a relatively simple adjustment path with firm values more or less immediately jumping to their new long-run values, others show significant 'overshooting' of firm values. Third, our simulations reveal that sectoral firm values invariably fall as a result of tariff cuts, even in scenarios where sectoral capital stocks increase in the majority of sectors. Firm values did, however, increase under multilateral tariff reductions.

Finally, our results also nicely exhibit the intertemporal substitution effects of announcing in advance, and gradually implementing a given commercial policy change. Adjustment paths in many cases become non-monotonic. Thus, tariff reductions that are preannounced and anticipated by the public, tend to depress the domestic economy in the short-run giving rise to a short-run improvement in the current account. Non-monotonicities may, however, even arise without such anticipation effects, as we have shown in our sensitivity analysis.

## References


[1] Armington, Paul S., 1969, "A Theory of Demand for Products Distinguished by Place of Production", *IMF-Staff Papers* 16, 159–176.

[2] Auerbach, Alan J. and Laurence J. Kotlikoff, 1987, *Dynamic Fiscal Policy*, Cambridge: Cambridge University Press.

[3] Blanchard, Olivier J., 1985, "Debt, Deficits, and Finite Horizons", *Journal of Political Economy* 21, 223–247.

[4] Blanchard, Olivier J. and Stanley Fischer, 1989, *Lectures on Macroeconomics*, Cambridge: MIT Press.

[5] Bovenberg, Lans A. and Lawrence H. Goulder, 1992, "Introducing Intertemporal and Open Economy Features in Applied General Equilibrium Models", in: Henk Don, Theo van de Klundert and Jarig van Sinderen, eds., *Applied General Equilibrium Modelling*, Dordrecht: Kluwer Academic Publishers, 47–64.

[6] Breuss, Fritz and Jean Tesche, 1991, *A CGE Model for Austria. Some Implications of Trade Liberalization, Empirica – Austrian Economic Papers*, 18, 135–165.

[7] Brock, Philip, 1988, "Investment, the Current Account, and the Relative Price of Non–Traded Goods in a Small Open Economy", *Journal of International Economics*, 24, 235–253.

[8] Buiter, Willem H., 1988, "Death, Birth, Productivity Growth and Debt Neutrality", *Economic Journal* 98, 279–293.

[9] Deardorff, Alan V. and Robert M. Stern, 1986, *The Michigan Model of World Production and Trade*, Cambridge: MIT Press.

[10] Engel, Charles and Kenneth Kletzer, 1990, "Tariffs and Saving in a Model with New Generations", *Journal of International Economics* 28, 71–91.

[11] Frenkel, Jacob A. and Assaf Razin, 1987, *Fiscal Policy and the World Economy*, Cambridge: MIT Press.

[12] Gavin, Michael, 1990, "Structural Adjustment to a Terms of Trade Disturbance. The Role of Relative Prices", *Journal of International Economics*, 28, 217–243.

[13] Gavin, Michael, 1991, "Tariffs and the Current Account. On the Macroeconomics of Commercial Policy", *Journal of Economic Dynamics and Control*, 15, 27–52.

[14] Goulder, Lawrence H. and Barry Eichengreen, 1989a, *Trade Liberalization in General Equilibrium: Intertemporal and Inter-Industry Effects*, NBER Working Paper No. 2965, Cambridge/Mass.: NBER.

[15] Goulder, Lawrence H. and Barry Eichengreen, 1989b, "Savings Promotion, Investment Promotion and International Competitiveness," in: Feenstra, Robert, ed., *Trade Policies for International Competitiveness*, Chicago: University of Chicago Press, 5–44.

[16] Hayashi, Fumio, 1982, "Tobin's Marginal q and Average q: A Neoclassical Interpretation", *Econometrica* 50, 213–224.

[17] Helpman, Elhanan and Paul R. Krugman, 1989, Trade Policy and Market Structure, Cambridge: MIT Press.

[18] Keuschnigg, Christian, 1991a, *How to Compute Perfect Foresight Equilibria*, University of Bonn.

[19] Keuschnigg, Christian, 1991b, "The Transition to a Cash Flow Income Tax", *Swiss Journal of Economics and Statistics* 127, 113–140.

[20] Keuschnigg, Christian and Wilhelm Kohler, 1992, *Modelling Intertemporal General Equilibrium: An Application to Austrian Commercial Policy*, Research Memorandum No. 303, 304, Vienna: Institute for Advanced Studies.

[21] Kohler, Wilhelm, 1991a, "Income Distribution and Labor Market Effects of Austrian Pre- and Post-Tokyo-Round Tariff Protection", *European Economic Review*, 35, 139–154.

[22] Kohler, Wilhelm, 1991b, "Multilateral Trade Liberalization: Some General Equilibrium Simulation Results for Austria", *Empirica - Austrian Economic Papers*, 18, 167–199.

[23] Matsuyama, Kiminori, 1988, "Terms-of-Trade, Factor Intensities and the Current Account in a Life-Cycle Model", *Review of Economic Studies* 55, 247-262.

[24] Mussa, Michel L., 1978, "Dynamic Adjustment in the Heckscher-Ohlin-Samuelson Model", *Journal of Political Economy 86*, 775–791.

[25] Obstfeld, Maurice, 1989, "Fiscal Deficits and Relative Prices in a Growing World Economy", *Journal of Monetary Economics* 1989, 461–484.

[26] O'Rourke, Kevin, 1989,"Tariffs and the Current Account with Short-Run Capital Specificity", *Economics Letters 30*, 67–70.

[27] Razin, Assaf and Lars Svensson, 1983, "Trade Taxes and the Current Account", *Economics Letters 13*, 67–70.

[28] Sen, Partha and Stephen J. Turnovsky, 1989, "Tariffs, Capital Accumulation, and the Current Account in a Small Open Economy", *International Economic Review*, 30, 811–831.

[29] Srinivasan, T.N. and John Whalley, eds., 1986, *General Equilibrium Trady Policy Modeling*, Cambridge: MIT Press.

[30] Summers, Lawrence H., 1981, Taxation and Corporate Investment: A q-Theory Approach, *Brookings Papers on Economic Activity* 1, 67–127.

[31] Weil, Philippe, 1989, "Overlapping Families of Infinitely-Lived Agents", *Journal of Public Economics* 38, 183–198.

[32] Wilcoxen, Peter J., 1989, *A Fast Algorithm for Solving Rational Expectations Models*, University of Melbourne: Impact Research Centre.

# 7 Appendix: Tables and Figures

Table 1: Basic Parameters

| | | |
|---|---|---|
| $x$ | **prod. growth rate** | 0.025 |
| $n$ | pop. growth rate | 0.010 |
| $\theta$ | prob. of death | 0.060 |
| $\rho$ | **subj. discount rate** | 0.006 |
| $\gamma$ | intertemp. el. of subst. | 0.800 |
| $\alpha$ | **share of consumpt.** | 0.722 |
| $i^*$ | world interest rate | 0.055 |
| $\delta_i$ | depreciation rate | 0.150 |
| $\psi_i$ | adjustment cost param. | 10.000 |
| $t_y$ | income tax rate | 0.200 |
| $e_i$ | invest. expensing rate | 0.400 |

Table 2: Value Added and Average Tariff Rates

| | Sector & Commodity Class. | Shorthand | VA | Pre | Post | % red. |
|---|---|---|---|---|---|---|
| 1 | Agriculture & Forestry | Agr/For | 5.433 | 6.758 | 4.751 | 29.696 |
| 2 | Mining | Min/Quar | 0.622 | 1.280 | 1.185 | 7.407 |
| 3 | Foodstuff | Food | 3.476 | 5.384 | 4.028 | 25.177 |
| 4 | Textiles & Clothing | Tex/Clot | 2.690 | 4.922 | 3.764 | 23.524 |
| 5 | Wood & Wood Processing | Wood | 2.233 | 2.648 | 2.272 | 14.199 |
| 6 | Paper & Paper Processing | Paper | 2.162 | 3.316 | 2.747 | 17.166 |
| 7 | Chemicals (excl. Pretroleum) | Chemic | 2.931 | 2.261 | 1.981 | 12.381 |
| 8 | Petroleum | Petrol | 0.482 | 1.751 | 1.579 | 9.866 |
| 9 | Non-ferrous Minerals | Nonferr | 2.011 | 2.911 | 2.463 | 15.394 |
| 10 | Basic Metals | MetProd | 2.788 | 1.720 | 1.553 | 9.707 |
| 11 | Metal Processing | MetProc | 10.992 | 2.536 | 2.189 | 13.680 |
| 12 | Energy & Water Supply | Energy | 3.318 | 0.000 | 0.000 | 0.000 |
| 13 | Construction | Constr | 9.319 | 0.000 | 0.000 | 0.000 |
| 14 | Commerce | Trade | 14.165 | 0.000 | 0.000 | 0.000 |
| 15 | Hotels & Restaurants | Hot/Cat | 2.827 | 0.000 | 0.000 | 0.000 |
| 16 | Transport & Communication | Trans | 5.368 | 0.000 | 0.000 | 0.000 |
| 17 | Banking, Insur. & Real Est. | RealEst | 9.042 | 0.000 | 0.000 | 0.000 |
| 18 | Other Sectors | OthSer | 5.680 | 0.000 | 0.000 | 0.000 |
| 19 | Public Services | Public | 14.458 | 0.000 | 0.000 | 0.000 |

## Table 3: Long-Run Macro Effects

| Variables | | Tokyo | Free |
|---|---|---|---|
| $p^I$ | investment p.i. | -0.402 | -2.163 |
| $p^c$ | consumption p.i. | -0.554 | -2.506 |
| $p^v$ | full price index | -0.540 | -2.437 |
| $w$ | wage rate | -0.501 | -2.258 |
| $z$ | gov. transfers | -1.263 | -6.035 |
| $y$ | disp. wage income | -0.680 | -3.152 |
| $H$ | human wealth | -0.680 | -3.152 |
| $A$ | financial wealth | -0.680 | -3.152 |
| $M^v$ | full consumption | -0.680 | -3.152 |
| $C$ | commodity cons. | -0.126 | -0.662 |
| $L^s$ | labor supply | 0.120 | 0.610 |
| $K$ | capital stock | 0.008 | 0.373 |
| $EV$ | welfare change | -0.141 | -0.732 |
| $S^F$ | trade bal. surplus | 0.014 | 0.069 |
| $S+R$ | private saving | -0.143 | -0.661 |
| $p^I I$ | investment spending | -0.117 | -0.536 |
| $\nabla D^g$ | gov. deficit | 0.000 | 0.000 |
| $\nabla D^f$ | current account | -0.026 | -0.125 |

Lower part of table reports changes of variables in percent of value added.

## Table 4: Long-Run Industrial Effects of Tokyo-Round

| Sector | | $\mu_i$ | $\theta_i$ | $p_i^h$ | $\tilde{p}_i$ | $V_i$ | $K_i$ | $L_i^d$ | $F_i$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Agr/For | 0.607 | 2.000 | -0.405 | -0.415 | -0.538 | -0.133 | -0.073 | -0.125 |
| 2 | Min/Quar | 0.500 | 0.155 | -0.416 | -0.482 | -0.185 | 0.234 | 0.283 | 0.273 |
| 3 | Food | 0.775 | 0.779 | -0.448 | -0.474 | -0.552 | -0.136 | -0.061 | -0.082 |
| 4 | Tex/Clot | 0.983 | 1.452 | -0.419 | -0.484 | -0.463 | -0.045 | 0.051 | 0.034 |
| 5 | Wood | 0.851 | 1.654 | -0.431 | -0.474 | -0.234 | 0.183 | 0.266 | 0.243 |
| 6 | Paper | 0.868 | 1.215 | -0.479 | -0.476 | -0.274 | 0.144 | 0.228 | 0.207 |
| 7 | Chemic | 0.827 | 2.741 | -0.367 | -0.469 | -0.000 | 0.417 | 0.498 | 0.472 |
| 8 | Petrol | 0.500 | 0.135 | -0.180 | -0.470 | -0.535 | -0.119 | -0.071 | -0.086 |
| 9 | Nonferr | 0.992 | 1.424 | -0.420 | -0.467 | -0.338 | 0.077 | 0.174 | 0.141 |
| 10 | MetProd | 1.091 | 2.376 | -0.356 | -0.481 | 0.052 | 0.472 | 0.579 | 0.558 |
| 11 | MetProc | 0.581 | 1.505 | -0.387 | -0.471 | -0.162 | 0.255 | 0.312 | 0.294 |
| 12 | Energy | 0.360 | 0.340 | -0.374 | -0.444 | -0.410 | 0.000 | 0.036 | 0.015 |
| 13 | Constr | 0.324 | 1.500 | -0.425 | -0.463 | -0.411 | 0.004 | 0.035 | 0.023 |
| 14 | Trade | 0.970 | 1.500 | -0.438 | -0.453 | -0.459 | -0.047 | 0.048 | 0.002 |
| 15 | Hot/Cat | 0.970 | 1.500 | -0.429 | -0.452 | -0.133 | 0.281 | 0.376 | 0.329 |
| 16 | Trans | 0.970 | 1.500 | -0.422 | -0.485 | -0.404 | 0.015 | 0.109 | 0.094 |
| 17 | RealEst | 0.970 | 1.500 | -0.429 | -0.435 | -0.461 | -0.053 | 0.043 | -0.022 |
| 18 | OthSer | 0.970 | 1.500 | -0.436 | -0.465 | -0.526 | -0.111 | -0.016 | -0.051 |
| 19 | Public | 0.970 | 1.500 | -0.482 | -0.482 | -0.502 | -0.084 | 0.011 | -0.008 |

$\theta_i$ is the price elasticity of export demand. $\mu_i$ is elasticity of factor substitution.

## Table 5: Demand Effects of Tokyo-Round

| Sector | | $C_i^d$ | $C_i^m$ | $\xi_i^{C,m}$ | $I_i^d$ | $I_i^m$ | $\xi_i^{I,m}$ | $\sigma_i^m$ |
|---|---|---|---|---|---|---|---|---|
| 1 | Agr/For | -0.501 | 2.217 | 0.348 | -0.089 | 3.626 | 0.170 | 1.413 |
| 2 | Min/Quar | 0.132 | 0.955 | 0.655 | 0.022 | 0.000 | 0.000 | 0.551 |
| 3 | Food | -0.207 | 0.985 | 0.050 | 0.053 | 0.000 | 0.000 | 0.797 |
| 4 | Tex/Clot | -0.546 | 1.361 | 0.446 | -0.010 | 2.046 | 0.131 | 1.581 |
| 5 | Wood | -0.250 | -0.250 | 0.351 | 0.037 | 0.231 | 0.026 | 0.969 |
| 6 | Paper | -0.115 | -0.447 | 0.527 | 0.085 | 0.000 | 0.000 | 1.905 |
| 7 | Chemic | -0.333 | 0.206 | 0.558 | -0.028 | 0.859 | 0.022 | 1.065 |
| 8 | Petrol | -0.526 | 3.167 | 0.167 | -0.235 | 3.555 | 0.133 | 1.046 |
| 9 | Nonferr | -0.492 | 0.892 | 0.474 | 0.025 | 0.724 | 0.026 | 1.596 |
| 10 | MetProd | -0.122 | -0.743 | 0.587 | -0.091 | 0.220 | 0.418 | 2.012 |
| 11 | MetProc | -0.325 | -0.194 | 0.542 | 0.019 | -0.087 | 0.560 | 1.712 |
| 12 | Energy | -0.311 | -0.475 | 0.000 | -0.020 | 0.000 | 0.000 | 0.440 |
| 13 | Constr | -0.257 | 0.000 | 0.000 | 0.031 | 0.000 | 0.000 | 1.100 |
| 14 | Trade | -0.244 | 0.000 | 0.000 | 0.044 | 0.000 | 0.000 | 0.100 |
| 15 | Hot/Cat | -0.252 | 0.000 | 0.000 | 0.035 | 0.000 | 0.000 | 0.100 |
| 16 | Trans | -0.259 | 0.000 | 0.000 | 0.028 | 0.000 | 0.000 | 0.100 |
| 17 | RealEst | -0.252 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.100 |
| 18 | OthSer | -0.247 | -0.290 | 0.000 | -0.008 | -0.051 | 0.000 | 0.100 |
| 19 | Public | -0.200 | 0.000 | 0.000 | 0.088 | 0.000 | 0.000 | 0.100 |

$\xi_i$ give the import shares in consumption and investment. $\sigma_i^m$ denote elasticities of substitution between imports and home goods.

## Table 6: Financing Tariff Cuts

| | Variables, % changes | Base | Pol.1 | Pol.2 | Pol.3 |
|---|---|---|---|---|---|
| $p^v$ | full price index | -0.540 | -0.520 | -0.106 | -0.487 |
| $p^c$ | consumption p.i. | -0.554 | -0.539 | -0.027 | -0.393 |
| $w$ | wage rate | -0.501 | -0.472 | -0.312 | -0.433 |
| $y$ | disp. wage income | -0.680 | -0.641 | -0.255 | -0.639 |
| $C$ | commodity cons. | -0.126 | -0.103 | -0.228 | -0.247 |
| $L^s$ | labor supply | 0.120 | 0.113 | -0.039 | -0.062 |
| $K$ | capital stock | 0.008 | 0.012 | -0.229 | -0.260 |
| $EV$ | welfare change | -0.141 | -0.122 | -0.149 | -0.153 |
| $A$ | financial wealth* | -0.680 | -0.641 | -0.255 | -0.639 |
| $V$ | firm values* | -0.344 | -0.326 | -0.315 | -0.501 |
| $D^g$ | gov. debt* | 0.000 | -0.212 | -0.043 | -0.198 |
| $D^f$ | foreign wealth* | -0.336 | -0.104 | 0.104 | 0.060 |

* Changes in percent of initial financial wealth. Policy 1: real debt constant, transfers adjusted. Pol. 2 and 3: both real debt and real transfers constant. Pol. 2 adjusts indirect taxes while pol. 3 adjusts direct taxes.

## Table 7: Sensitivity Analysis

| | Variables, % changes | Base | Multil. | Par.1 | Par.2 | Par.3 | Par.4 | Par.5 | Par.6 |
|---|---|---|---|---|---|---|---|---|---|
| $p^v$ | full price index | -0.540 | -0.049 | -0.489 | -0.589 | -0.531 | -0.909 | -0.515 | -0.798 |
| $p^c$ | consumption p.i. | -0.554 | -0.156 | -0.489 | -0.595 | -0.547 | -0.855 | -0.534 | -0.765 |
| $w$ | wage rate | -0.501 | 0.228 | -0.380 | -0.572 | -0.487 | -1.048 | -0.464 | -0.886 |
| $y$ | disp. wage income | -0.680 | 0.072 | -0.727 | -0.755 | -0.669 | -1.252 | -0.630 | -1.075 |
| $q$ | Tobin's Q | -0.413 | 0.032 | -0.339 | -0.456 | -0.404 | -0.746 | -0.388 | -0.640 |
| $K$ | capital stock | 0.008 | 0.213 | -0.089 | -0.046 | -0.018 | -0.166 | 0.012 | -0.213 |
| $L^s$ | labor supply | 0.120 | 0.103 | 0.000 | 0.122 | 0.122 | 0.137 | 0.111 | 0.127 |
| $C$ | commodity cons. | -0.126 | 0.228 | -0.239 | -0.161 | -0.123 | -0.401 | -0.096 | -0.313 |
| $EV$ | welfare change | -0.141 | 0.122 | -0.239 | -0.167 | -0.139 | -0.347 | -0.116 | -0.279 |
| $A$ | financial wealth* | -0.680 | 0.072 | -0.727 | -0.755 | -0.669 | -1.252 | -0.630 | -1.075 |
| $V$ | firm values* | -0.344 | 0.209 | -0.364 | -0.427 | -0.359 | -0.776 | -0.481 | -1.091 |
| $D^f$ | foreign wealth* | -0.336 | -0.137 | -0.363 | -0.328 | -0.310 | -0.476 | -0.149 | 0.016 |
| $x$ | prod. growth rate | 2.515 | 2.515 | 2.515 | 2.509 | 2.515 | 2.515 | 3.929 | 3.929 |

* Changes in percent of initial financial wealth. Par.1: fixed labor supply ($\alpha = 1$), Par.2: $\sigma_i^m$ scaled by 2, Par.3: $\mu_i$ scaled by 1.5, Par.4: $\theta_i$ scaled by 0.5, Par.5: $e_i = 0$ and $\delta_i = 0.1$, Par.6: $\mu_i$ scaled by 1.5, $\theta_i$ scaled by 0.5, $e_i = 0$ and $\delta_i = 0.1$. See table 1 for base case values.

## Fig.2: Firm Values and Capital Stocks, Percent Changes

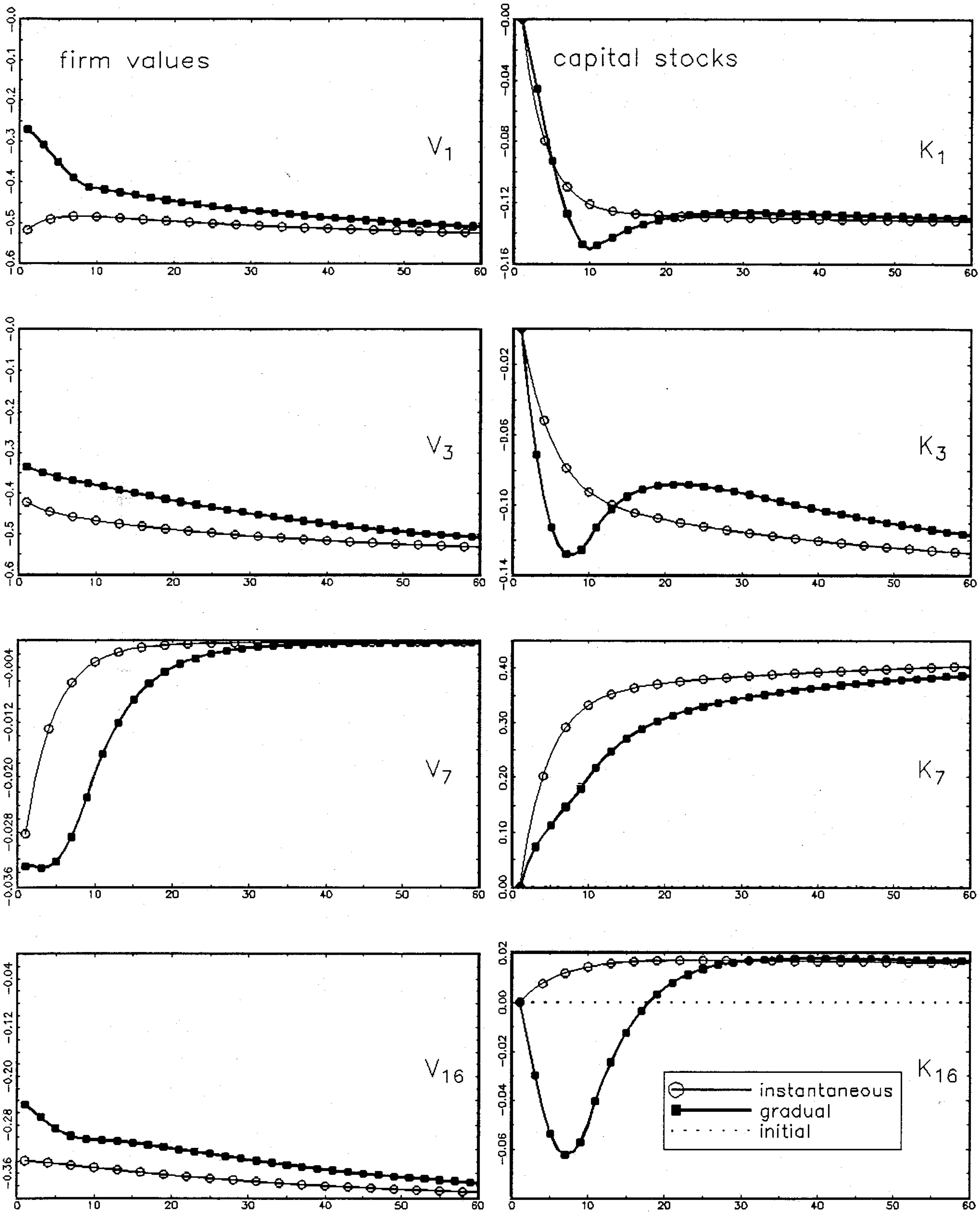


**Fig. 3: Household Sector**

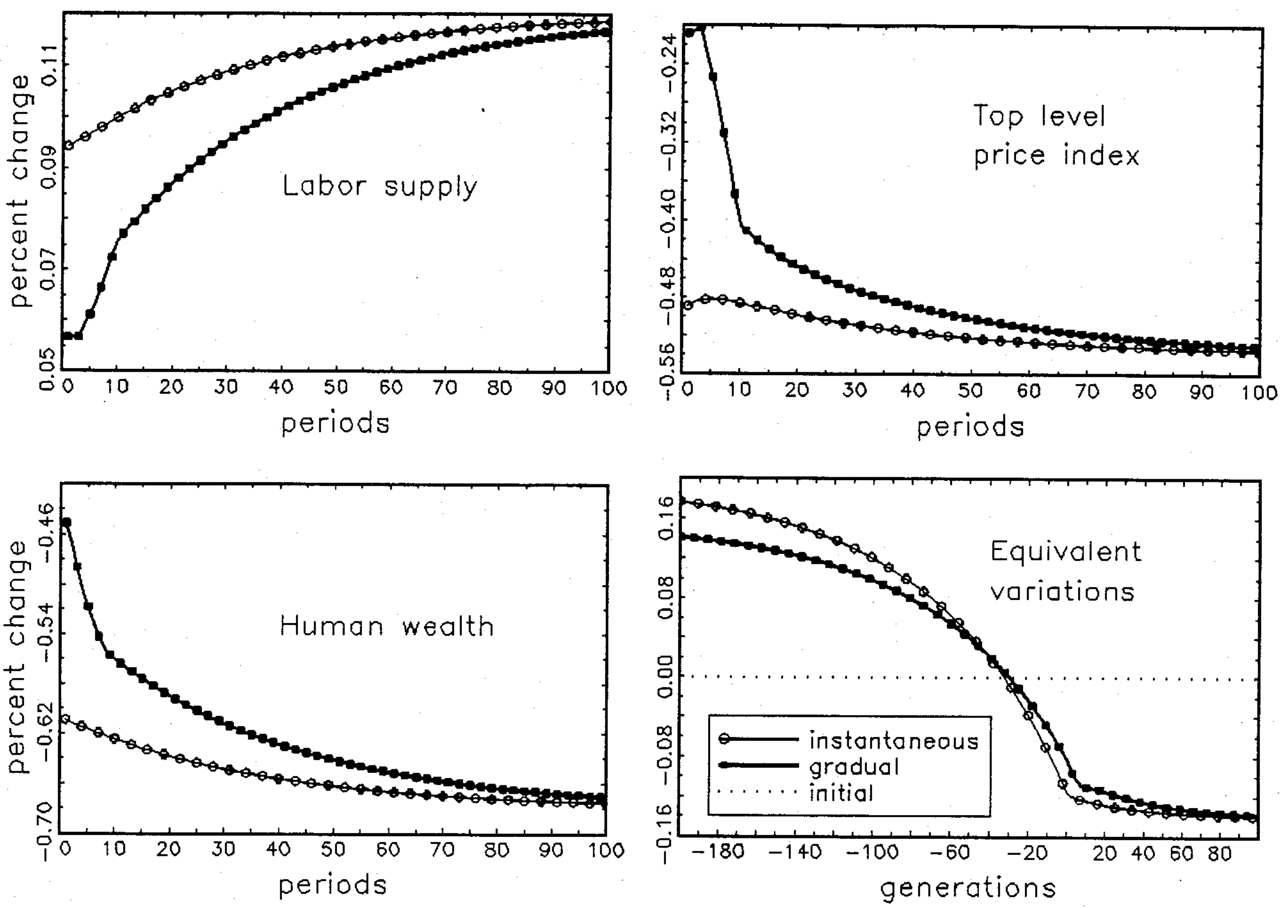



**Fig. 4: Current Account**

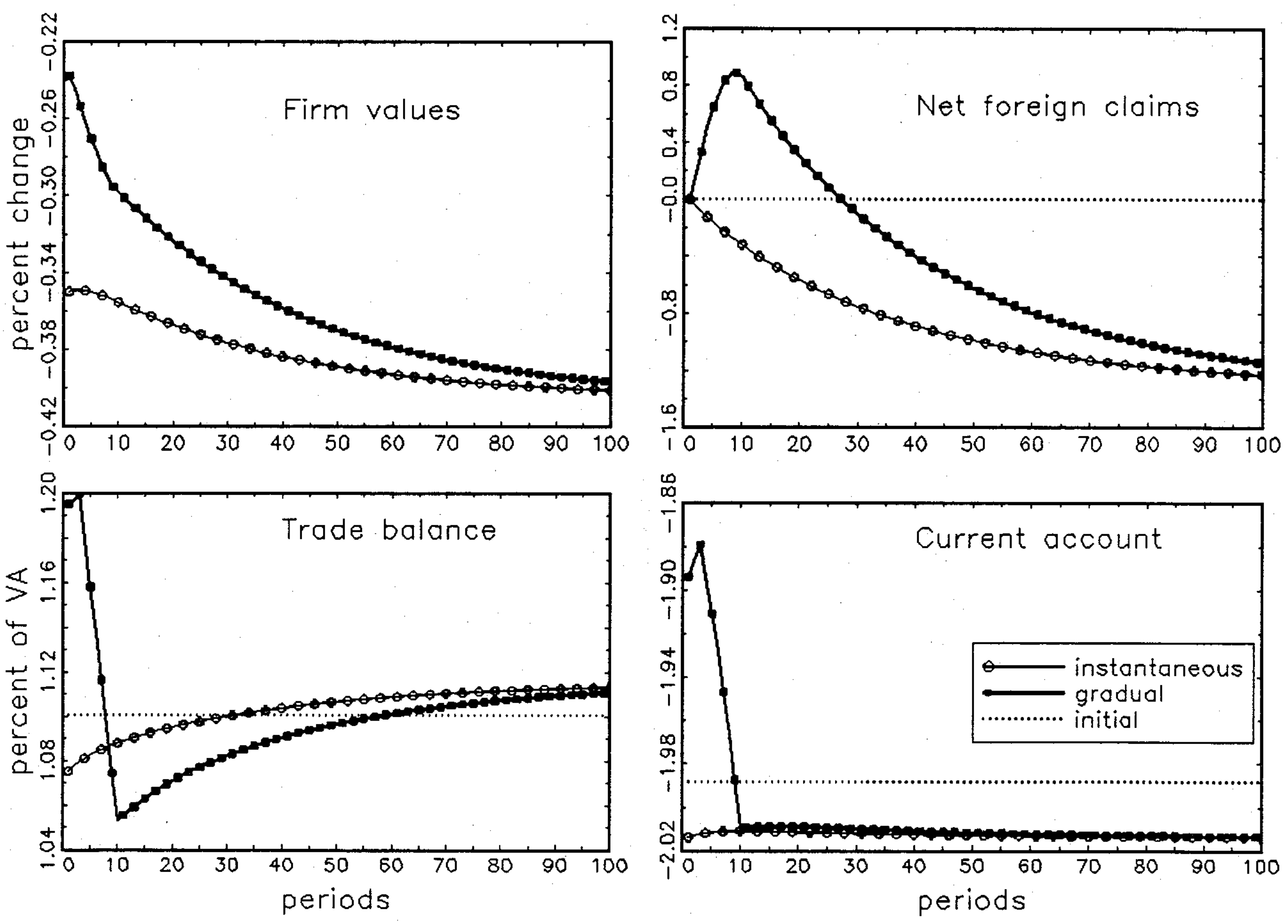


Fig. 5: Alternative Budgetary Policies

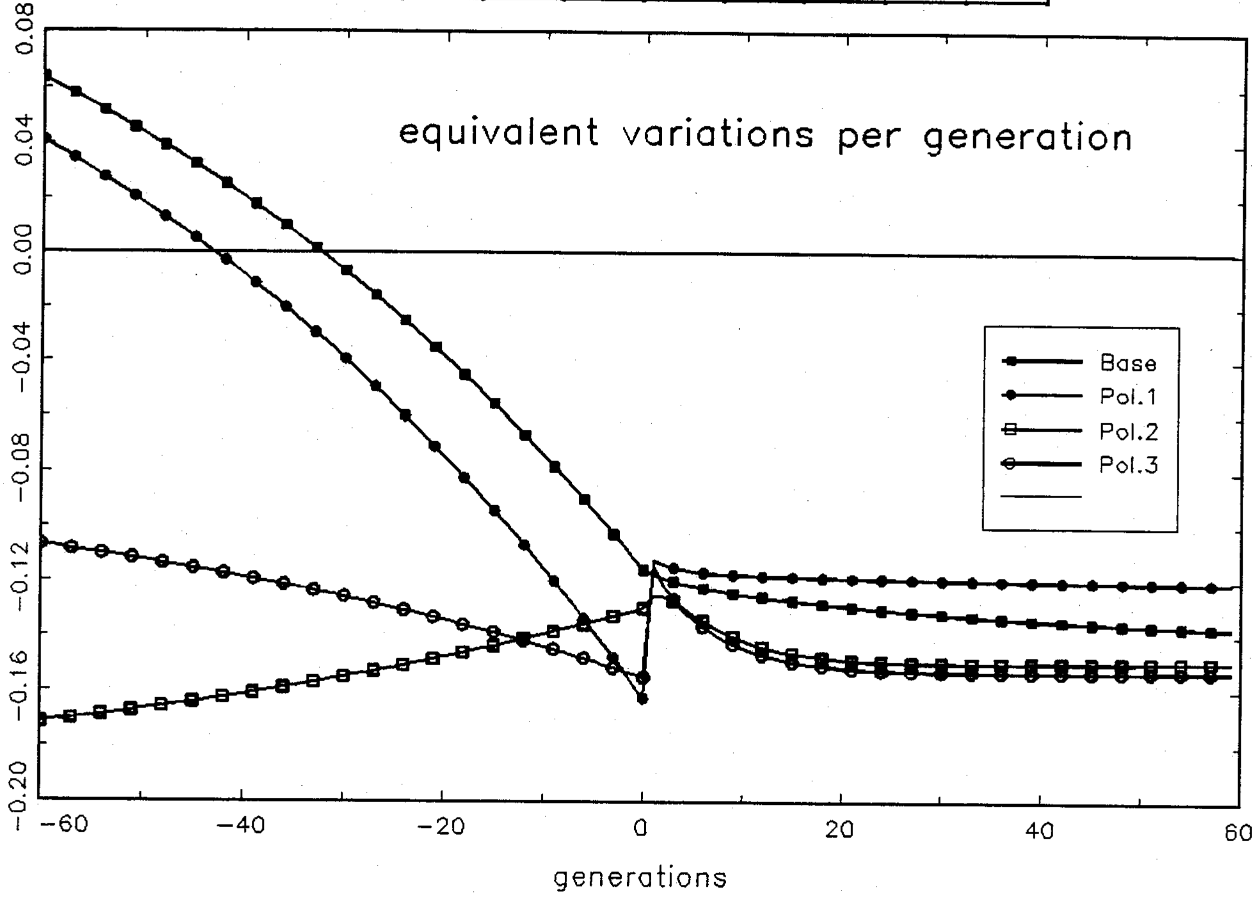



Fig. 6: Multilateral Tariff Cuts

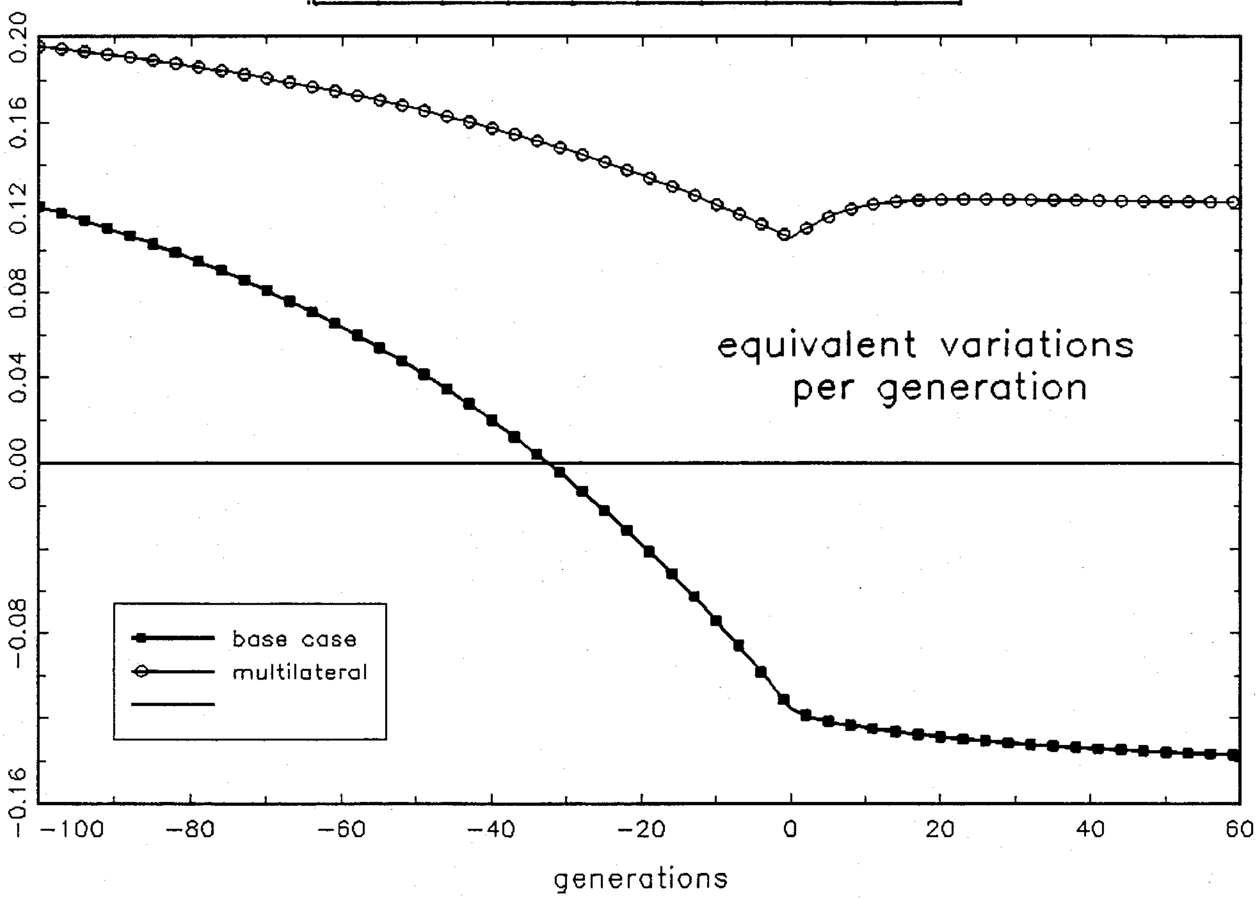


Fig. 7: Export Elasticity and Welfare

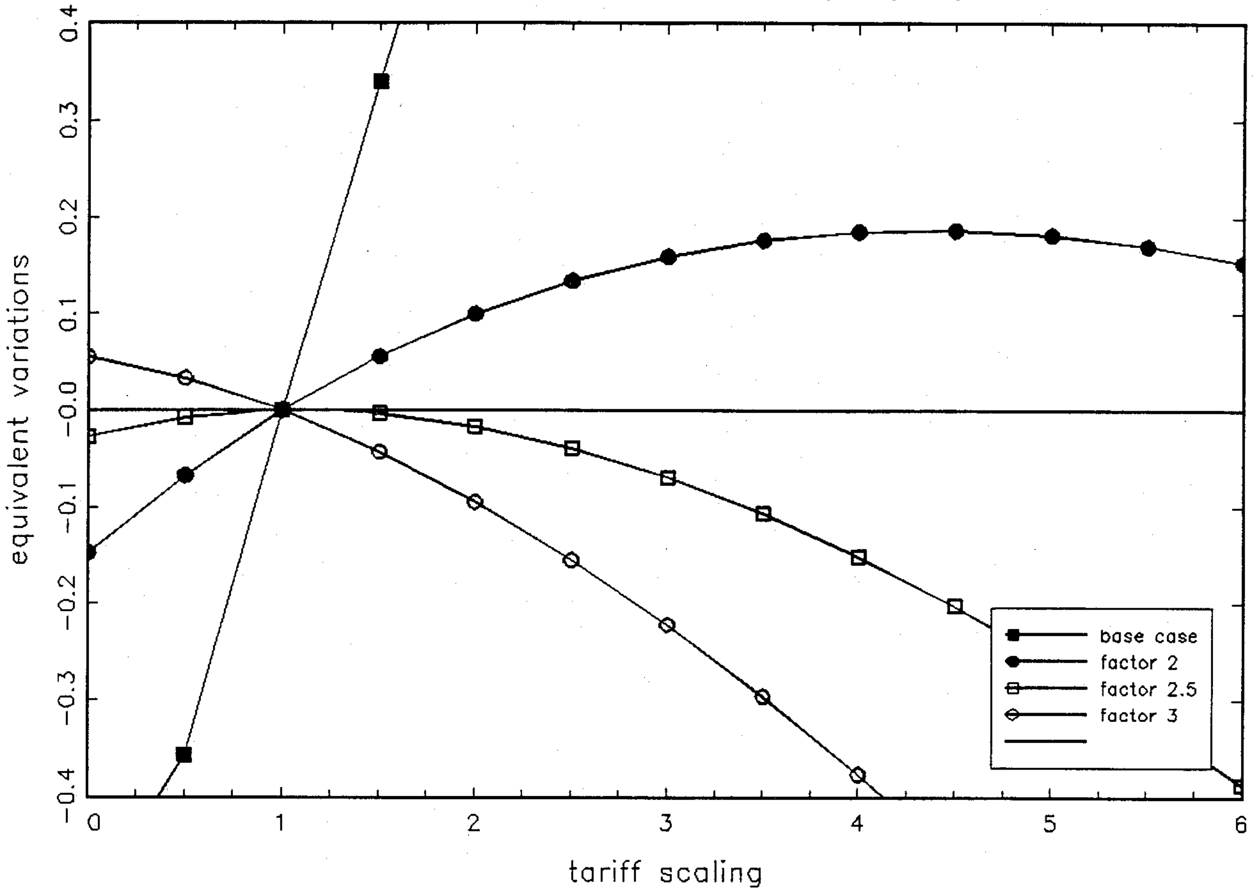



Fig. 8: Foreign Debt Dynamics