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Abstract

An intertemporal general equilibrium model of the United States and MERCOSUR is created to analyze the dynamic adjustments in both regions' commodity and capital markets after trade liberalization. Simulation results show that tariff reductions initiated by MERCOSUR have small positive effects on the U.S. production, trade, consumption and investment, and stimulates MERCOSUR's growth, and improves its current account. If tariffs are eliminated by both regions, both regions are better off from points of intertemporal social welfare, international trade, domestic investment, and growth. Agriculture benefits more from trade reform, which implies that rural-agricultural sector might have been a victim of trade protection policies.

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I. Introduction

Following a period of economic crisis in the 1980s, Latin American countries are replacing longstanding import substitution development strategy with an outward-oriented policy strategy to attain microeconomic efficiency and macroeconomic stability and to foster growth and industrialization. Nations in this regions are deregulating domestic markets, liberalizing trade and finance, dismantling direct control over prices and resource allocation, privatizing public enterprises, and showing renewed interest in regional economic cooperation and integration.

With such policy changes, as the risk of a general collapse of the world's financial system due to the debt crisis had been considerable reduced, foreign capital has returned to the region during 1990s on a scale that few have foreseen. Following almost a decade of stagnation and macroeconomic instability, growth has picked up at the turn of the decade and is being maintained, with budget deficits and inflation under control. However, there is no reason to believe that the painful adjustments in Latin American countries are over (see UNCTAD, 1995). The Mexican crisis of December 1994 and its aftermath have indicated that the recovery will be long and painful, involving considerable resource reallocations.

With respect to regional integration, most Latin American countries are now revitalizing efforts toward some degrees of regional economic cooperation. Within the Latin American Integration Association, Argentina, Brazil, Paraguay, and Uruguay agreed in 1990 to establish the Southern Common Market (MERCOSUR). With its $700,000 million GDP[1], MERCOSUR is the second largest trading block in the West Hemisphere after NAFTA, and its trade with the United States accounts for about 20 percent of its total trade. For this reason, in this paper we build a dynamic general equilibrium model to focus in analyzing the possible impacts of tariff

[1] Using 1992 data; see table 4 in Rivera, 1995.

reforms initiated by MERCOSUR on MERCOSUR itself and on the United States.

Applied Computable General Equilibrium models (CGE) have been widely used to analyze trade reform effects on both developing and developed countries. However, standard CGE models are static in specification or, at best, incorporate naive dynamic features in the form of a sequence of static one-period solutions. Such static CGE models only take into account inter-sectional resource shifts, and hence cannot consider intertemporal resource reallocation through investment and consumption/savings decisions. It should be stated that investment or capital accumulation is the most important source of growth. Effects of trade reforms on investment and, hence, on growth are ignored by a static CGE model. This is typically inappropriate in an era when capital markets become more and more globally integrated, and international investment is a highly visible growing influence on the world's economy.

In the recent years, multi-sector intertemporal general equilibrium models have been developed to remedy the above-mentioned deficiencies of static CGEs. Among others, see Wilcoxen (1988), Ho (1989), Jorgenson and Wilcoxen (1990), McKibbin (1993), Mercenier and Sampaïo de Souza (1994), Mercenier (1995), Go (1994), Keuschnigg and Kohler (1994, 1995). Most of these models are single country models (except McKibbin 1993 and Mercenier 1995), and hence dynamic inter-regional effects cannot be captured and analyzed.

Latin America as a region is a highly indebted economy, and capital flows will considerably increase after it intends to foster the development of a more open and hence more competitive economy. This is the reason this report analyzes the dynamic adjustments of production, trade, investment, consumption/savings, and foreign debt caused by trade union and tariff reform by using a multi-sector, multi-region intertemporal general equilibrium model.

The report is organized as follows: Section II presents the structure of the dynamic CGE model. Then the calibration procedure regarding the dynamic requirements of the model is discussed in Section III. In Section IV, the economic structures of the two regions are presented by the benchmark data. Section V simulates different tariff reductions and analyzes the dynamic adjustments of production, trade, investment, consumption/savings, and foreign; changes in steady state production and trade are also compared with those that would have been obtained from a static model. Finally, the last section summarizes the conclusions of this study.

II. The model

The model developed in this study is based on the neoclassical growth theory, and is a dynamic CGE model with multi-regions and multi-sectors specification. Any exogenous parameter, such as productivity coefficient or labor supply growth rate, can generate growth along steady state path but cannot be endogenously affected by policy variables. Hence, the exogenous steady-state growth, associated with changes in any exogenous parameter, is ignored in the model. However, transitional growth, associated with dynamic adjustment in investment and capital accumulation caused by changes in policy variables, can be observed and will be analyzed in this paper.

Consumption/savings. In each region the representative household owns land, labor, and all financial wealth (define below) to maximize his intertemporal utility over an infinite horizon by allocating income between consumption and savings. For simplicity reason, we assume no independent government investment. Government spends all its tax revenues on consumption or transfer to households and, hence, fiscal deficit is ignored[2]. For the purpose of numerical implementation, the intertemporal problem is formulated in discrete time. Thus household's discounted utility of the temporal sequence of aggregated consumption over an infinite time horizon is:

$$\text{Max } \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho}\right)^t u(TC_{nt}) \tag{1}$$

where ρ represents the rate of time preference which should be positive and identical for all regions, u(.) is the instantaneous felicity at each time period. TC_{nt} which is the instantaneous aggregate consumption generated from final goods is as follows:

$$TC_{nt} = \prod_i C_{nit}^{a_{ni}} \tag{2}$$

[2] Government budget deficits in some countries of MERCOSUR, such as Brazil and Argentina, are high and drastic reduction of tariff protection will have important fiscal effects on their economies. Since we will focus our attention on the future borrowing behavior of the economy as a whole, the behavior of the government and, hence, government budget deficit are ignored by the analysis.

Where C_{nit} is final good i in region n, and $\Sigma_i a_{nit} = 1$. The household in each region maximizes (1) subject to an intertemporal budget constraint:

$$\Sigma_{t=0}^{\infty} R_t Ptc_{nt} TC_{nt} \leq \Sigma_{t=0}^{\infty} R_t [(1 - ldt_{nt}) wld_{nt} LD_{nt} + (1 - lbt_{nt}) wlb_{nt} LB_{nt} + TI_{nt}] + \omega_{n0} \quad \textbf{(3)}$$

where $R_t = \Pi_{s=0}^{t} 1/(1+r_s)$, represents the discount factor, r_s is the instantaneous interest rate; Ptc_{nt} is consumer price index such that $Ptc_{nt}TC_{nt} = \sum_i PC_{nit}C_{nit}$; wld_{nt} is the land rental rate, wlb_{nt} is the wage rate; TI_{nt} is the lump sum transfer of government revenues; ldt_{nt} and lbt_{nt} are household land and labor income tax, respectively; and, finally, ϖ_{n0} is the value of the household's initial financial wealth.

It is useful to describe the relationship between intertemporal budget constraint and current budget constraint, since in the following analysis the current budget constraint plays important role in determining the levels of consumption and savings. In an open economy, the representative household's financial wealth, ϖ_{n0}, is not limited to the value of the initial capital stock, defined as VK_{n0}. If the value of capital stock exceeds the household's assets, the difference, $VK_{n0} - \varpi_{n0}$, must correspond to net claims by foreigners on the domestic economy. Conversely, if ϖ_{n0} exceeds VK_{n0}, then $\varpi_{n0} - VK_{n0}$ represents net claims by domestic residents on foreign economies. Let $D_{n0} = VK_{n0} - \varpi_{n0}$ be the n-th region's initial net foreign debt, then the n-th region's household wealth is $\varpi_{n0} = VK_{n0} - D_{n0}$. The flow of the current income generated from financial wealth includes current net income from capital stock. Households allocate their total income flows, including financial and non-financial, between consumption and savings. The current budget constraint for the household is:

$$\begin{aligned} SAV_{nt} &= (1 - ldt_{nt}) wld_{n1t} LD_{nt} + (1 - lbt_{nt}) wlb_{nt} LB_{nt} + TI_{nt} \\ &\quad + (1 - kt_{nt}) wk_{nt} K_{nt} - r_t D_{nt-1} - Ptc_{nt} TC_{nt} \end{aligned} \quad \textbf{(4)}$$

where SAV_{nt} is n-th region's household savings; wk_{nt} is the current capital rental price and kt_{nt} is capital income tax rate; $r_t D_{nt-1}$ is the interest payments on the outstanding foreign debt; and $Ptc_{nt}TC_{nt}$ are total consumption expenditures. The Lagrangian of the intertemporal problem is:

$$L = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho}\right)^t u(TC_{nt})$$
$$+ \lambda \Big(\sum_{t=0}^{\infty} R_t [(1 - ldt_{nt}) wld_{nt} LD_{nt} + (1 - lbt_{nt}) wlb_{nt} LB_{nt} + TI_{nt}] \qquad (5)$$
$$+ VK_{n0} - D_{n0} - \sum_{t=0}^{\infty} R_t Ptc_{nt} TC_{nt} \Big)$$

The Euler equation, derived from first order condition of the utility maximization, implies that the marginal felicity in two adjacent periods has to satisfy the following conditions:

$$\frac{u'_{nt+1}(1+\rho)^{-1}}{u'_{nt}} = \frac{Ptc_{nt+1}(1+r_{t+1})^{-1}}{Ptc_{nt}} \qquad (6)$$

where u_t' is the derivative of time period t's felicity with respect to the aggregate consumption TC_{nt}. Equation (6) implies that the marginal rate of substitution between consumption at time t and t+1 has to be equal to the ratio of consumption price index at time t and t+1. Since the economy is assumed to borrow from or lend to the rest of world freely, and by assuming that the rest of world asset market is at its steady state, r_t can be normalized to be equal to ρ.

Firms and investment. Assuming that the technology exhibits constant returns to scale and capital as an input factor is perfectly mobile among sectors, producers of the final goods need only maximize their temporal profits. Competition among firms ensures that at the equilibrium capital rental price, wk_{nt}, is equilibrated with the value of the marginal product of each industry, $P_{nit}\partial F_i/\partial K_{nit}$, and this equates the demand for capital with its stock.

The aggregate capital stock is managed by an independent investor who decides on investment and passes all profits to the households. This setup was first used by Wilcoxen (1988) and Ho (1989). For a multi-sector model, the introduction of this bank artifact isolates the capital pricing and investment decision from household consumption and saving decisions. The investor chooses a time path of investment to maximize the discounted profit over an infinite horizon:

$$\text{Max } \sum_{t=0}^{\infty} \frac{1}{(1+r)^t}[(1-kt_{nt})wk_{nt}K_{nt} - vI_{nt}] \tag{7}$$

Subject to capital accumulation equation:

$$K_{nt+1} = (1-\delta_n)K_{nt} + I_{nt} \tag{8}$$

where vI_{nt} is the value of investment in region n at time t, I_{nt} is the physical new capital good, δ_n is the constant capital depreciation rate. New capital equipment, I_{nt}, is a composite good produced from final goods, i.e., $I_{nt} = I(ID_{n1t}, ID_{n2t}, ID_{n3t}, ID_{n4t})$, where ID_{nit} is the demand for good i used to produce new capital goods in region n. Assuming that the technology to produce capital goods exhibits constant returns to scale, then the unit cost to produce capital equipment is uniquely determined by the prices of the final goods. Besides the costs of using final goods, we assume that there is no additional installation cost. Hence, at equilibrium with a positive investment, the value of each unit of capital good equals its unit cost. Thus, $vI_{nt} = PI_{nt}I_{nt}$, where PI_{nt} is the cost for each unit of I_{nt}. The Hamiltonian of the problem is

$$H = \frac{1}{(1+r)^t}[(1-kt_{nt})wk_{nt}K_{nt} - PI_{nt}I_{nt}] + \frac{\gamma_{nt}}{(1+r)^t}[(1-\delta_n)K_{nt} + I_{nt} - K_{nt+1}] \tag{9}$$

Differentiating w.r.t. control variable I_{nt} we obtain the following equation equalizing the shadow price of capital good, γ_{nt}, with the production unit cost of capital:

$$PI_{nt} = \gamma_{nt} \tag{10}$$

and differentiating w.r.t. state variable K_{nt} we obtain the Euler equation for investor:

$$\frac{(1-kt_{nt})wk_{nt}}{(1+r)^t} + \gamma_{nt}\frac{(1-\delta_n)}{(1+r)^t} - \gamma_{nt-1}\frac{1}{(1+r)^{t-1}} = 0 \tag{11}$$

Substituting equation (10) into (11), we obtain the no-arbitrage condition as follows:

$$r_t PI_{nt-1} = (1-kt_{nt})wk_t - \delta_n PI_{nt} + PI_{nt} - PI_{nt-1} \tag{12}$$

That is, households are willing to hold the claims to the existing capital as only as the total returns to capital match the returns to a perfectly substitutable asset, namely, a foreign asset of size PI_{nt-1}. The left side of equation (12) is the returns from a perfect substitutable asset at size PI_{nt-1}, and the right side is the total returns from one unit of capital good, which includes: an infinite stream of net "dividends", $(1 - kt_{nt})wk_{nt}$, minus the loss of the value of capital equipment caused by depreciation, $\delta_n PI_{nt}$, plus a claim to an instantaneous capital gain (or loss), which is equal to $PI_{nt} - PI_{nt-1}$, if the cost to produce one unit of capital changes over time. The no-arbitrage condition of equation (12) is used to determine the level of investment in a dynamic CGE model when imperfect substitution between a domestically produced and consumed good and a foreign good (Armington assumption) is specified[3].

Foreign capital and debt. As investment and savings are independently determined in the model, in each time period, the difference between the value of investment, $PI_{nt}I_{nt}$, and the household savings, SAV_{nt}, if positive, is the increase in debt borrowed from foreigners, i.e.,

$$D_{nt} - D_{nt-1} = r_t D_{nt-1} + FB_{nt} \tag{13}$$

where FB_{nt} represents a trade deficit. The capital flows between regions can be analyzed when the foreign debt is traced by region.

Steady state conditions. Additional equilibrium conditions at steady state are specified as follows:

$$r + \delta_n = \frac{(1 - kt_{nt})wk_{nss}}{PI_{nss}} \tag{14}$$

$$I_{nss} = \delta_n K_{nss} \tag{15}$$

$$FB_{nss} + rD_{nss} = 0 \, . \tag{16}$$

Equation (14) implies that, at steady state, the net marginal returns to capital, normalized by the

[3] See Diao, Yeldan and Roe (1996) for more detail discussion about the role of Armington assumption in investment determination.

marginal value of capital, is constant and is equal to the interest rate plus depreciation. Equation (15) implies that investment just covers the depreciated capital, hence the stock of capital per labor remains constant. Equation (16) states that the debt is constant. Furthermore, if the economy holds debt at steady state (i.e., D_{nss} is positive), it has to have trade surplus to pay the interests on the outstanding debt, i.e., FB_{nss} has to be negative, and $FB_{sns} + rD_{nss} = 0$.

The traditional Armington functions are all specified in the context of within-period framework, and the dynamic construction of the model does not affect their specification. For consumers or investors, goods imported from abroad or produced domestically are not identical. This imperfect substitution relation is reflected with an Armingtonian constant elasticity substitution (CES) function within each time period. Furthermore, it can be assumed that the goods consumed by consumers and used for investment are different and there are different substitution elasticities for goods produced at home and imported from abroad. To simplify the analysis, we assume that the composite goods used for consumption or for investment are same goods. Composite goods are also used as intermediate inputs in each production sector, which is similar as in a static CGE model.

III. Calibration strategy

The data employed here are drawn primarily from the Global Trade Analysis Project (GTAP) database (Hertel and Tsigas, 1995) which is aggregated into a three region, four sector data set. Features of this type of multi-regional SAM and aspects of its construction are described in Wang (1994). Three aggregated regions include: the United States (U.S.), Southern Common Market (MERCOSUR) and the Rest of World (ROW). Due to data limitations, MERCOSUR is represented by the aggregation of Brazilian and Argentine data, which, in terms of national domestic product, comprises 97% of the total MERCOSUR's economy (including Uruguay and Paraguay). Bilateral trade between U.S. and MERCOSUR is observed in the model, and terms of trade are endogenously determined. Trade between U.S. and MERCOSUR with ROW does not have such bilateral relation, i.e., ROW is not treated as a region in which representative household and firm have their behavior functions. A group of demand functions are used to capture the market influence of U.S. or MERCOSUR on the price of the goods traded with ROW. By assuming a perfect world capital market, interest rate faces by each region has to be the same. As the ROW is large and assumed at its steady state, we can normalize the interest rate to equal to the rate of time preference in household intertemporal utility.

There are four aggregate production sectors/commodities: agriculture and food processing (AGFD), mineral and material (MINE), manufacturing (MAFC), and services (SERV), and three primary inputs: land, labor and capital. Land is employed only in the agricultural sector. Labor is further classified as agricultural and non-agricultural labors. Taking account the existence of imperfections in labor markets among MERCOSUR countries, labor is assumed not to move between agriculture and non-agriculture, while non-agricultural labor is mobile among the three non-agricultural sectors. Capital is an economy wide factor which is mobile among all sectors. None of the production factors can move internationally. The supply of land and labor are fixed, while capital is accumulated by foregone final outputs. As mentioned above, technical change is also ignored in the model, i.e., the exogenous growth rate associated with changes in productivity and population are set to be equal to zero[4].

Some of the following assumptions on the model calibration, concerning the region's exogenous environment, are some what arbitrary. However, as we are interested in deviations with respect to a reference path in our counterfactual experiments, these assumptions are relatively harmless. As in static models, where calibration begins with the assumption that data are obtained from an economy in equilibrium, we assume that the economy is evolving along a balanced (equilibrium) growth path. Hence, the 1992 social accounting matrices of the U.S. and MERCOSUR are regarded as if they were derived from an economy in its "base run" steady state equilibrium. While in a static CGE model only the elasticity of substitution rates are determined from an outside source, in a dynamic model additional information must be specified, e.g., time discount rate in intertemporal utility, or interest rate, elasticity of intertemporal substitution, capital depreciation rate, and the initial stock of capital.

Calibration approaches depend upon the different strategies that can be employed to

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[4] But the transitional growth associated with movement from the initial capital stock to the new steady state growth path, in response to any policy change, can be observed in the model.

determine which dynamic parameters are determined from the sources outside of the model as starting points. The calibration method used here is the same as in Mercenier (1995). For data consistency, we try to choose as fewer as possible outside determined parameters. We first set elasticity of intertemporal substitution to be unit, i.e., the intratemporal utility function is of the Cobb-Douglas form, and the world interest rate, r_0, which is the same as the consumer time discount rate, ρ. The price of capital goods, PI_{n0}, is uniquely determined by the composite good prices, Pc_{ni}, which can be calculated using the same approach as most traditional static CGE model calibration. Once PI_{n0} is determined, the quantity of investment I_{n0} can be calibrated from the SAMs. The initial level of capital stock can be derived from equation (15), i.e., $K_{n0} = I_{n0}/\delta_n$. Capital depreciation rate, δ_n, can be calibrated from steady state no-arbitrage condition as follows:

$$\delta_n = \frac{r_0 PI_{n0} I_{n0}}{wk_{n0} K_{n0} - PI_{n0} I_{n0}}. \tag{17}$$

The product $wk_{n0}K_{n0}$ in equation (17) is provided by the SAMs, but each element of the product, wk_{n0} and K_{n0} is unknown. To separate the steady state capital rental price from the quantity of initial capital stock, we employ equation (14). Consequently, the level of the initial capital stock can be obtained.

The initial level of trade deficit, FB_{n0} is given by the SAMs. If a region runs an initial trade deficit (surplus), to satisfy the steady state condition, its foreign debt must be negative (positive). For example, the U.S. is characterized by trade deficit in its 1992 SAM. Hence, the calibrated initial level of its foreign debt has to be negative, i.e., U.S. owns foreign assets initially; while MERCOSUR has trade surplus and hence is characterized by initial foreign debt.

In a static CGE model it is well known that different elasticities of substitution for Armington specification or production functions affect the simulation results. In the case of a dynamic model, in addition to these the time discount rates affect the simulation results also. Different values of the parameters not only affect the results at steady state equilibrium, but also the transition paths of endogenous variables and the pace of their convergence to the steady state.

The terminal conditions also influence the simulation results. In a dynamic applied model with an infinite horizon, model developers are typically most interested in results for finite time periods. Hence, the imposition of a terminal condition becomes pertinent for a discrete time dynamic CGE model when there are transitional paths for endogenous variables. Since the so-called terminal conditions are, in fact, merely conditions for the steady state (see equation (14) to (16)), an ideal terminal period should be chosen at the time when a steady state equilibrium is asymptotically approached. Arbitrarily choosing a terminal period can affect the dynamic equilibrium solution and transitional time paths of some key variables. A practical way to determine the terminal time period is to observe whether there are significant changes in critical variables along the transitional path as the aggregate number of time periods change, and hence adjust the time-frame used for the model. Implementing the time-aggregation technique a la Mercenier and Michel (1994) can reduce required aggregate number of time periods, and hence is applied in this report.

IV. Economic structures of the data

The economic structure, including sectoral shares of production and trade in value terms, of the two regions is presented in table 1.

Table 1. Sectoral shares of production and trade, 1992
(Values of total production, exports and imports are 100 percent)

	Production		Exports		Imports	
	U.S.	MERCOSUR	U.S.	MERCOSUR	U.S.	MERCOSUR
Ag.& food	6.95	17.15	9.33	34.03	5.07	6.39
Mineral & material	16.77	24.85	19.34	37.74	27.54	31.37
Manufacturing	11.25	13.23	44.89	17.28	50.12	36.38
Services	65.03	44.77	26.43	10.94	17.26	25.85

U.S. agriculture, either from the point of view of country's production or its trade, is the smallest sector, while MERCOSUR agriculture accounts for 17 percent of total regional production, and 34 percent of total regional exports. Regarding net trade, both regions are net exporters of agricultural goods and net importers of manufacturing goods. Also, the U.S. is a net exporter of services and net importer of mineral and material goods, while MERCOSUR is a net exporter of mineral and material goods and net importer of services (see table 2).

Table 2. Values of sectoral net export, 1992 (1000 million US dollars)

	U.S.	MERCOSUR
Ag. & food	22.54	14.65
Mineral & material	-58.73	5.05
Manufacturing	-50.90	-7.85
Services	45.80	-6.27

A comparison of regional economic activities is presented in table 3, where the production, exports and imports of MERCOSUR are contrasted with those of the U.S..

Table 3. Relative economic magnitude of MERCOSUR (U.S. production, exports and imports are 100 percent)

	Production	Exports	Imports
Ag. & food	29.44	32.67	9.43
Mineral & material	17.67	17.47	8.49
Manufacturing	14.03	3.45	5.41
Services	8.21	3.71	11.16

From the production point of view, the size of the MERCOSUR's agriculture is about 30 percent of the U.S., while services is only about 8 percent. Regarding exports, MERCOSUR's agricultural exports are equivalent to 33 percent of that of the U.S., while service exports are only equivalent to 4 percent. MERCOSUR's sectoral imports range from 5 percent (manufacturing) to 11 percent (services) of those of the U.S..

Table 4. Initial sectoral tariff rates, 1992

	U.S.		MERCOSUR	
	fr MERCOSUR	fr ROW	fr U.S.	fr ROW
Ag. & food	0.088	0.099	0.208	0.246
Mineral & material	0.100	0.050	0.124	0.173
Manufacturing	0.058	0.126	0.285	0.368
Services	0.0	0.033	0.0	0.079

The initial tariff rates are presented in table 4. MERCOSUR's agricultural tariff rates are about 2.4 times higher than those of the U.S., while its manufacturing tariff rates are about 5 times higher. It should be noted that non-tariff barriers play an important roles in MERCOSUR trade policy. However, because of insufficient data, elimination of non-tariff barriers cannot be included in the trade reform simulations in the following section.

V. Tariff reform simulations -- tariff reduction

Three different tariff reduction scenarios are simulated in our dynamic framework to evaluate the effects of trade liberalization. They include: (1) 30 percent tariff reduction by MERCOSUR on its imports from U.S. and ROW; (2) MERCOSUR's tariff rates on its all imports from U.S. and ROW are adjusted to the levels that U.S. imposes on its imports from MERCOSUR and ROW; and (3) complete tariff liberalization, i.e., eliminating all existing tariffs both regions impose on their imports. It should be pointed out that, MERCOSUR is now a full customs union moving toward a common market to achieve free trade among its members. In addition it is seeking to advance trade integration with other countries and groups of countries (Rivera, 1995). In our simulations, we do not take into account any trade reform inside MERCOSUR and the effects on its member countries. As MERCOSUR is aggregated into a single region in our model, the intra-regional trade and, hence, trade protection among countries in the region are ignored. All simulated dynamic effects of tariff reforms result from the reductions of MERCOSUR's tariffs imposed on the imports from countries outside MERCOSUR. As we demonstrate in the following subsections, since an unilateral tariff reduction by MERCOSUR as a group has small impact on the U.S. economy, any intra regional trade reform among MERCOSUR's member countries would not be expected to affect the U.S. economy in greater degree than that of the MERCOSUR acts as a group. However intra regional trade reforms may affect MERCOSUR's member countries or MERCOSUR as a group differently from the inter regional reform that we simulate.

In the following analysis, we will discuss the dynamic changes in some economic variables under different trade reforms. We first consider the changes in the main macro economic indicators, such as consumption and investment. We then examine changes in production, exports and imports. These results are compared with those that would have been observed in a static model. Finally, we examine the dynamic effects of tariff reductions on the balance of trade and foreign debt, on the social welfare including intertemporal utility and wage rates.

1. Dynamic effects of tariff cuts on savings and investment

A key difference between dynamic and the static models of general equilibrium lies in the intertemporal changes in household savings and investment along transitional paths in response to changes in trade policies. In a static equilibrium model, savings and investment decisions are not based on any "forward-looking" optimization process. Households are typically assumed to save a "fixed" share of income, while investment decisions depend on historical shares or current rates of returns to capital. In dynamic CGE models, savings and investment are the result of a dynamic optimization process based on a sequence of present and future prices. In response to changes in policy instruments, the optimal levels of savings and investment change along their transitional paths to approximate a new steady state. These new paths, in turn, have repercussions on all other choice variables of both consumers and firms.

The different transitional paths of aggregate consumption, household savings, investment and capital stocks of the two regions under different tariff cut scenarios are depicted in figures 1 - 8. Changes in the levels of these variables at the year when the shock is introduced and at the steady state are shown in table 5. Dynamic changes become insignificant as the steady state equilibrium is approached, convergence paths, drawn in figures 1 - 8 and subsequent figures, are truncated at period 25 where 99 percent of the transitional life of each variable under study is approached. Note all variables are expressed as percentage of their values at the base steady state equilibrium.

Table 5. Dynamic effects of tariff reductions on consumption, domestic savings rate, investment and capital stock (% Changes from the base-steady state equilibrium values)

	Exp1		Exp2		Exp3	
	Year 1	Steady State	Year 1	Steady State	Year 1	Steady State
USA						
Consumption	100.02	100.11	100.09	100.25	101.97	103.40
Savings rate	100.08	100.01	100.17	100.02	102.64	100.25
Capital	100.00	100.18	100.00	100.39	100.00	103.38
Investment	100.27	100.18	100.58	100.39	108.87	103.38
MERCOSUR						
Consumption	101.31	101.92	100.53	104.62	104.79	107.44
Savings rate	100.92	100.17	102.21	100.45	103.58	100.83
Capital	100.00	101.23	100.00	103.07	100.00	105.49
Investment	102.47	101.23	106.28	103.07	110.86	105.49

Exp1: 30% tariffs cut by MERCOSUR (30% cut)
Exp2: MERCOSUR tariff rates reduced to the U.S. levels (US' level tariff)
Exp3: eliminating all tariffs in both regions (0 tariff)

In general, trade liberalization simulation results indicate that tariff reduction would stimulate consumption and investment in both regions. Such positive adjustments are greater in the region which reduces its tariff rates more. As MERCOSUR's agriculture and manufacturing tariff rates are 2.4 and 5 times higher than those of the U.S., dynamic adjustments in MERCOSUR are greater than those in the U.S.. Dynamic adjustments in investment are greater than the adjustment on any other variable at the year when the shock is introduced (year 1). The greater the tariff cuts, the greater the adjustment in investment. When a new steady state is approached, the adjustment in investment becomes smaller. Consumption adjustments, on the other hand, are relatively smoother, that is, its increase in the year of the shock is relatively small, and its change becomes larger when the steady state approaches.

With an intertemporal utility function and the hypothesis of perfect foresight, the households are able to correctly predict future prices and their incomes. When households make decisions on current consumption, they already take into consideration their future earnings. Hence, the model exhibits permanent income-type behavior. The reduction or the elimination of tariffs lowers all imported good prices, which, consequently, lowers the price index, Ptc_{nt}. The decline in the consumption price index cause nominal consumption expenditure to fall; however, the real consumption rises smoothly along its transitional path (see figures 1 - 2). The greater the tariff cut the larger the increase in total consumption both in the first time period, when tariffs are reduced, and at the steady state.

The transitional path of aggregate investment is affected by changes in the cost of new capital goods. As discussed above (page 7), in the absence of adjustment costs the price of new capital good is always equal to the unit cost of its production, PI_n. We observe that investment is more responsive and, hence, more elastic to an exogenous shock at the year of the shock. Investment costs are uniquely determined by the price of its inputs, the composite good price. With reduction of tariff rates, the Armingtonian composite price level decreases, and the cost of producing capital goods falls, the aggregate investment increases. Simulation results reveal that at the year of the shock investment adjusts abruptly in the regions where tariffs are reduced. After this, investment path converges to its steady state smoothly. If everything else is held constant, the greater the size of the exogenous shock the greater the initial change in investment.

The transitional path of aggregate investment is also affected by the rental cost of capital. Increased capital stock depresses its rental price, wk_n. We observe that, comparing with base steady state equilibrium, the rental price of capital initially falls after tariffs are reduced and it continuously falls until a new steady state is approximated. However, the no-arbitrage condition defined in equation (12) requires that along its transition path, with interest rate held fixed, the decline in the investment cost has to precede the decline of the capital rental price. That is, the returns to capital relative to the cost of producing capital goods has to rise over time; otherwise the dynamic equilibrium condition of no-arbitrage opportunities would be violated. Figures 29 - 30 trace this proposition for the scenario where all tariffs are eliminated in both regions. As observed during the early phases of the dynamic adjustment, the transitional path of wk_n lies above the path of price of capital equipment, PI_n, and hence the aggregate investment enjoys a further positive inducement. Once the paths of wk_n and PI_n are overlapped and cease changing, a new steady state has been approached asymptotically.

Domestic household savings do not need to increase simultaneously to finance the increase in investment. In an open economy investment and saving decisions are made independently, and investment can be financed through foreign borrowing. We observe that domestic savings may fall after the shock. Using foreign assets to finance investment means that domestic households do not need to reduce their current consumption when investment increases. Nor do households need to reduce their future consumption as the economy expands in the future due to the increased investment.

Increase in investment cause the stock of capital to rise (figures 5 - 6). Also, the larger the reduction of the tariff rates the greater the increases in the capital stock. When both regions eliminate their tariffs completely, capital stock increases by 3 percent in U.S. and 5 percent in MERCOSUR (comparing with base-run level of capital stock, see table 5, Exp3). In the scenario where MERCOSUR reduces its tariffs unilaterally, capital stock only rises 0.2 - 0.4 percent for the U.S., and 1 - 3 percent for MERCOSUR. Thus, although capital supply is constant at steady state and growth rate is zero along steady state path in the exogenous growth theory with constant technology and labor supply, as adapted in this study, trade reform does affect growth positively by dynamic adjustment in capital accumulation along its transitional path.

The increased capital stock will affect the whole economy including production and trade. In the following subsections such effects can be observed when changes in outputs and trade due to dynamic adjustments are compared with those that would have been obtained from a static model.

2. Dynamic effect of tariff cuts on production

In order to compare the dynamic effects with those that would have been observed in a static model, so that the contribution of capital accumulation due to trade policy changes can be evaluated, we derive the static effects of tariff reduction on production and trade by "forcing" our dynamic model to behave as a static one with all intratemopral features identical with those of the dynamic version. To do so, we eliminate all dynamic difference equations from the dynamic version, and exogenously fix all stock variables including stock of capital and foreign debt at their base year steady state levels. Hence, real investment and foreign borrowing (i.e., imbalance of trade) are fixed at their base year levels. However, the investment expenditure is not fixed, as the current price of capital formation is still endogenously determined. The dynamic versus the static effects on sectoral production are presented in table 6 while different transitional paths of sectoral production under the three tariff reduction scenarios are depicted in figures 9 - 16. All results are compared with the base year data, and the dynamic results, shown in table 6, reflect the steady state equilibrium.

Table 6. Dynamic versus static effects of tariff reductions on sectoral output (% Changes from the base values)

	Exp1		Exp2		Exp3	
	Dynamic	Staitc	Dynamic	Static	Dynamic	Static
USA						
AGFD	100.09	100.01	100.20	100.03	102.19	100.73
MINE	99.91	99.87	99.74	99.65	101.23	99.83
MAFC	100.10	100.01	100.30	100.09	102.25	100.48
SERV	100.08	100.02	100.18	100.05	100.97	99.93
MERCOSUR						
AGFD	101.06	101.46	102.63	101.13	104.51	101.84
MINE	101.06	101.35	102.79	101.01	105.05	101.83
MAFC	100.19	99.48	100.46	98.71	101.00	97.93
SERV	100.33	99.81	100.75	99.49	101.30	99.08

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

In the simulations, the dynamic effects on sectoral production are greater than the static effects under the same tariff cut scenarios in most cases. If reducing tariffs causes a sectoral output to increase in the static model, this sector's output increases much more in the dynamic model. If such change is negative in the static model, then it is possible to become positive in the dynamic model. Taking MERCOSUR as an example, when it cuts import tariffs unilaterally, its agricultural sector benefits more relatively to the other three sectors in the static model, while in the dynamic model, the mineral and material sector benefits more. In scenario three where both regions eliminating all tariffs, the production of the U.S.'s two sectors: mineral and material and services and MERCOSUR's two sectors: manufacturing and service falls in the static analysis.

But all sectors benefit from tariff reform in the dynamic model. The main reason for the larger dynamic effects on the sectoral output is that trade reforms affect investment and hence the stock of capital. Static models do not include investment behavior at all. When the reallocation of resources across sectors is affected by changes in the total availability of resources, as in a dynamic model, changes in sectoral outputs can be greater than in a static model where the supply of resources is held fixed.

3. Reducing tariffs stimulating both regions' exports

Trade liberalization stimulates both regions' exports in the dynamic model, while it is not always true for the static analysis, in which U.S. reduces its service sector exports under scenarios 1 and 3, and reduces its all sectoral exports except manufacturing sector under scenario 2. Furthermore, when U.S. increases its total exports of a specific sector, it is not necessary for this sector's exports to MERCOSUR to rise. A typical example is U.S. services, of which exports to MERCOSUR fall under all three scenarios. These results are shown in table 7; the dynamic results are chosen at their steady state level. The transitional paths of sectoral exports are depicted in figures 17 - 24.

Table 7. Dynamic versus static effects of tariff reductions on exports
(% Changes from the base-steady state equilibrium values)

	Exp1		Exp2		Exp3	
	Dynamic	Static	Dynamic	Static	Dynamic	Static
U.S.						
AGFD	100.79	100.38	101.77	100.84	119.84	112.86
to MERCOSUR	108.95	108.99	117.58	117.67	143.26	141.29
MINE	100.77	100.44	101.49	100.72	120.99	115.25
to MERCOSUR	103.58	103.59	96.88	96.88	118.79	117.36
MAFC	100.84	100.60	102.12	101.58	122.80	119.26
to MERCOSUR	109.57	109.40	131.76	131.22	146.31	144.31
SERV	100.37	100.10	100.81	100.20	117.29	112.45
to MERCOSUR	99.08	98.74	97.77	96.94	98.36	96.52
MERCOSUR						
AGFD	107.68	105.76	118.85	113.85	132.33	123.03
to U.S.	102.51	101.93	105.94	104.52	123.72	121.69
MINE	110.45	108.36	126.80	121.05	149.44	137.95
to U.S.	103.52	102.85	108.54	106.87	130.91	127.62
MAFC	111.35	109.74	129.82	125.36	152.63	143.34
to U.S.	104.11	103.54	110.26	108.82	118.87	115.68
SERV	109.81	108.18	125.03	120.68	141.67	133.21
to U.S.	101.23	101.01	102.95	102.43	103.15	101.90

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

We observe that except service sector and one case in mineral and material sector, U.S.'s exports to MERCOSUR increase more than MERCOSUR's exports to the U.S.. The main reason is that, under scenarios 1 and 2 where only MERCOSUR reduces its tariffs, its imports from U.S. increases more than what U.S. imports from MERCOSUR. With bilateral trade between these two regions, we observe that U.S.'s exports to MERCOSUR increase more. Under scenario 3 where both regions eliminate their tariffs, MERCOSUR's import prices are still lower than those of the U.S., as MERCOSUR has higher tariff rates in the base-run. Thus, similar results as in the other two scenarios are observed. Dynamic effects of tariff reductions on the bilateral trade can also be observed by comparing changes in the sectoral share of trade between U.S. and MERCOSUR (see table 8).

Table 8 Sectoral share of bilateral trade between U.S. and MERCOSUR (Values of total trade are 100)

	Base	Exp1	Exp2	Exp3
US exports to MERCOSUR				
Ag. & food	4.19	4.32	4.28	4.67
Mineral & material	24.52	24.01	20.62	22.60
Manufacturing	49.33	51.09	56.43	55.89
Services	21.96	20.58	18.67	16.84
MERCOSUR exports to U.S.				
Ag. & food	22.80	22.74	22.64	23.17
Mineral & material	44.36	44.42	44.49	46.57
Manufacturing	26.45	26.57	27.76	24.93
Services	6.39	6.27	6.11	5.33

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

In this table, the value of total exports from U.S. to MERCOSUR or from MERCOSUR to U.S. are summed to 100. After MERCOSUR reduces its tariffs unilaterally, the shares of agricultural and manufacturing exports in the total exports of U.S. to MERCOSUR rise, while the shares of mineral and manufacturing exports from MERCOSUR to U.S. rise. When both regions eliminate their tariffs completely, their agricultural export shares both rise. Besides this, the share of manufacturing exports rises in the U.S., while the share of mineral and material exports rises in MERCOSUR.

It is obvious that sectoral exports experienced larger increases compared with changes in the sectoral outputs (see table 6). Given that at the same time the total consumption increases in each region (see table 5), this implies that demand for home goods either increases less than that of the imported good or falls, and hence the involved economies become more interdependent from trade point of view than before the reforms.

Changes in the sectoral exports and imports affect the regional net trade situation. Recalling that in the base year U.S. and MERCOSUR are both net exporters of agricultural goods, while U.S. is also a net exporter of services and MERCOSUR is a net exporter of mineral and material goods. Changes in the net exports of these three sectors are presented in table 9.

Table 9. Changes in sectoral net exports after tariff reductions (Base-run is 100 percent)

	Exp1	Exp2	Exp3
U.S.			
Ag. & food	100.34	100.67	111.56
Services	101.21	102.68	147.38
MERCOSUR			
Ag. & food	105.25	113.46	121.63
Mineral & material	114.21	140.98	176.94

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

The values of net exports rise in both regions, regardless of which region reduces tariffs. However, when both regions eliminate tariffs, U.S. agricultural net exports rise by 12 percent, and service net exports rise by 47 percent. MERCOSUR's net exports of both sectors rise significantly and its net exports of mineral and material products are almost doubled. These results imply that tariff reduction allows each region to better realize its comparative advantage in trade.

4. Dynamic effects of tariff cuts on the balance of trade and foreign debt

In the 1992 U.S. SAM, U.S. has a trade deficit of $42,528 million, which is equivalent to 7 percent of its total exports, but it runs a trade surplus with MERCOSUR of $2,694 million, equivalent to 23 percent of its exports to MERCOSUR. MERCOSUR has $5,895 million trade surplus, equivalent to 11 percent of its total exports, but its trade deficit with U.S. is equivalent to 30 percent of its exports to U.S.. During the first 5 - 7 years of the tariff reduction scenarios, the U.S. trade deficit increases while the MERCOSUR trade surplus falls (see figures 25 - 26). As in the case of investment, the adjustment in the balance of trade in the initial year is much greater than in any other time period. The drastic change in each region's current account reflects that increases in investment at the first year are financed primarily through foreign borrowing. As investment smoothly converges to its steady state level, the demand for foreign borrowing diminishes, and, hence, the increases in U.S. trade deficit or decreases in MERCOSUR trade surplus become smaller. After 5 - 7 years, U.S. starts to reduce its trade deficit below the base-run level, while MERCOSUR starts to increase its trade surplus above the base-run level. The reason for these trends is that, at the new steady state, foreign debt/assets for each region have to become constant again. For the U.S. the first 5 - 7 years' increases in its trade deficit cause the accumulated foreign assets to fall below the base-run level (see figure 27), while for MERCOSUR, accumulated foreign debt rises above the base-run level (see figure 28). If a region's foreign debt increases in the first few years after tariff reforms, it must raise its trade surplus to a level above the base-run level in order to reach a constant level of foreign debt at the new steady state. The reverse is true for a region whose foreign assets fall (see figures 25 - 26). Table 10 shows the effects of tariff cuts on the trade imbalance and foreign debt/assets in the initial year and at the steady state.

Table 10. Dynamic effects of tariff reductions on trade imbalance and foreign debt/assets
(% Changes from the base-steady state equilibrium values)

	Exp1		Exp2		Exp3	
	Year 1	Steady State	Year 1	Steady State	Year 1	Steady State
<u>U.S.</u>						
Total trade deficit	101.89	98.22	103.97	96.02	170.87	61.78
Trade surplus with MERCOSUR	124.21	119.99	164.60	153.59	167.25	154.63
Trade deficit with ROW	103.22	99.52	107.58	99.45	170.65	67.31
Foreign assets	100.00	98.22	100.00	96.02	100.00	61.78
<u>MERCOSUR</u>						
Total trade surplus	83.55	112.06	56.18	131.51	21.72	158.38
Trade deficit with U.S.	124.21	119.99	164.60	153.59	167.25	154.63
Trade surplus with ROW	96.30	114.55	90.18	138.43	67.36	157.20
Foreign debt	100.00	112.06	100.00	131.51	100.00	158.38

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

Changes in the imbalance of the trade between U.S. and MERCOSUR are different from those in the total regional trade deficit or surplus. At the new steady state, the U.S. increases its trade surplus with MERCOSUR, which is equivalent to MERCOSUR increasing its trade deficit with U.S., even though the total trade deficit falls in the U.S. and the total trade surplus rises in MERCOSUR. The larger the tariff cuts, the greater such trade imbalance between U.S. and MERCOSUR. Trade imbalance between U.S. and MERCOSUR has to move at the opposite direction of the regional total trade deficit/surplus. If U.S. wants to reduce its total trade deficit at the new steady state, it has to increase its trade surplus with MERCOSUR and decrease its trade deficit with ROW. If MERCOSUR, on the other hand, wants to achieve a higher trade surplus at the new steady state, the positive changes in its trade deficit with U.S. have to be smaller than the increases in its total trade surplus, since its trade with ROW has the larger share.

Changes in foreign debt/assets reflect the dynamic adjustment in foreign capital flows. Simulation results show that trade reform stimulates foreign capital to flow into both regions along the transitional path. In the first 5 - 7 years, as the U.S. trade deficit increases and the MERCOSUR trade surplus falls, we observe a drastic inflow of foreign capital to both regions. After that, although U.S. trade deficit falls below its base-run steady state level and MERCOSUR trade surplus rises above its base-run level, interest payments on the outstanding debt cause foreign capital to continue to flow into these two regions. Only when the new steady state is approached, does foreign capital inflow cease, the foreign debt/assets become constant. When U.S. does not change its tariff rates, inflow of foreign capital is very limited (its foreign assets decline only 2 - 4 percent in Exp1 - 2). When both regions eliminate their tariffs completely, foreign capital inflows cause U.S. foreign assets to fall by 38 percent and MERCOSUR foreign debt to increase by 58 percent. On the other hand, foreign inflows cause MERCOSUR foreign debt to increase by only 12 percent when it reduces its tariff rates by 30 percent.

Capital inflows are the results of dynamic adjustment in investment. With a smooth increase in real consumption, increased investment along the transitional path is primarily financed through foreign capital. During the first year, when tariffs are eliminated completely in both regions, foreign borrowing, which is zero at the base-run steady state, finances 4 percent of total investment in both regions. Thus, about 70 - 90 percent of the increased investment in the first year is financed through foreign borrowing. After that, as investment converges to its steady state level smoothly, the ratio of borrowing to total investment falls until it approximates zero again at the new steady state. Table 11 presents the ratio of foreign borrowing to increased investment in the first year of the new tariff policy.

Table 11. Ratios of foreign borrowing to the increased investment in the first year of trade reform

	Exp1	Exp2	Exp3
U.S.	48.00	47.31	70.02
MERCOSUR	92.02	92.19	85.18

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

Table 11 indicates that if U.S. does not undertake tariff reform, only half of its increased investment which is relatively small needs to be financed through foreign borrowing. On the other hand, under tariff reform MERCOSUR must finance its increased investment mainly through foreign borrowing. When both regions eliminate tariffs, both face greater adjustment in their investment; the demand for foreign capital increases, and 70 and 85 percent of the first year's increased investment is financed through foreign borrowing for the U.S. and MERCOSUR, respectively. Drastic adjustments in foreign capital flows also indicate that the impacts of trade reform on capital market are much greater than on commodity markets.

5. Dynamic effects of tariff cuts on intertemporal utility, wages and sectoral capital allocation

In a typical static CGE model, the welfare analysis of trade liberalization can be accomplished by calculating the level of equivalent variation from the static social welfare function. In a dynamic model this analysis can be achieved by calculating a similar equivalent variation from the intertemporal utility function (see for instance Mercenire, 1995 for detail), such that transitional and long term effects of the policy on the household's well-being can both be measured. Simulation results show that reducing tariffs makes both regions better off with respect to intertemporal social welfare. Since U.S. does not reduce tariffs in the first two scenarios, its intertemporal utility level rises less than 2 percent, while MERCOSUR's utility level rises by 5 - 11 percent. When both regions eliminate tariffs completely, intertemporal social welfare increases about 12 percent for the U.S. and almost 22 percent for MERCOSUR. These results are presented in table 12.

Table 12. Dynamic effects of tariff reductions on region's intertemporal utility
(% Changes over the base-run level)

	Exp1	Exp2	Exp3
U.S.	100.65	101.54	111.55
MERCOSUR	104.63	111.46	121.48

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

Given that each region is better off from intertemporal utility point of view, wages, land

and capital rental prices can move in different directions after tariff reforms. The base year data allow wage rates of agricultural and non-agricultural sectors to be different as labor is differentiated between agriculture and non-agriculture, while capital rental price is equal across sectors. Because technical change is ignored in the model and the supply of labor is fixed, the possibility of labor migration from rural to urban is also ignored. Given these assumptions, the dynamic effects on wages, land and capital rental prices, and the rural/urban wage ratios are shown in table 13.

Table 13. Dynamic effects of tariff reductions on wage rates and rural/urban wage ratios

	Base	Exp1	Exp2	Exp3
U.S.				
Land rent	100.0	100.034	100.081	100.12
Capital rent	100.0	99.849	99.666	95.61
Ag. wage	100.0	100.034	100.081	100.12
Non-ag. wage	100.0	100.032	100.083	98.85
Rural/urban ratio	138.531	138.532	138.528	140.31
MERCOSUR				
Land rent	100.0	100.05	100.26	100.98
Capital rent	100.0	97.94	95.12	92.33
Ag. wage	100.0	100.05	100.26	100.98
Non-ag. wage	100.0	98.89	97.40	96.32
Rural/urban ratio	43.41	43.91	44.68	45.50

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

Table 13 demonstrates that tariff reduction rises the returns to land but lowers capital rental price. In general, agricultural wage earners benefit, while non-agricultural wage earners are hurt. The larger the tariff reduction the larger is the increase in land rent and agricultural wages and the larger is the decreases in non-agricultural wages. When MERCOSUR adopts unilateral tariff reform, both agricultural and non-agricultural wages rise slightly in the U.S. and the rural/urban wage ratios remain almost constant. When both regions eliminate all their tariffs completely, only then do U.S. agricultural wages rise and non-agricultural wages fall, resulting in an increase in the rural/urban wage ratio.

Given constant technology, constant land supply, and constant agricultural and non-agricultural labor supplies, any increase in capital stock will depress the capital rental price. Changes in wages are determined by both commodity prices and capital supply. For given commodity prices, if capital supply increases, then labor has more capital at its disposal and becomes relatively scarce to capital. Hence, real wages would rise. On the other hand, for given capital supply, a decline in commodity prices would cause wages to fall. We observe that the increase in capital is proportionally greater in agriculture than in non agricultural sectors (see Table 14). At the same time, agricultural prices fall less than non-agricultural prices. Putting these two factors together, wages rise for agricultural sector and fall for non-agricultural sector. Changes in capital allocation cross sectors and the shares of capital between agricultural and non-agricultural sectors are presented in table 14.

Table 14. Changes in capital allocation and shares of capital among sectors

	Base	Exp1	Exp2	Exp3
Demand for capital				
U.S.				
Agriculture	100.00	100.185	100.42	104.72
Non-agriculture	100.00	100.175	100.39	103.30
Mineral & material	100.00	100.02	99.99	103.26
Manufacturing	100.00	100.25	100.63	104.98
Services	100.00	100.20	100.45	103.18
MERCOSUR				
Agriculture	100.00	102.16	105.40	109.37
Non-agriculture	100.00	101.04	102.57	104.66
Mineral & material	100.00	101.48	103.83	106.95
Manufacturing	100.00	100.71	101.74	103.32
Services	100.00	100.88	102.10	103.75
Capital shares				
U.S.				
Agriculture	5.65	5.65	5.65	5.72
Non-agriculture	94.35	94.35	94.35	94.28
Mineral & material	14.26	14.24	14.20	14.24
Manufacturing	5.50	5.51	5.52	5.59
Services	74.59	74.60	74.63	74.45
MERCOSUR				
Agriculture	17.62	17.79	18.02	18.27
Non-agriculture	82.38	82.21	81.98	81.73
Mineral & material	24.50	24.56	24.68	24.84
Manufacturing	9.48	9.43	9.36	9.29
Services	48.39	48.22	47.94	47.60

Exp1: 30% tariff cuts by MERCOSUR

Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

The top part of table 14 shows that capital employed in agriculture increases more than in non-agriculture after tariff reductions. If we compare these changes with the change in total capital supply shown in table 5, we can see that agricultural capital rises proportionally more than the change in total capital supply, while the non-agricultural capital rises proportionally less than the change in total capital supply. Consequently, the share of capital employed in agriculture rises in the region where tariffs are eliminated (see the second part of table 14). This result implies that agriculture, as a sector, benefits more from tariff reform than non-agricultural, as a sector.

The reason that more capital moves into agriculture is that the positive supply response of agriculture to tariff reduction is greater than that of the non-agricultural sectors as a group. Tariff reduction by a region lowers the region's foreign prices and, hence, affects producer and consumer price levels negatively. However, as agriculture has lower level of world market dependence relative to non-agricultural sectors as a group, agricultural prices fall less. These results are presented in table 15.

Table 15. Changes in agricultural producer price over non-agricultural producer price*
(Non-agricultural price is 100)

	Exp1	Exp2	Exp3
U.S.	105.04	104.98	104.95
MERCOSUR	100.48	101.26	102.01

* Non-agricultural producer price is a weighted average index calculated from three non-agricultural prices.

Table 15 shows that relative prices of agricultural products rise in both regions after tariff reductions. This is the main reason that agriculture has a greater production response to tariff reductions, and, hence, attract an inflow of the more mobile resource, capital.

Among the non-agricultural sectors capital allocation and, hence, capital shares also change. Under all simulations, capital employed in manufacturing increases more than in the other non-agricultural sectors for the U.S., while capital employed in the mineral and material sector increases more than in the other sectors for MERCOSUR.

Comparing wage rates and capital rental rates between MERCOSUR and the U.S., we observe that agricultural wages in MERCOSUR rise more than in the U.S., while non-agricultural wages in U.S. fall less than in MERCOSUR. Furthermore, as capital accumulates faster in MERCOSUR than in U.S. (see table 5), capital rental price in MERCOSUR falls more relative to U.S. capital price. These results are shown in table 16.

Table 16. MERCOSUR wage, capital rental rates compared with U.S.
(The values in U.S. are 100)

	Base	Exp1	Exp2	Exp3
Wage				
agriculture	5.11	5.12	5.12	5.19
Non-ag.	16.32	16.14	15.89	15.90
Capital rental	102.33	100.48	97.77	98.26

Exp1: 30% tariff cuts by MERCOSUR
Exp2: MERCOSUR tariff rates reduced to the U.S. levels
Exp3: eliminating all tariffs in both regions

VI. Summary and Conclusions

An intertemproal general equilibrium model of the United States and MERCOSUR is created to analyze the dynamic adjustments in both regions' commodity and capital markets after trade liberalization. As the capacities of MERCOSUR production and trade are much smaller than those of the U.S., tariff reduction initiated by MERCOSUR have small effects on the U.S. production, trade, consumption and investment. Such limited effects, however, are positive in terms of social welfare, economic growth and trade promotion in the U.S.. Intertemporal social welfare increases; investment and, hence, capital stock increases; capital does not flow out, rather, capital inflows are observed. In terms of U.S. - MERCOSUR bilateral trade, tariff reform by MERCOSUR creates an opportunity for U.S. trade diversion in agricultural and manufacturing sectors, i.e., the United States significantly increases its agricultural and manufacturing good exports to MERCOSUR.

Tariff reform stimulates MERCOSUR's economy; investment increases about 1 - 3 percent; capital flows into the region to finance the increased investment, and its domestic saving rate rises at the same time; both its exports and imports increase significantly, and, when the economy converges to its new steady state, total exports grow faster than total imports, hence the current account improves and the trade surplus increases.

When tariffs are eliminated completely in both regions, both regions are better off. Intertemporal social welfare increases; investment booms by 9 - 11 percent initially, and the steady state level of capital stock increases by 3 - 5 percent. Both economies grow and outputs of all sectors increase; two digit growth rates in exports and imports are observed; foreign capital flows into both regions and domestic saving rates rise; finally the current accounts improve, i.e., for the United States the trade deficit falls and for MERCOSUR the trade surplus rises.

Agriculture benefits most from trade reform. The relative increase in agricultural prices means that the rural-agricultural sector might have been a victim of pre-reform protectionist policies. After tariff reform, capital moves into agriculture more than into non-agricultural sectors, and, as a results, agricultural output rises proportionally more than non-agricultural as a sector. Furthermore, both returns to land and agricultural wages rise but non-agricultural wages fall when the region reduces its tariffs.

The model is based on neoclassical growth theory. Any exogenous parameter, such as productivity growth and/or labor supply growth rate, each may generate growth along the steady state path, are ignored in this model as it cannot be affected by trade reform. However, trade reforms do stimulate growth by endogenously affecting dynamic adjustments in investment and capital accumulation along their transitional paths. The only source of growth in this model is capital accumulation, which has been shown by other studies to explain less than one third of growth in many countries (King and Rebelo, 1993). If other growth factors, such as technical change, research and development of new intermediate inputs[5], and/or improvement in labor productivity, can be endogenously influenced by commodity prices and/or trade policies, the observed growth effects of trade reforms simulated in this paper and the effects of change in growth rate on other important economic variables should be greater than what we report here.

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[5] One study result derived from a simple dynamic CGE model based on the application of R&D-based endogenous growth theory shows that changes in a country's trade policy can affect steady state growth rate (see Diao, Elfasha, Roe, and Yeldan, 1996).

Financial assets observed in the real world are ignored in the model, hence foreign capital flows are mainly attracted by changes in recipient region's investment and/or consumption caused by trade reforms. Short-term capital inflows driven by speculative rent-seeking account for about 30 percent of total capital inflows in the Latin American countries (World Bank, 1996), and play a crucial role in this region's economic development and stability, and furthermore, macroeconomic policies, which affect capital flows, are all ignored in the model. Hence, the relationship between commodity markets and capital markets, and the impacts of trade liberalization on capital movements between regions are more complicated and beyond the scope of the analysis done by this paper.

References

[1] Brooke, A., D. Kendrick and A. Meeraus (1988) *GAMS: A User's Guide*, Scientific Press, San Francisco, CA.

[2] Devarajan, S. and D.S. Go (1995) "The Simplest Dynamic General Equilibrium Model of an Open Economy", Forthcoming in the *Journal of Policy Modeling.*

[3] Diao, X., E.Yeldan, and T.L. Roe (1996) "A Simple Dynamic Applied General Equilibrium Model of a Small Open Economy: Transitional Dynamics and Trade Policy", Discussion Paper 96-3, Department of Economics, Bilkent University, Ankara, Turkey.

[4] Diao, X., E.H. Elbasha, T.L. Roe, and E.Yeldan (1996) " A Dynamic CGE Model: An Application of R&D-Based Endogenous Growth Theory", EDC Bulletin 96-1, Economic Development Center, University of Minnesota.

[5] Go, D.S. (1994) "External shocks, adjustment policies, and investment in a developing economy - illustrations from a forward-looking CGE model of the Philippines", *Journal of Development Economics* 44: 229-261.

[6] Hertel, T.W. and M.E. Tsigas (1995) *GTAP Database, Version 3*, Purdue University.

[7] Ho, M.S. (1989) "The Effects of External Linkages on U.S. Economic Growth: A Dynamic General Equilibrium Analysis", Unpublished Ph.D. thesis submitted to Harvard University.

[8] Jorgenson, D.W. and P. Wilcoxen (1990) "Intertemporal general equilibrium modeling of U.S. environmental regulation", *Journal of Policy Modeling* 12: 715-744.

[9] Keuschniggs, C. and W. Kohler (1994) "Modeling Intertemporal General Equilibrium: An Application to Austrian Commercial Policy", *Empirical Economics* 19:131-164.

[10] Keuschnigg, C. and W. Kohler (1995) "Dynamic of Trade Liberalization", forthcoming in F. Francois and K. Reinert (eds.), *Applied Trade Policy Modeling: A Handbook*, Cambridge: Cambridge University Press.

[11] King, R.G. and S.T. Rebelo (1993) "Transitional Dynamics and Economic Growth in the Neoclassical Model", *American Economic Review* 83(4): 908-931.

[12] McKibbin, W.J. (1993) "Integrating Macroeconometric and Multi-Sector Computable General Equilibrium Models", Brookings Discussion Papers in International Economics, No. 100.

[13] Mercenier, J. (1995) "An Applied Intertemporal General Equilibrium Model of Trade and Production with Scale Economies, Product Differentiation and Imperfect Competition", mimeo, C.R.D.E. and Department of Science Economics, University of Montreal.

[14] Mercenier J. and M. Sampaïo de Souza (1994) "Structural Adjustment and Growth in a Highly Indebted Market Economy: Brazil", in J. Mercenier and T. Srinivasan (eds.) *Applied General Equilibrium Analysis and Economic Development*, Ann Arbor: University of Michigan Press.

[15] Mercenier J. and P. Michel (1994) "Discrete-time finite horizon approximations of infinite horizon optimization problems with steady-state invariance", Econometrica 62(3): 635-656.

[16] Rivera, S.A. (1995) "After NAFTA: Western Hemisphere Trade Liberalization and Alternative Paths to Integration", *The Social Science Journal* 32(4):389-406.

[17] Turner, P. (1995) "Capital Flows in Latin America: A New Phase", BIS Economic Papers No. 44, Bank for International Settlements, Monetary and Economic Department, Basle.

[18] UNCTAD (1995) *Trade and development Report, 1995*, Report by the secretariat of the United Nations Conference on Trade and Development, United Nations, Geneva.

[19] United States International Trade Commission (1992) "U.S. Market Access in Latin America: Recent Liberalization Measures and Remaining Barriers", USITC Publication 2521, Investigation No. 332-318.

[20] Wang, Z. (1994) "The Impact of Economic Integration Among Taiwan, Hong Kong and China -- A Computable General Equilibrium Analysis", Ph.D. Dissertation, Department of Applied Economics, University of Minnesota.

[21] Wilcoxen, P.J. (1988) "The Effects of Environmental Regulation and Energy Prices on U.S. Economic Performance", Unpublished Ph.D. thesis submitted to Harvard University.

[22] World Bank (1996) *World Debt Tables: External Finance for Developing Countries*, Washington DC.

Appendix: Equations and Variables in the Dynamic CGE Model

A.1. List of equations

The time-discrete intertemporal utility

$$U_{n0} = \Sigma_{t=0}^{\infty} (\frac{1}{1+\rho})^t \ln(TC_{nt})$$

$$TC_{nt} = \Pi_i CD_{ni}^{a_{ni}}$$

Within period equations (time subscript t is skipped)

A.1.1 Price system

$$PM_{nsi} = (1 + tm_{nsi})PWM_{nsi}$$

$$PX_{ni} = (1 - te_{ni})PWM_{sni}$$

$$PC_{ni} = \frac{1}{\Lambda_{ni}} [\Sigma_s \beta_{nsi}^{\sigma m_{ni}} PM_{nsi}^{1-\sigma m_{ni}} + (1 - \Sigma_s \beta_{si})^{\sigma m_{ni}} PX_{ni}^{1-\sigma m_{ni}}]^{\frac{1}{\sigma m_{ni}}}$$

A.1.2 Armington functions

$$M_{nsi} = \Lambda_{ni}^{1+\sigma m_{ni}} [\beta_{nsi} \frac{PC_{ni}}{PM_{nsi}}]^{\sigma m_{ni}} C_{ni}$$

$$D_{ni} = \Lambda_{ni}^{1+\sigma m_{ni}} [(1 - \Sigma_s \beta_{nsi}) \frac{PC_{ni}}{PX_{ni}}]^{\sigma m_{ni}} C_{ni}$$

A.1.3. Value added

$$PVA_{ni} = \frac{1}{A_{ni} \prod_f \alpha_{nif}^{\alpha_{nif}}} wld_n^{\alpha_{nid}} wlb_n^{\alpha_{nib}} wk_n^{\alpha_{nk}}$$

$$PVA_{ni} = (1 - it_{ni}) PX_{ni} - \Sigma_j PC_{nj} IO_{nij}$$

A.1.4. Factor market equilibrium

$$\sum_i \alpha_{nid} PVA_{ni} X_{ni} = wld_n LD_n$$

$$\sum_i \alpha_{nib} PVA_{ni} X_{ni} = wlb_n LB_n$$

$$\sum_i \alpha_{nik} PVA_{ni} X_{ni} = wk_n K_n$$

A.1.5. Demand system

$$PC_{ni} CD_{ni} = a_{ni} (Y_n - SAV_n)$$

$$PC_{ni} GD_{ni} = b_{ni}(\sum_i it_{ni} PX_{ni} X_{ni} + \sum_{is} te_{ni} PWM_{sni} M_{sni} + \sum_i tm_{nsi} PWM_{nsi} M_{nsi})$$

$$INTD_{ni} = \sum_j IO_{nij} X_{nj}$$

$$PC_{ni} INVD_{ni} = \theta_{ni} PI_n I_n$$

$$I_n = A_{nk} \prod_i INVD_{ni}^{\theta_{ni}}$$

A.1.6. Household income

$$Y_n = wld_n LD_n + wlb_n LB_n + wk_n K_n - rFD_n$$

A.1.7. Commodity market equilibrium

$$C_{ni} = CD_{ni} + INVD_{ni} + INTD_{ni}$$

A.1.8. Trade balance

$$FB_{ns} = \sum_i (PWM_{nsi} M_{nsi} - PWM_{sni} M_{sni})$$

Dynamic difference equations

A.1.9. Euler equation for consumption

$$\frac{Y_{nt+1} - SAV_{nt+1}}{Y_{nt} - SAV_{nt}} = \frac{1 + r}{1 + \rho}$$

A.1.10. No-arbitrage condition for investment

$$(1 + r) PI_{nt-1} = wk_{nt} + (1 - \delta_n) PI_{nt}$$

A.1.11. Capital accumulation

$$K_{nt+1} = (1 - \delta_n)K_{nt} + I_{nt}$$

A.1.12. Foreign debt

$$FD_{nt+1} = (1 + r)FD_{nt} + \Sigma_s FB_{nst}$$

A.1.13. Terminal conditions (steady state constraints)

$$\delta_n K_{nss} = I_{nss}$$

$$rPI_{nss} = wk_{nss} - \delta_n PI_{nss}$$

$$rFD_{nss} + \Sigma_s FB_{nsss} = 0$$

$$r = \rho$$

A.1.14. Welfare evaluation

$$\Sigma_{t=0}^{\infty}\left(\frac{1}{1+\rho}\right)^t \ln(\hat{TC}_n(1 + \varphi_n)) = \Sigma_{t=0}^{\infty}\left(\frac{1}{1+\rho}\right)^t \ln(TC_{nt})$$

where [illegible] is base year total consumption. That is welfare gain resulting from the policy change is equivalent from the perspective of the representative household to increasing the reference consumption profile by φ_n percent.

A.2. Glossary

A.2.1 Parameters

Λ_{ni} shift parameter in Armington function for i in region n

A_{ni} shift parameter in value added function for i in region n

A_{nk} shift parameter in capital good production function in region n

a_{ni} share parameter in household demand function for i in region n

b_{ni} share parameter in government demand function for i in region n

α_{nif} share parameter in value added function of sector i for factor f in region n

β_{nsi} share parameter in Armington function for own good i in region n

θ_{ni} share parameter in capital good production function for input i in region n

σm_{ni} elasticity of substitution in Armington function for i in region n

IO_{nij} input-output coefficient for i used in sector j in region n

ρ rate of consumer time preference

δ_n capital depreciation rate in region n

A.2.2. Exogenous variables

LD_{nt} land supply in region n

LB_{nt} labor supply in region n

tm_{nsit} tariff rate for i imported from region s to region n

te_{nit} export tax rate for i in region n

it_{nit} indirect tax rate for i in region n

PWM_{nsit} world import price for good i imported from region s to region n

r world interest rate

A.2.3. Endogenous variables

PX_{nit} producer price for i in region n

PC_{nit} composite good price for i in region n

PVA_{nit} price of value added for i in region n

PI_{nt} unit cost of capital good in region n

wld_{nt} land rental rate in region n

wlb_{nt} wage in region n

wk_{nt} capital rental price in region n

X_{nit} output of good i in region n

C_{nit} total absorption of composite good i in region n

D_{nit} own good i in region n

M_{nsit} import good i imported from region s to region n

TC_{nt} household aggregate consumption in region n

CD_{nit} household demand for composite good i in region n

GD_{nit} government demand for composite good i in region n

$INVD_{nit}$ investment demand for composite good i in region n

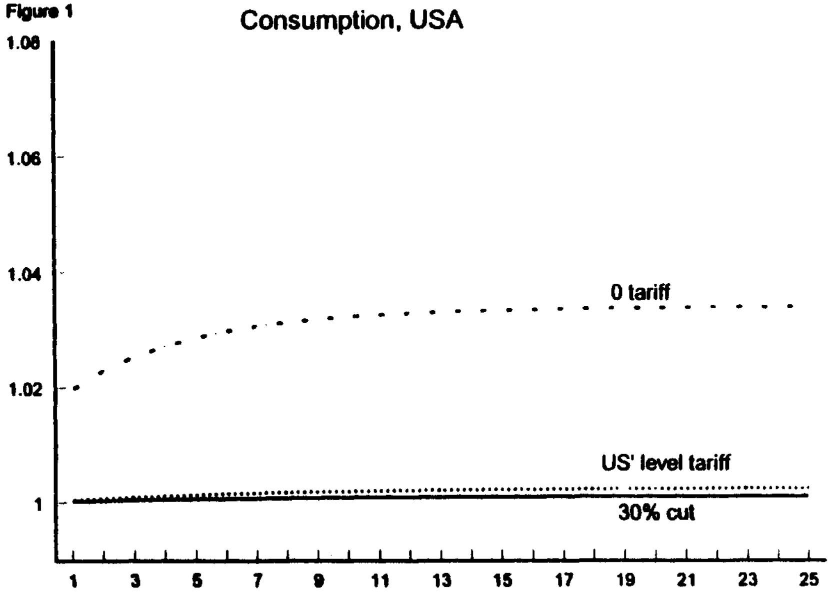
$INTD_{nit}$ intermediate demand for composite good i in region n

Y_{nt} household income in region n

SAV_{nt}	household savings in region n
K_{nt}	capital stock in region n
I_{nt}	new capital goods produced in region n
FB_{nst}	trade deficit between region n and region s
FD_{nt}	foreign debt in region n

Changes in Consumption and Savings after Trade Reform
(Base-run steady state is 1.00)

Figure 1



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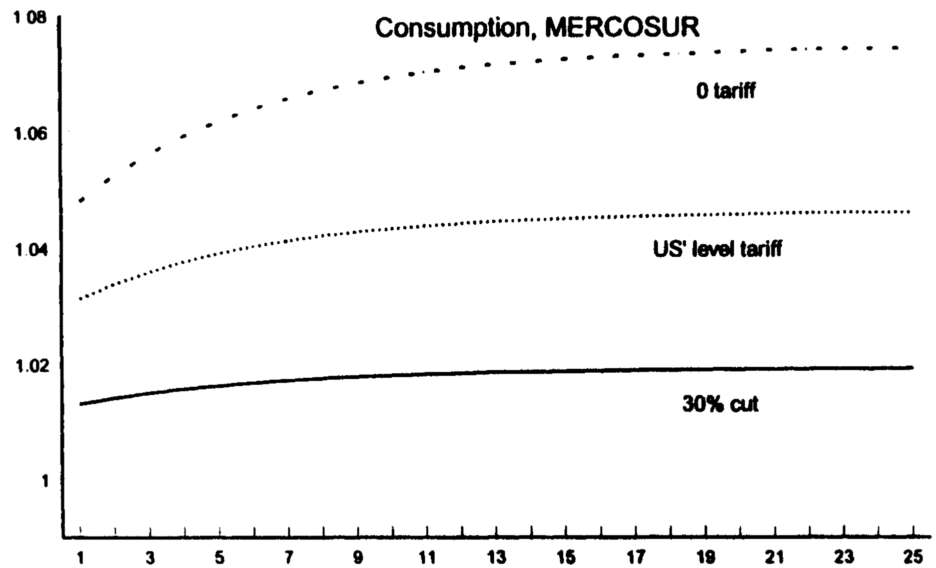

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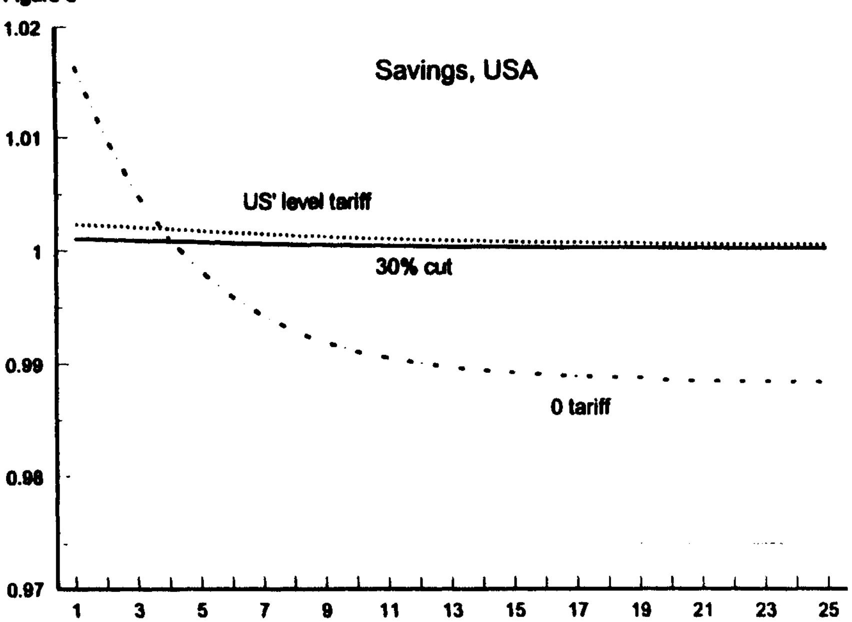

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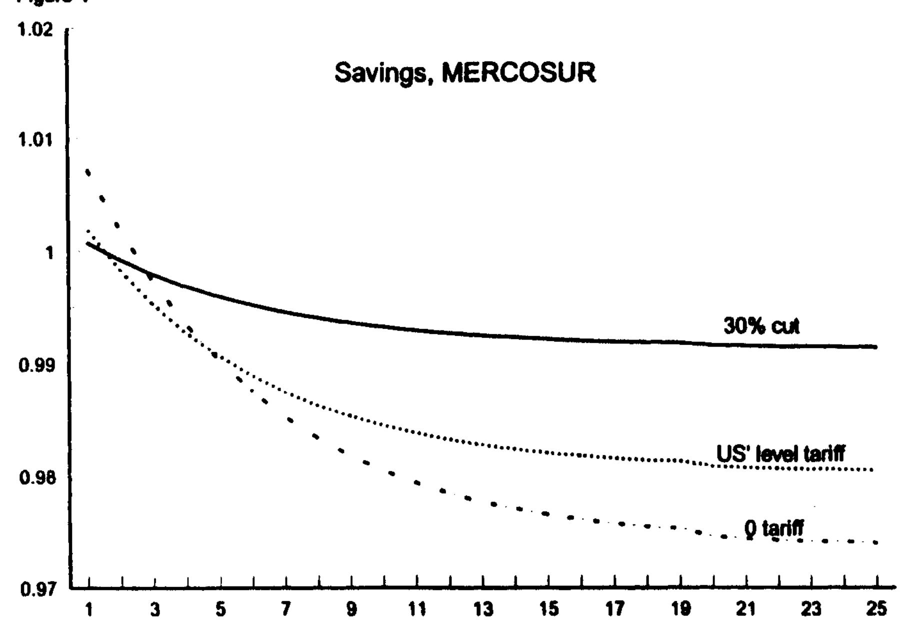
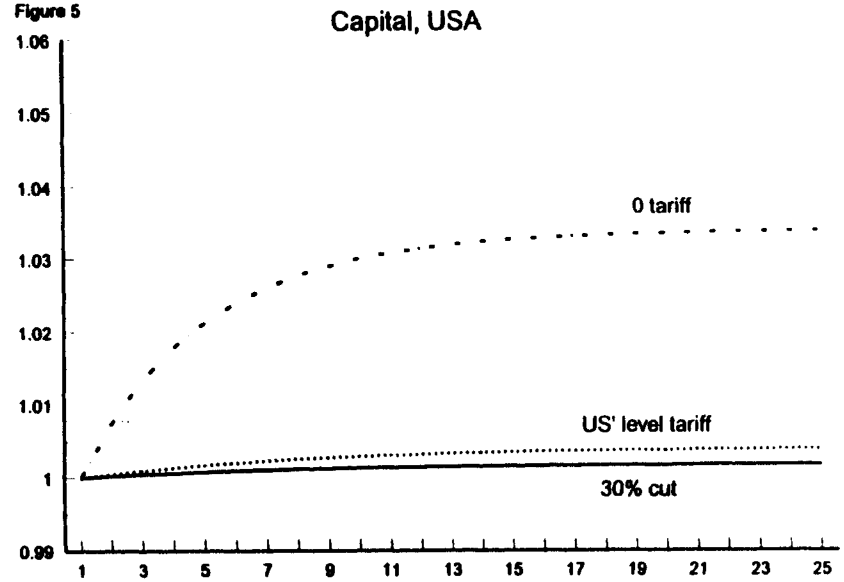


Changes in Capital and Investment after Trade Reform
(Base-run steady state is 1.00)

Figure 5



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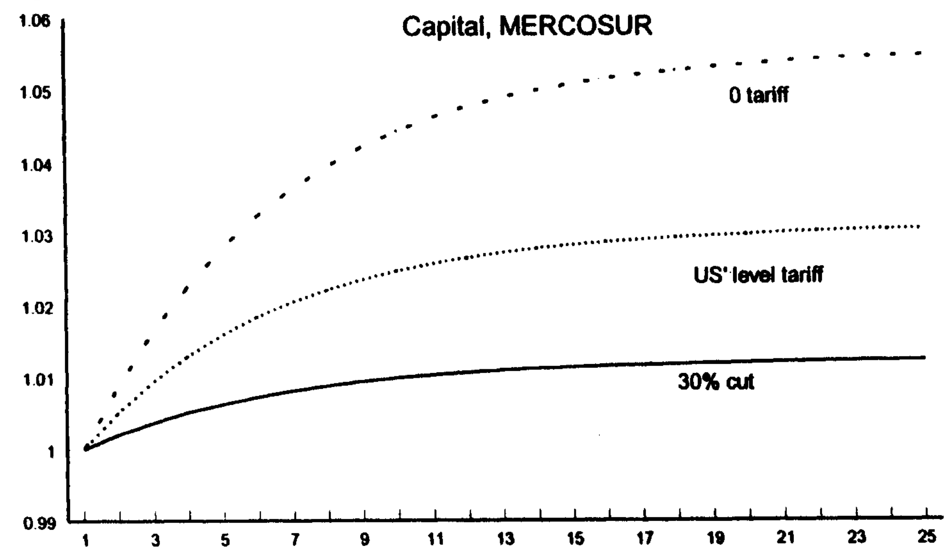

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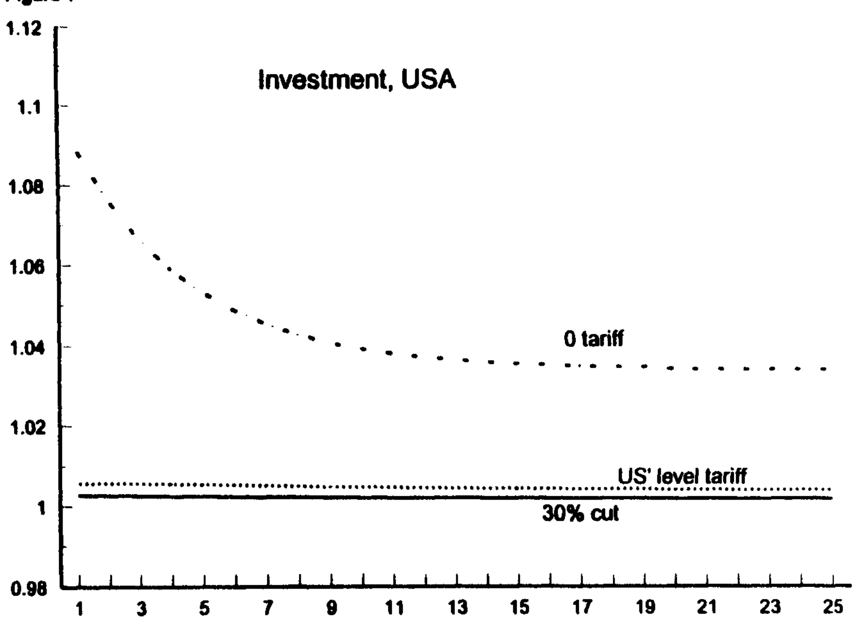

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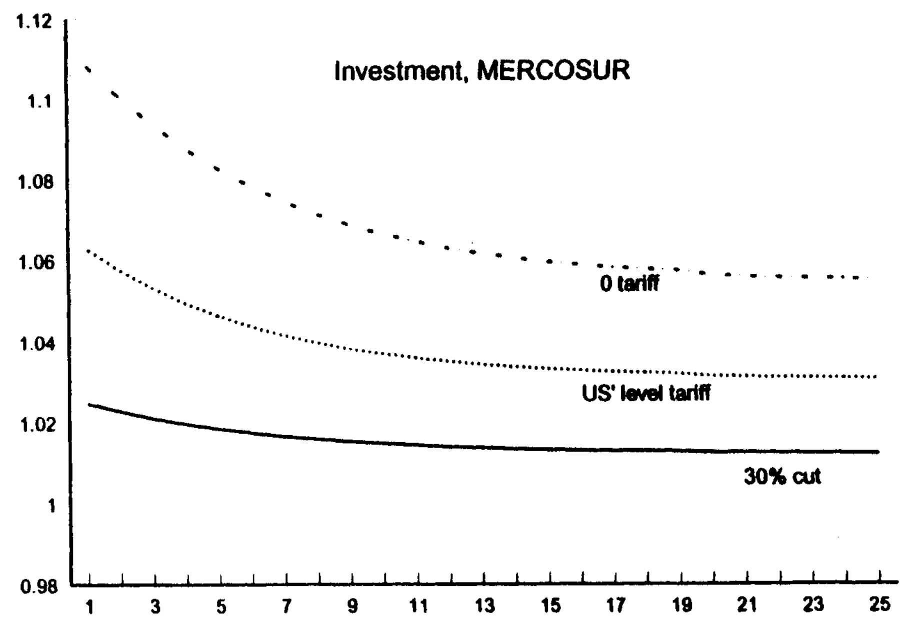
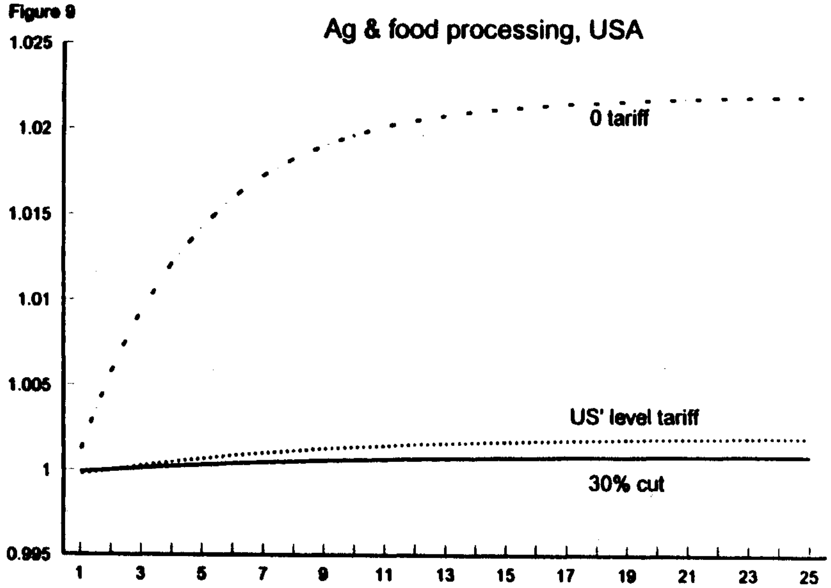


Changes in Outputs after Trade Reform
(Base-run steady state is 1.00)

Figure 9



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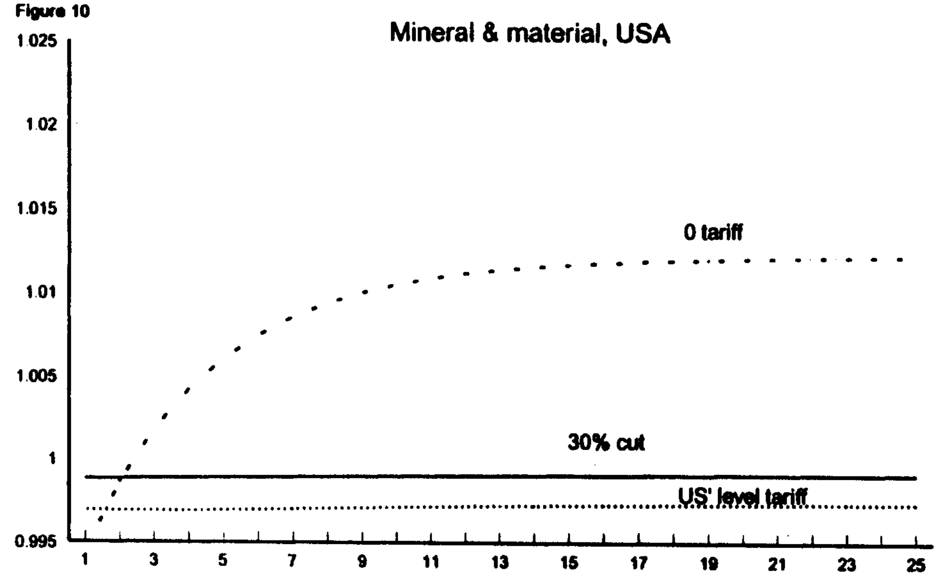

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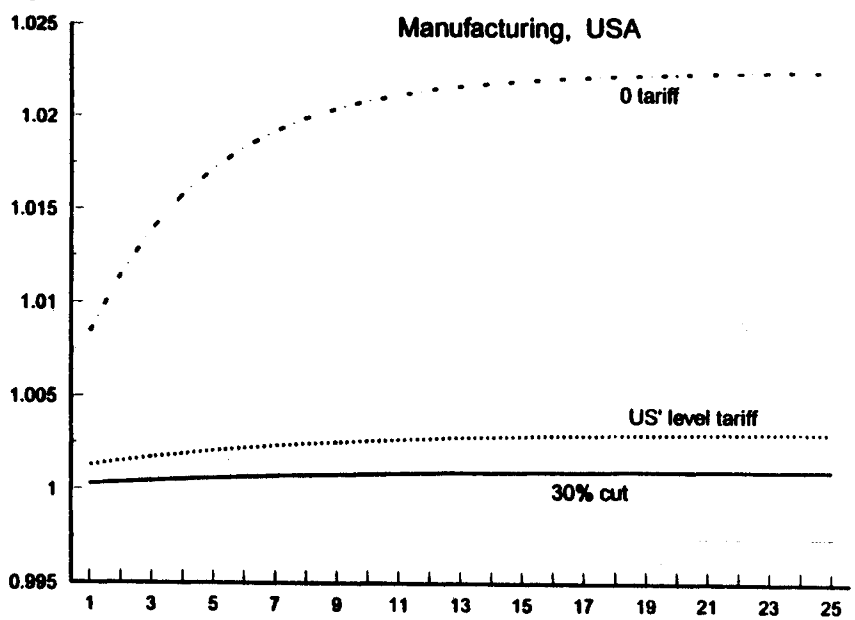

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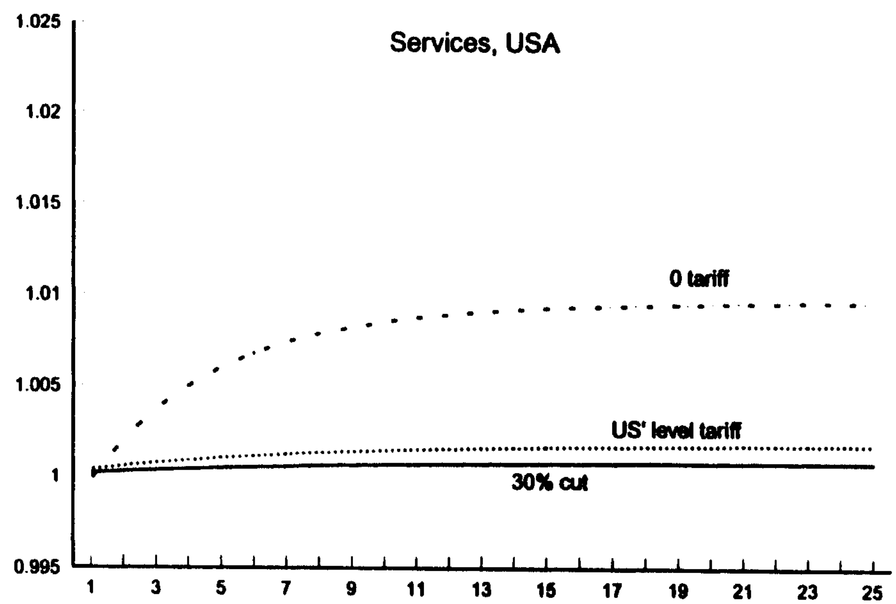
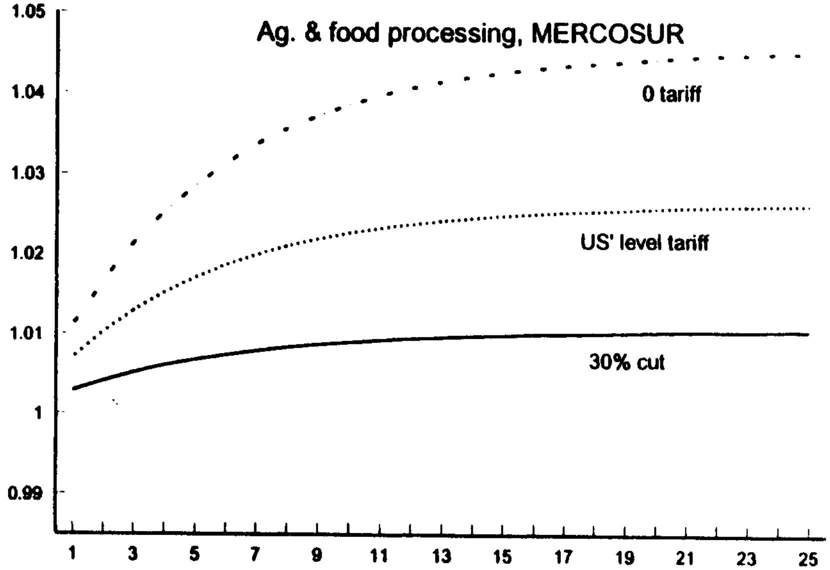


Changes in Outputs after Trade Reform
(Base-run steady state is 1.00)

Figure 13



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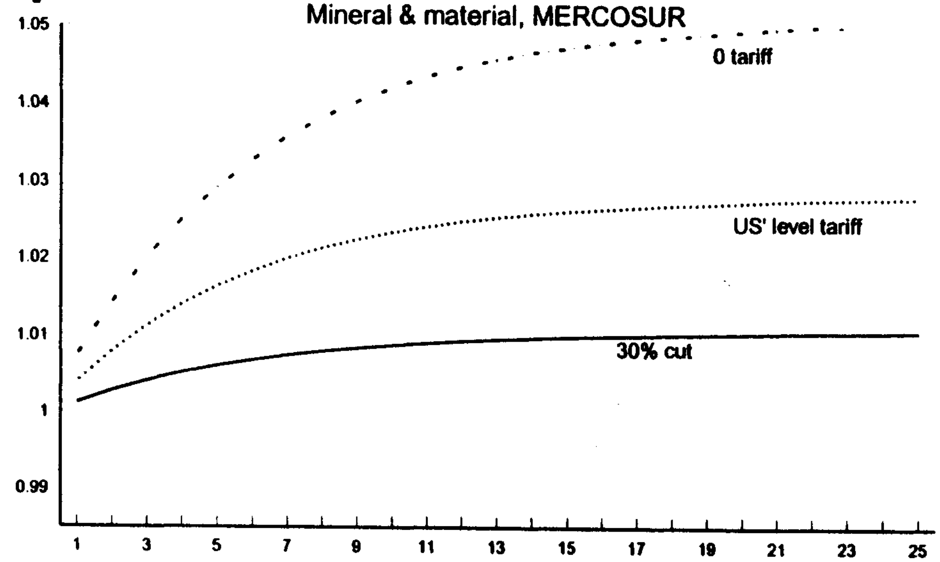

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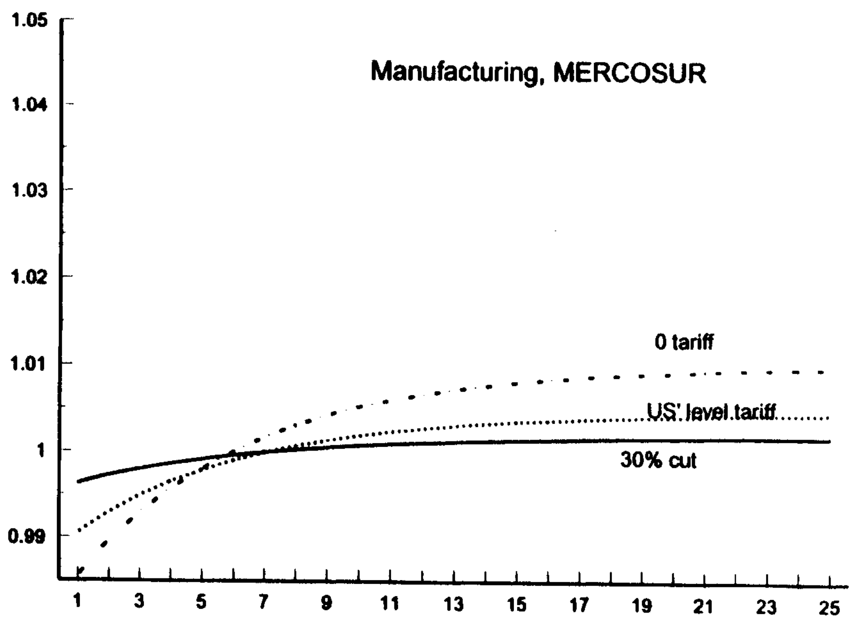

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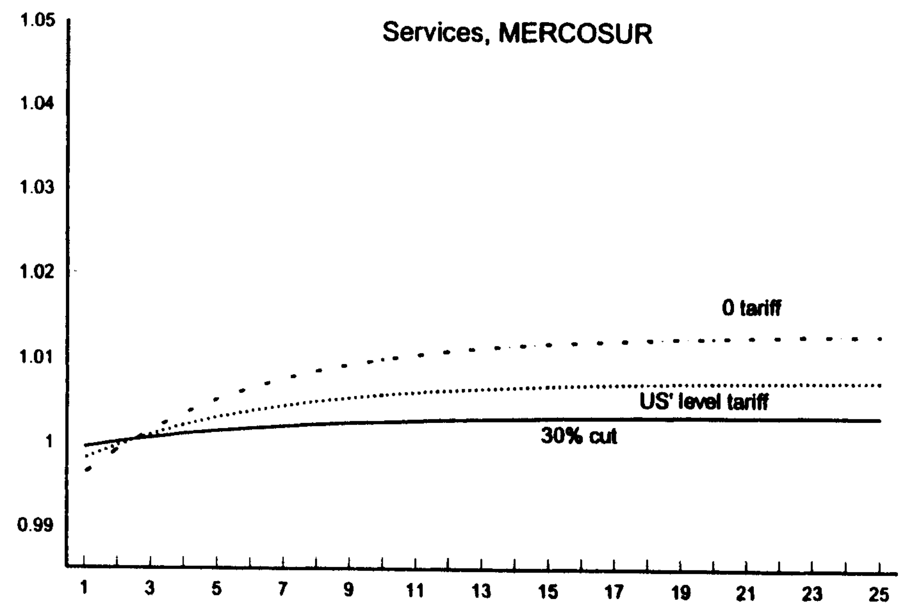
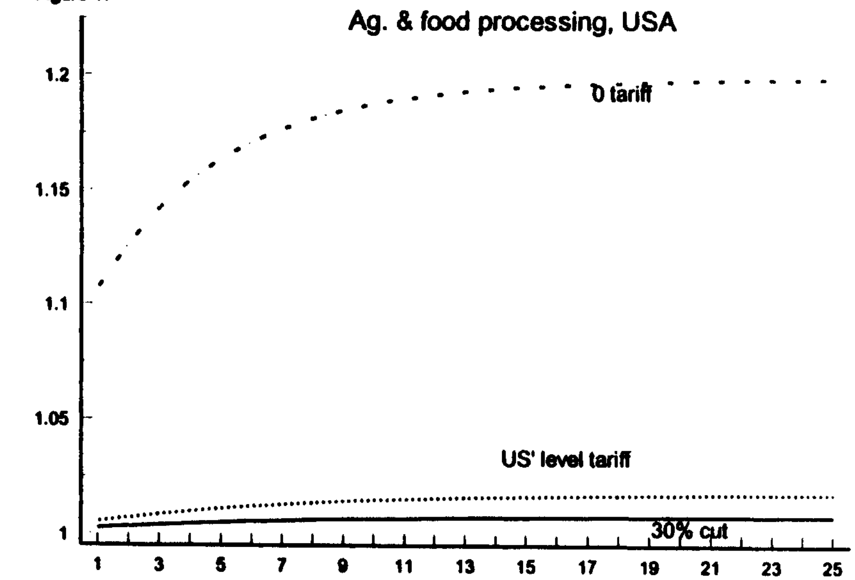


Changes in Exports after Trade Reform
(Base-run steady state is 1.00)

Figure 17



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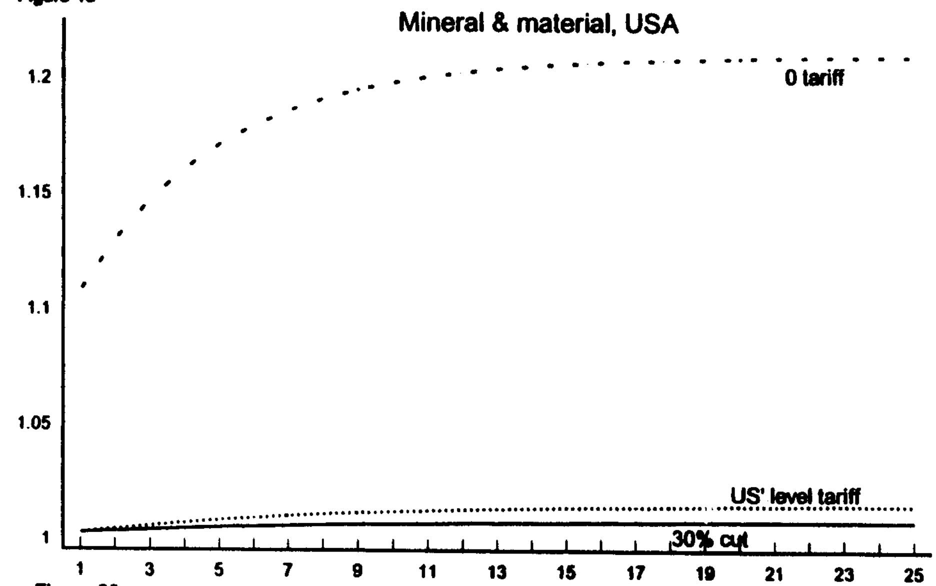

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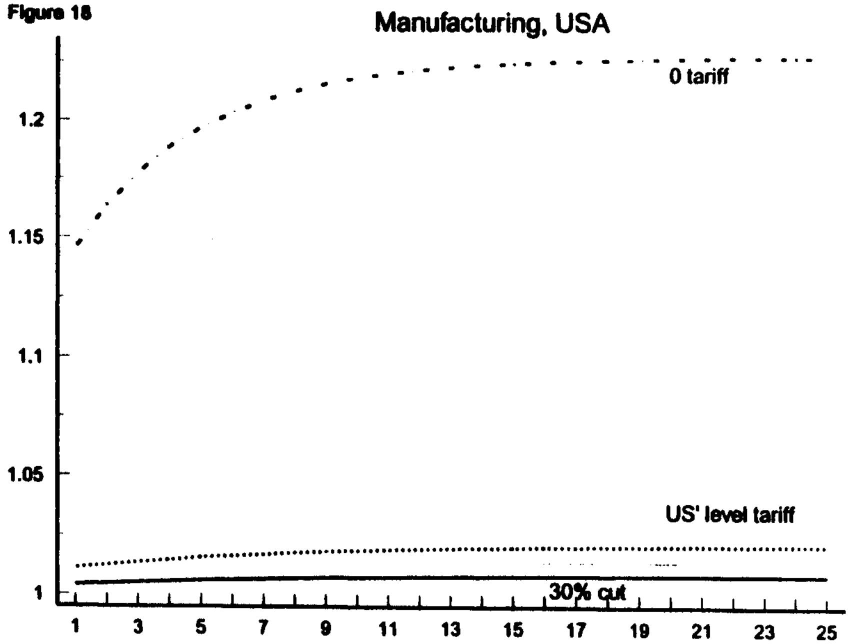

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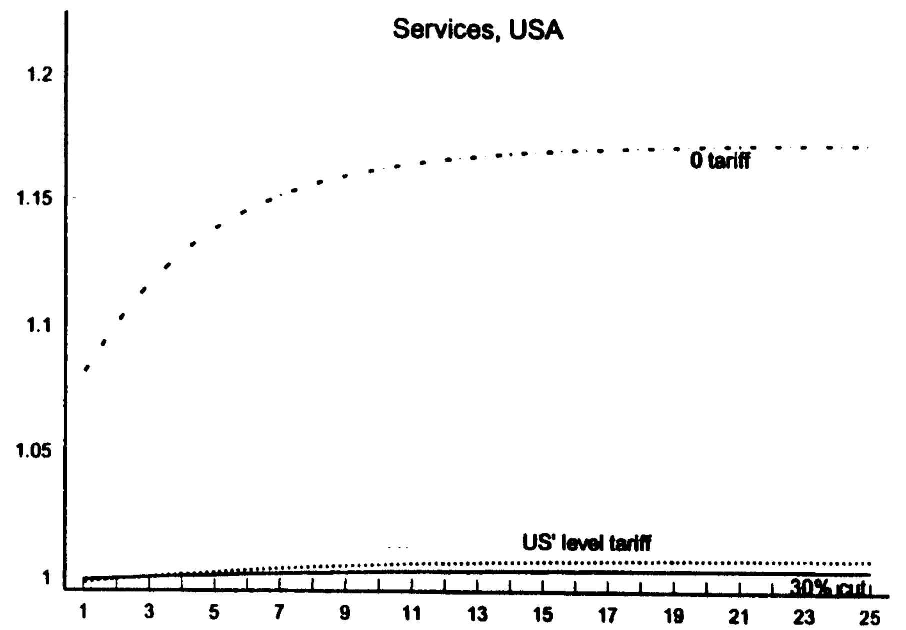
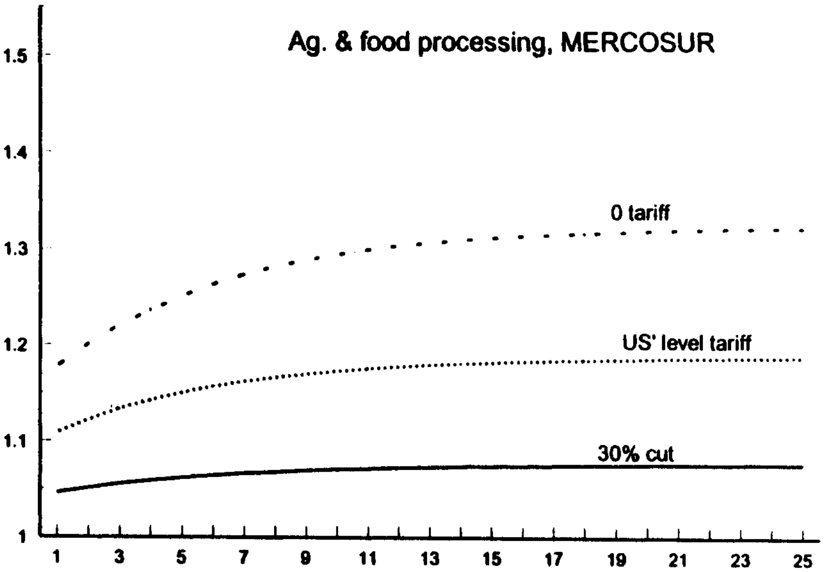


Changes in Exports after Trade Reform
(Base-run steady state is 1.00)

Figure 21



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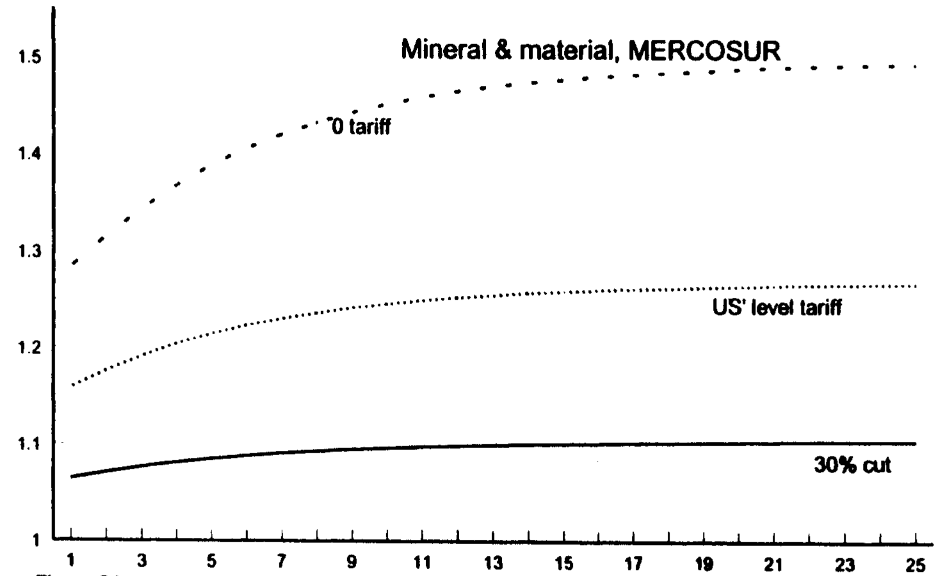

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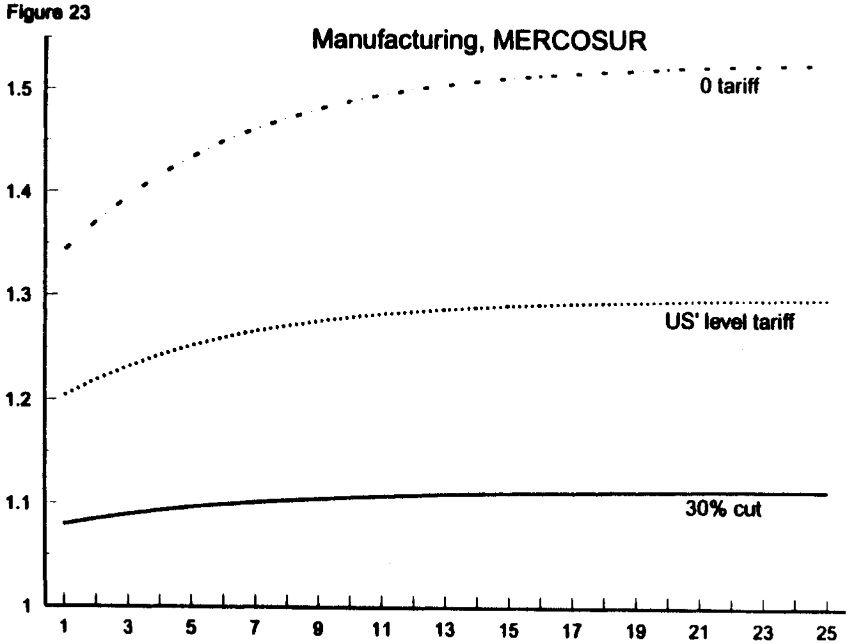

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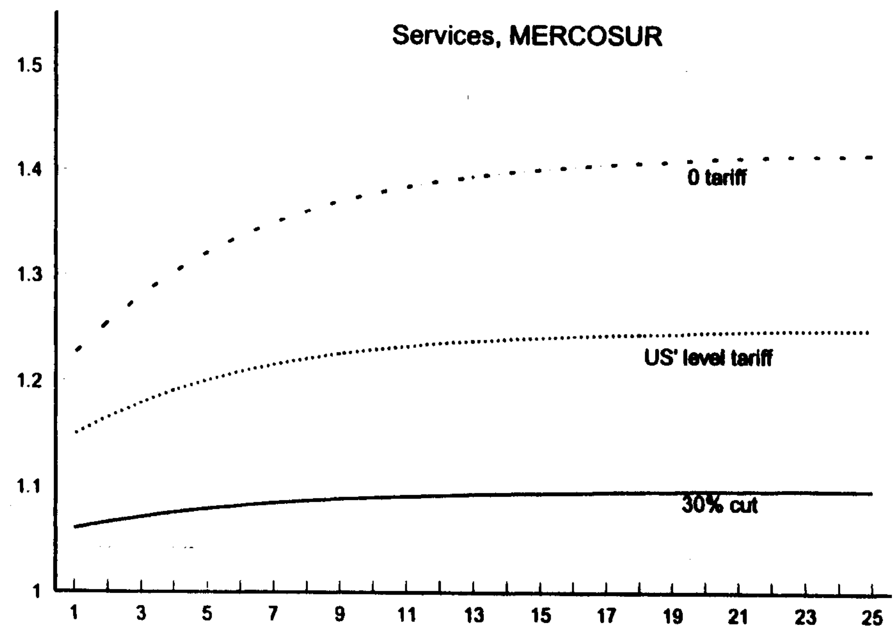
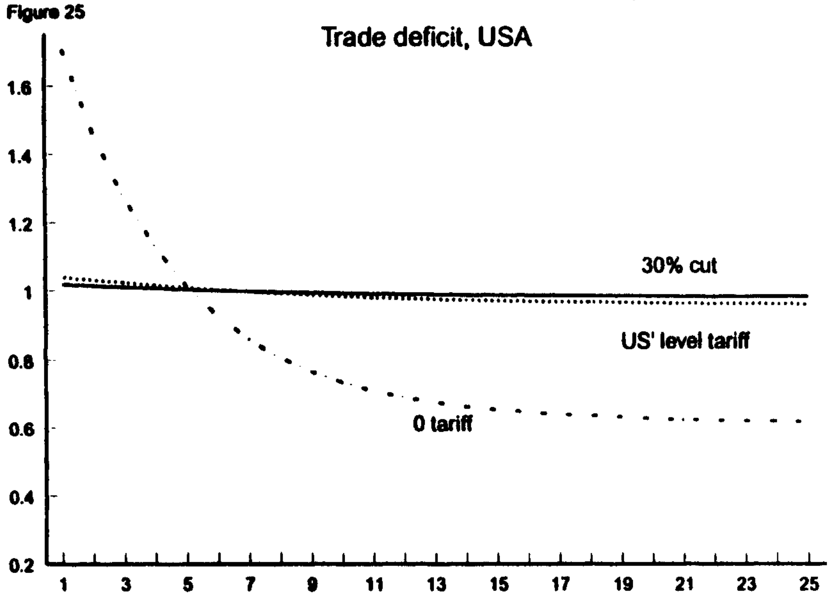


Changes in Trade deficit (Surplus) and Foreign Debt (Assets) after Trade Reform
(Base-run steady state is 1.00)

Figure 25



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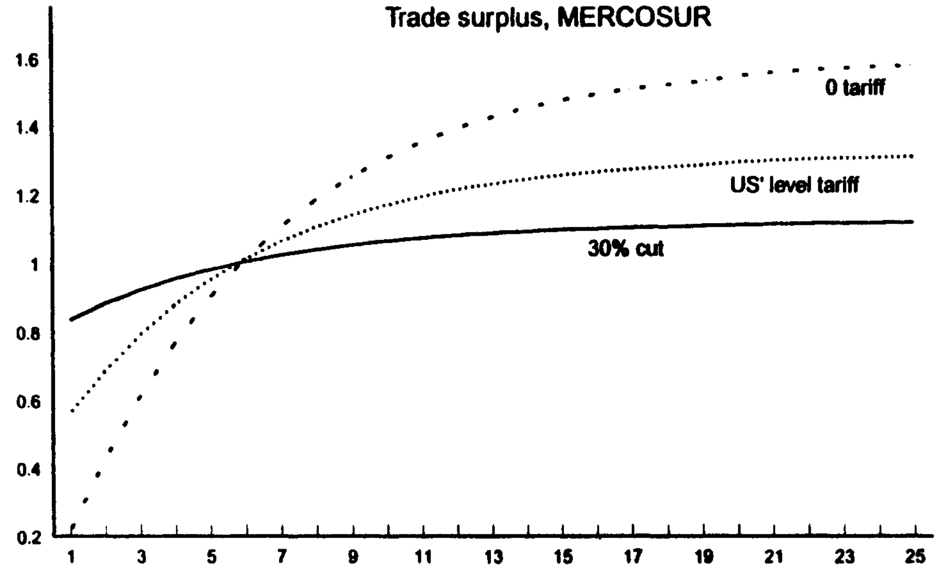

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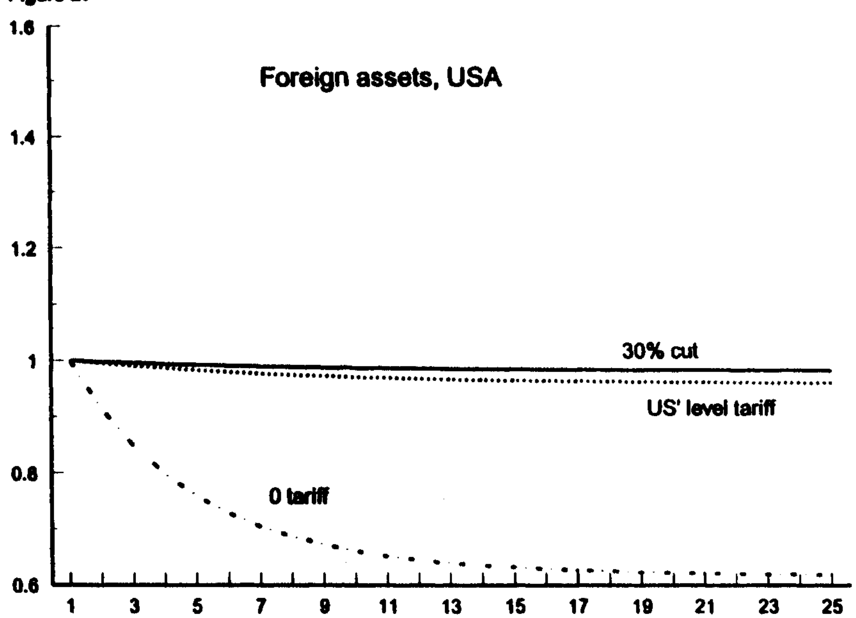

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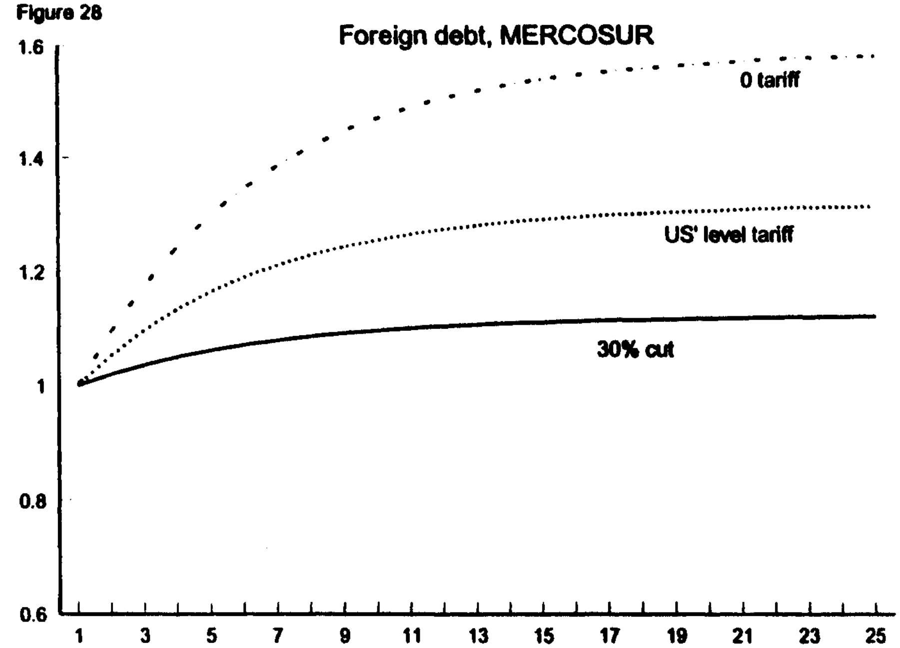


Changes in Prices of Capital goods and Rental Rates

(Eliminating tariffs in both regions, base-run steady state is 1.00)

Figure 29

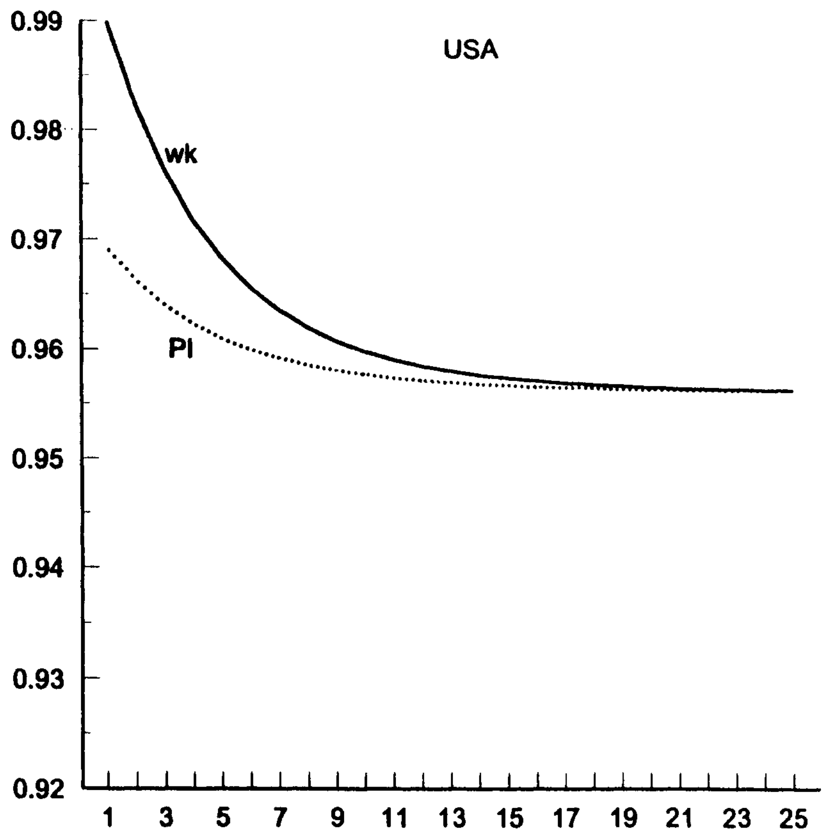
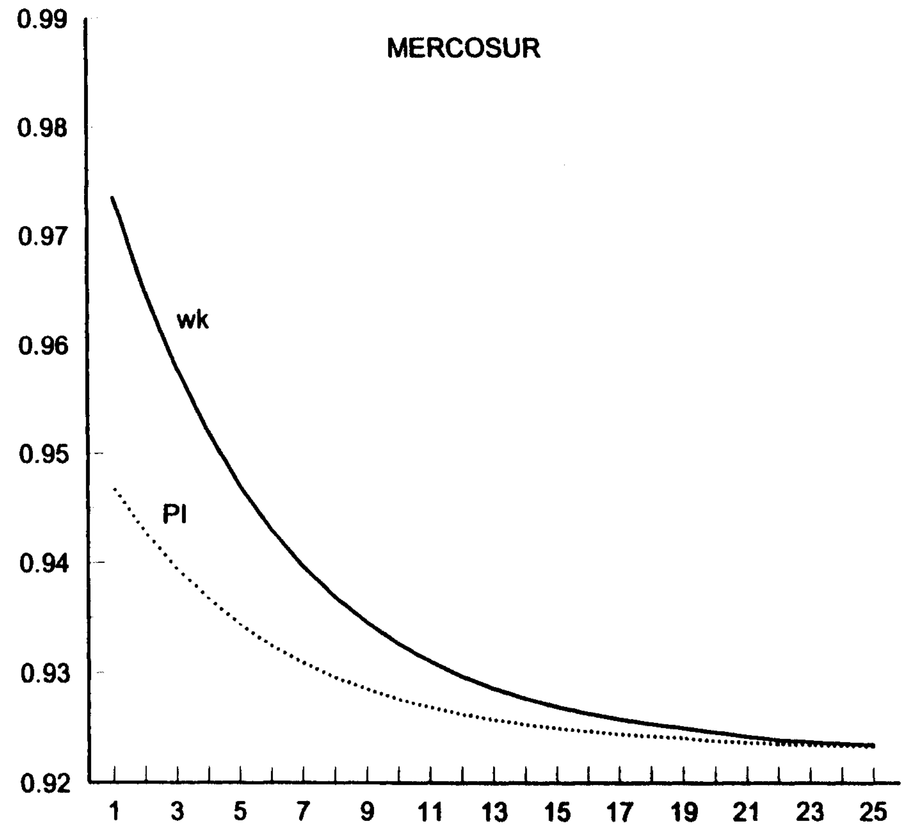


Figure 30



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