

# MACROECONOMIC INTERACTIONS BETWEEN LATIN AMERICA AND CHINA-INDIA IN A DYNAMIC INTERTEMPORAL MODEL OF THE WORLD ECONOMY

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## Abstract

This paper develops a perfect foresight dynamic intertemporal general equilibrium model of the world economy to study the nature of the short-run adjustment process and the likely quantitative impacts of economic, trade policy and financial reform developments in China and India on Latin America as a whole. A sequence of simulation experiments suggests that tariff reductions, rapid growth and financial liberalization reform in China and India have minor negative effects on GDP and technological growth, consumption and investment in Latin America and relatively stronger effects - but still small - on trade patterns, financial capital inflows, FDI and relative prices.

Trade liberalization and rapid economic growth based on productivity growth in China and India likely depress relative prices of primary commodities and manufactures produced in the developing world, causing a slight deterioration of the LAC region's terms of trade. The trade balance to GDP ratio improves slightly over the medium term as exports increase while imports fall somewhat. The destinations for Latin America exports tilt away from China and India and toward developed country markets as its export prices fall while imports from the developed world are substituted, in relative terms, with imports from China and India. Foreign direct investment flows toward Latin America fall by less than 1% relative to trend. With the emergence of China-India as a marginal net creditor to the rest of the world, FDI inflows in the future may come from this region, competing with developed countries for the role of FDI source.

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## 1. Introduction

The rapid growth and increasing integration into the international trade and financial systems of the two largest Asian economies, China and India, have been a major source of concern both in developed and developing countries during the last decade and a half. Much of the public debate and economic discussion on the global-, regional- or country-level implications of these developments has been cast in terms of a rather descriptive and partial contrast between challenges and opportunities. Up to now, this casting has paid little attention to their likely impact on Latin America and, more importantly, little attention has paid to provide quantitative assessments. It is high time to address this issue from a quantitative perspective.

This paper develops a dynamic intertemporal general equilibrium model of the world economy for analyzing the effect of China and India's economic, trade policy and financial reform developments on the Latin America region, with a focus on the linkages among trade, foreign direct investment (FDI), financial capital flows and productivity growth. In contrast to standard static trade models, our dynamic approach provides a unified framework for understanding not only long-run effects on resource allocations, relative prices, trade direction, and growth but also for understanding the dynamic path of adjustment, which is the focus of much public debate. The short-run implications for unemployment, wage inequality, balance of payments, FDI diversion, sectoral adjustment, etc. of Asian developments may not be fully understood by policymakers in the region or may be perceived as costly. The understanding of the short-run economic adjustment is critical for avoiding counterproductive policy changes in the LAC region.

The paper is structured as follows. Section 2 provides a brief description of the main features of the world economy model. Section 3 presents the formal theoretical model. Section 4 is a brief discussion of the solution algorithm. Section 5 describes the baseline calibration process and Section 6 sets up the sequence of numerical experiments and presents and discusses simulation results. Finally, Section 7 concludes.

## 2. Overview of the Model

Consider a world consisting of three regions indexed by  $j = \{1,2,3\}$  and inhabited by  $N^j$  households each. World household population is constant and normalized to unity, i.e.  $\sum_{j \in \{1,2,3\}} N^j = 1$ . Region 1 corresponds to the developed world part and is composed of the major industrial economies (including Korea, Hong Kong-China and Singapore); Region 2 comprises China and India (and also the rest of Asia) and Region 3 represents Latin America and the Caribbean. The three regions are both intratemporally and intertemporally linked by flows of trade in differentiated products - allowing for incomplete specialization in production and trade - and by flows of differentiated real assets - financial capital and foreign direct investment (FDI). Regions 2 and 3 share exactly the same underlying economic structure, differing only in how the economies are calibrated to match regional averages. Their major difference with Region 1 is based on the empirical fact that OECD countries are the primary source of FDI.<sup>1</sup> Consequently, Region 1 is the only net supplier of FDI and Regions 2 and 3 are modeled as competing net FDI importers.<sup>2</sup>

Another important difference lies in the nature of the growth process. Region 1 is modeled as the technological leader whose rate of technical progress is given by the rate at which the world technology frontier improves and is assumed constant for simplicity. Regions 2 and 3 lag behind the frontier of knowledge and benefit from a process of diffusion of innovations created in Region 1, since knowledge is considered non-rival. However, in contrast to a pure public good, knowledge is partially excludable and FDI is deemed as the main vehicle through which technology and knowledge transfers occur. Accordingly, the growth rate is determined endogenously and depends on the gap between the level of technology embodied in the stock of foreign capital in place and the

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<sup>1</sup> According to the JBIC Institute (2002) OECD countries accounted for over 90% of global outward FDI in 1998-2000.

<sup>2</sup> Empirical support to this modeling choice is also given by the JBIC Institute (2002): China and Latin America were the major recipients of FDI in 1998-2000, attracting 85% of total FDI flows outside the OECD area.

region's own level of technical efficiency. Region 1 investors fail to internalize the effect of their investment decisions abroad on productivity growth in recipient countries.

It must be noted that along the transitional path the growth rate can be accelerated by FDI inflows but along the steady-state equilibrium growth path, due to the process of technological catch up, the growth rate will be dictated by the rate of technical progress in the developed world. The idea of technology transfers through FDI has been explored by Glass and Saggi (1998) who provide a theoretical rationale for the limited ability of developing countries to attract state-of-the-art technologies through FDI. The FDI-growth nexus has been the subject of a large body of empirical literature. After appraising 16 empirical studies, the JBIC Institute (2002, p. 31) claims that the "(...) vast majority of the studies reviewed (...) indicate that FDI does make a positive contribution to both income growth and factor productivity in host countries."<sup>3</sup> The literature has also shown that the link between FDI and growth depends on the characteristics of the recipient country (degree of openness, human capital, trade regime, political and economic institutions, etc.). In the present model, the absorptive capacity and social capabilities of the host regions are taken as given.

Each region  $j$  produces two types of internationally traded goods indexed by  $i = \{L, H\}$ . Because goods with the same name but produced in different regions are regarded by consumers and producers as different goods, as imperfect substitutes, they need to be distinguished by the pair  $(j, i)$ , i.e., by industry and by place of production. Thus, consistent with trade data, the model accounts for cross-hauling: simultaneous exports and imports of goods of the same product category. Good  $i = \{L\}$  is a low-tech or primary good which is produced with domestically owned capital and unskilled labor and is used in all regions as intermediate input in the production of good  $H$ .

Good  $i = \{H\}$  is a high-tech or manufacturing good which is produced with domestically-owned capital, foreign-owned capital, skilled and unskilled labor and intermediate inputs.

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<sup>3</sup> For other and more critical assessments, see for instance Niar-Reichert and Weinhold (2001) and Nunnenkamp (2004).

Foreign ownership of productive assets introduces a wedge between GDP and GNP statistics since part of the GDP will be owed to foreign investors. In Regions 2 and 3 the production function is assumed to exhibit foreign capital-skill complementarity. The skill premium, defined as the relative price of skilled labor in terms of unskilled labor, is determined endogenously in the rational expectations equilibrium and depends positively on two forces: the ratio of unskilled to skilled employment (relative quantity effect) and the ratio of foreign-owned capital to skilled employment (foreign capital-skill complementarity effect). Imports and domestic production of the high-tech good are combined via an Armington aggregator into a single composite final good.

Each region is inhabited by three types of infinitely-lived households differing in borrowing-saving opportunities and skills.  $N^{j,w}$  households are savers or Ricardian consumers and the rest are spenders or liquidity-constrained consumers, if we make use of Mankiw's (2000) behavioral taxonomy, or they could be renamed as stakeholders and workers, respectively, if we draw on Danthine and Donaldson's (1995) terminology. Liquidity-constrained households, in turn, are disaggregated into two skill groups: skilled and unskilled workers. An exogenous fraction  $N^{j,s}$  of the labor force is skilled and the rest is unskilled.

The Ricardian/Non-Ricardian dichotomy has been introduced in the literature to overcome the failure of the Barro-Ramsey model (and the Diamond-Samuelson model) to explain why consumption follows closely the evolution of current income and the fact that many households have net worth near zero. High-wealth households save and consume but do not work, smooth consumption over time by trading in physical and financial assets and act in an optimizing, forward looking manner. They own all the low- and high-tech firms and the final good firm and are entitled to claim any profits that may result. Spenders or low-wealth households follow the rule of thumb of consuming their disposable labor income every period and do not save or borrow, rendering consumption smoothing unfeasible.

Furthermore, the two types of salaried workforce face different labor market structures. Skilled labor is inelastically supplied to the manufacturing sector and the corresponding wage is set in a perfectly competitive market. The market for unskilled labor is characterized by a real wage rigidity that arises from a right-to-manage bargaining process between firms and workers (Nickell and Andrews, 1983; Layard, Nickell and Jackman, 1991). In a right-to-manage framework a union represents all unskilled workers and the union and the firms bargain over wages but the level of employment, and thereby the level of equilibrium unemployment, is unilaterally determined by the firms. It is assumed that a fraction  $N_L^{j,u}$  of the unskilled labor force is available for work in the low-tech producing sector and the rest  $N_H^{j,u}$ , with  $N_L^{j,u} + N_H^{j,u} = 1$ , is available for work in the high-tech sector.

This general equilibrium framework can be used to study a wide range of policy issues in dynamic macroeconomics. This paper develops a model of the world economy for understanding and analyzing the effect on short-run adjustment as well as on long-run resource allocation in Latin America of China and India's growth developments and deeper integration into the international economic system. To model trade liberalization, it is assumed that each region has a government that levies tariffs on commodity imports and rebates collected revenues back to (high-wealth) households as lump-sum transfer payments. At the world equilibrium, all prices and quantities are determined endogenously such that firms, unions and households maximize and individual, regional and world resource constraints are satisfied. Regional current account imbalances are exactly offset by capital flows, reflecting the region's change in the net international investment position, and the equilibrium world interest rate is consistent with financial assets in zero net supply worldwide.

### **3. Model Formulation**

This section provides a detailed description of the world economy model. To avoid overly cumbersome notation, various conventions are adopted throughout the paper. First, although, in principle, model parameters vary across regions, their dependence on

the index  $j$ , that denotes the particular region, is not written explicitly. This shortcut should cause no confusion. Second, all variables are measured in regional per capita terms (unless otherwise stated) and no population growth is allowed. Third, following convention, region-wide, per capita aggregates are represented by capital letters while variables under the household's control are denoted by lower case letters. The exceptions are relative prices and rental rates which are written in lower case. In equilibrium, individual choices and the corresponding aggregate counterparts should be identical. Further, time is discrete and indexed by  $t$ ,  $t = 1, 2, \dots, \infty$ , and each period  $t$  in the model is assumed to be one year. The numeraire good is the good  $H$  produced in Region 1 whose price is fixed at 1,  $\forall t$ . All agents are assumed to be endowed with perfect foresight over the future path of trade policies.

### 3.1 The Developing World: Regions 2 and 3 ( $j = \{2, 3\}$ )

#### 3.1.1 Technical Progress

Let  $Z_t^j$  represent an index of labor-augmenting technological progress. Region 1 is the technological leader and expands the world technology (knowledge) frontier at a constant gross rate  $\eta^1$ :  $Z_{t+1}^1 = \eta^1 Z_t^1$ . The technology of follower regions, Regions 2 and 3, is determined by catch-up opportunities described by:

$$Z_t^j = (F_t^j)^{\alpha_z} (Z_{t-1}^j)^{1-\alpha_z} \quad j = \{2, 3\}$$

for  $\alpha_z$ ,  $1 > \alpha_z > 0$ , being a measure of the speed of diffusion. This specification implies that the current level of technology results from combining the technology of the lead region and that reached so far by followers. It is assumed that technology is ingrained in the level of foreign capital in place, where  $F_t^j$  is the stock of capital per inhabitant of Region  $j$  owned by Region 1 investors. Since  $\eta_t^j = Z_t^j / Z_{t-1}^j$ , an expression for the law of motion of the gross rate of growth can be obtained:

$$\log \eta_t^j = \alpha_z \left( \log \eta^1 + \log \left( \frac{F_t^j / Z_t^1}{F_{t-1}^j / Z_{t-1}^1} \right) \right) + (1 - \alpha_z) \log \eta_{t-1}^j \quad j = \{2,3\} \quad (1)$$

The growth rate is one of the state variables of the model and its steady state value is  $\eta^j = \eta^1$ . The stationary representation of the model, which can be derived by normalizing all growing per-capita variables by the regional index of technical progress, has a well-defined steady state where  $F_t^j / Z_t^1 = F_{t-1}^j / Z_{t-1}^1$ . Along the transition path, however, FDI may accelerate growth.

### 3.1.2 Firms and Technologies

The representative firm in the low-tech producing sector specializes in the production of an internationally traded intermediate good. The firm solves a succession of static profit maximization problems:

$$\begin{aligned} \max \quad & \Pi_{L,t}^j = p_{L,t}^j Y_{L,t}^j - w_t^{j,u} N_L^{j,u} E_{L,t}^{j,u} - r_{L,t}^j K_{L,t}^j \\ \text{subject to} \quad & E_{L,t}^{j,u}, K_{L,t}^j > 0 \quad j = \{2,3\} \end{aligned} \quad (P1)$$

where  $p_{L,t}^j$ ,  $w_t^{j,u}$  and  $r_{L,t}^j$  denote respectively the relative factory gate price of the intermediate good produced in Region  $j$ , the wage of the unskilled worker and the rental price of domestically-owned capital put in place at time  $t$  in sector  $L$ .  $\Pi_{L,t}^j$  represents the profits of the firm, expressed in per capita terms, and  $N_L^{j,u}$  the size of the labor force of unskilled workers available for work in sector  $L$ . To maximize profits the firm rents capital ( $K_{L,t}^j$ ) in a competitive market and determines the level of employment among the unskilled ( $E_{L,t}^{j,u}$ ), once this period's wage bargaining process - to be described shortly - has concluded.

The representative firm in the high-tech producing sector specializes in the production of an internationally traded good. This firm maximizes profits, period by period:

$$\begin{aligned} \max \quad & \Pi_{H,t}^j = p_{H,t}^j Y_{H,t}^j - w_t^{j,u} N_H^{j,u} E_{H,t}^{j,u} - w_t^{j,s} N_H^{j,s} E_{H,t}^{j,s} - r_{H,t}^j K_{H,t}^j - (r_{F,t}^j + \psi_t^j) F_t^j - \sum_{k \in \{1,2,3\}} p_{L,t}^{k,j} Y_{L,t}^{k,j} \\ \text{subject to} \quad & E_{H,t}^{j,u}, E_{H,t}^{j,s}, K_{H,t}^j, F_t^j, Y_{L,t}^{1,j}, Y_{L,t}^{2,j}, Y_{L,t}^{3,j} > 0 \quad j = \{2,3\} \end{aligned} \quad (P2)$$

where  $p_{H,t}^j$  is the relative price of the manufacturing good produced in Region  $j$ ,  $E_{H,t}^{j,u}$  and  $E_{H,t}^{j,s}$  denote the level of employment of unskilled and skilled workers in sector  $H$ ;  $N_H^{j,u}$  and  $N_H^{j,s}$  denote the size of the labor force of unskilled and skilled workers available for work in that sector and  $w_t^{j,u}$  and  $w_t^{j,s}$  are the corresponding wage rates measured in terms of the numeraire. As mentioned before, unskilled wages and employment are determined according to a right-to-manage bargaining process and skilled wages are determined in a competitive market, and in equilibrium adjust so that demand and supply of skilled labor match, i.e.  $E_t^{j,s} = 1 \quad \forall t$ , since the labor endowment is normalized to unity and supplied inelastically.  $K_{H,t}^j$  and  $F_t^j$  denote the stock of capital owned by residents and by foreign investors, both put in place for production in sector  $H$ .  $r_{H,t}^j$  and  $r_{F,t}^j$  are the relative rental prices of domestically- and foreign-owned capital and  $\psi_t^j$  is an exogenously given risk premium demanded by foreign investors for investment in Region  $j$ .

$Y_{L,t}^{k,j}$  is the amount of intermediate good per inhabitant of Region  $j$  used in Region  $j$  and produced in Region  $k$ ,  $k \in \{1,2,3\}$ .  $p_{L,t}^{k,j}$  is the relative price paid by the  $H$ -sector firm for the Region  $k$ 's intermediate input used in or imported by Region  $j$ . Note that the price of the intermediate good produced and sold domestically satisfies  $p_{L,t}^{j,j} = p_{L,t}^j$ , while the domestic price of imports is equal to the world price adjusted for tariffs, i.e.  $p_{L,t}^{k,j} = (1 + \tau_{L,t}^{k,j}) p_{L,t}^k$ , where  $\tau_{L,t}^{k,j}$  represents bilateral tariff and non-tariff barriers applied to imports from Region  $k$  sold in Region  $j$ .

Both production technologies exhibit constant returns to scale. Value added in sector  $L$  ( $Y_{L,t}^j$ ) is given by the following Cobb-Douglas production function:

$$Y_{L,t}^j = A_L (K_{L,t}^j)^{\alpha_L} (Z_t^j N_L^{j,u} E_{L,t}^{j,u})^{1-\alpha_L} \quad j = \{2,3\} \quad (2)$$

for  $A_L > 0$  and  $1 > \alpha_L > 0$  for  $\forall j$ .  $A_L$  is a scaling factor and  $\alpha_L$  is the capital share. Gross production in sector H ( $Y_{H,t}^j$ ) is described by a two-level CES function. The top level combines a valued added component ( $VA_{H,t}^j$ ) and an intermediate good component ( $S_{H,t}^j$ ):

$$Y_{H,t}^j = A_H \left\{ \omega_Y (VA_{H,t}^j)^{\sigma_Y} + (1 - \omega_Y) (S_{H,t}^j)^{\sigma_Y} \right\}^{\frac{1}{\sigma_Y}} \quad j = \{2,3\} \quad (3)$$

for  $1 \geq \omega_Y \geq 0$ ,  $A_H > 0$  and  $\sigma_Y \in (-\infty, 0) \cup (0, 1)$  for  $\forall j$ .  $\omega_Y$  is a parameter determining the share of the two components,  $\sigma_Y$  is the substitution parameter determining the elasticity of substitution between the value added and intermediate goods, given by  $1/(1 - \sigma_Y)$ , and  $A_H$  is a shift parameter.

At the lower level of production, the value added component is described by a nested CES technology:

$$VA_{H,t}^j = A_V (K_{H,t}^j)^{\alpha_H} \left[ \omega_V (Z_t^j N_H^{j,u} E_{H,t}^{j,u})^{\sigma_V} + (1 - \omega_V) \left\{ \omega_\lambda (F_t^j)^{\sigma_\lambda} + (1 - \omega_\lambda) (Z_t^j N_H^{j,s} E_{H,t}^{j,s})^{\sigma_\lambda} \right\}^{\frac{\sigma_V}{\sigma_\lambda}} \right]^{\frac{(1-\alpha_H)}{\sigma_V}} \quad j = \{2,3\} \quad (4)$$

for  $1 \geq \omega_V, \omega_\lambda \geq 0$ ,  $A_V > 0$ ,  $(\sigma_V, \sigma_\lambda) \in (-\infty, 0) \cup (0, 1)$  for  $\forall j$ . As before, these are parameters of distribution, scale and substitution, respectively.  $\alpha_H \in (0, 1)$  denotes the share in output of capital owned by residents. The elasticity of substitution between foreign capital and unskilled labor is  $1/(1 - \sigma_V)$  and the elasticity of substitution between foreign capital and skilled labor is  $1/(1 - \sigma_\lambda)$ . Foreign capital-skill complementarity holds when the elasticity of substitution between foreign capital and unskilled labor is higher than that between foreign capital and skilled labor.

The equilibrium skill premium associated with this technology is given by:

$$\frac{w_t^{j,s}}{w_t^{j,u}} = \frac{(1-\omega_v)(1-\omega_\lambda)}{\omega_v} \left[ \omega_\lambda \left( \frac{F_t^j}{N^{j,s}} \right)^{\sigma_\lambda} + (1-\omega_\lambda) \right]^{\frac{\sigma_v}{\sigma_\lambda}-1} \left( \frac{N_H^{j,u} E_{H,t}^{j,u}}{N^{j,s}} \right)^{1-\sigma_v} \quad j = \{2,3\} \quad (5)$$

If  $\sigma_v > \sigma_\lambda$ , the production function exhibits foreign capital-skill complementarity, and the skill premium increases with a rise in the stock of foreign capital relative to skilled employment (foreign capital-skill complementarity effect) and increases with a rise in unskilled employment relative to skilled employment (relative quantity effect) (see Krusell et al., 2000).

At the first level of production the other component is an aggregate intermediate input, which is an Armington composite good:

$$S_{H,t}^j = A_S \left( \sum_{k \in \{1,2,3\}} \omega_{k,S} (Y_{L,t}^{k,j})^{\sigma_S} \right)^{\frac{1}{\sigma_S}} \quad j = \{2,3\} \quad (6)$$

for  $1 \geq \omega_{k,S} \geq 0$ ,  $A_S > 0$ ,  $\sigma_S \in (-\infty, 0) \cup (0, 1)$  for  $\forall j$ . Without loss of generality the  $\omega_{k,S}$ 's are constrained to sum to one. The composite intermediate input is simply an aggregate of intermediate goods produced in the three regions.

Finally, the representative retailer firm in the final good sector uses type-H goods, both domestically produced and imported, as inputs to produce a composite final good. The retailer firm solves the following problem:

$$\begin{aligned} \max \quad & \Pi_{R,t}^j = p_{R,t}^j Y_{R,t}^j - \sum_{k \in \{1,2,3\}} p_{H,t}^{k,j} Y_{H,t}^{k,j} \\ \text{subject to} \quad & Y_{H,t}^{1,j}, Y_{H,t}^{2,j}, Y_{H,t}^{3,j} > 0 \quad j = \{2,3\} \end{aligned} \quad (P3)$$

where  $Y_{H,t}^{k,j}$  is the amount of good H per inhabitant of Region j used by Region j retailer and produced in Region k.  $p_{H,t}^{k,j}$  is the relative price paid for the Region k's good H used in or imported by Region j. The price of good H produced and sold domestically satisfies:  $p_{H,t}^{j,j} = p_{H,t}^j$  and  $p_{H,t}^{1,1} = p_{H,t}^1 = 1$ , while the domestic price of imports is equal to the corresponding world price adjusted for tariffs, i.e.  $p_{H,t}^{k,j} = (1 + \tau_{H,t}^{k,j})p_{H,t}^k$ , where  $\tau_{H,t}^{k,j}$  represents bilateral tariff and non-tariff barriers applied to imports from Region k sold in Region j.  $Y_{R,t}^j$  is an Armington aggregator:

$$Y_{R,t}^j = A_R \left( \sum_{k \in \{1,2,3\}} \omega_{k,R} (Y_{H,t}^{k,j})^{\sigma_R} \right)^{\frac{1}{\sigma_R}} \quad j = \{2,3\} \quad (7)$$

where  $\sigma_R$  determines the Armington substitution elasticity and the  $\omega_{k,R}$ 's are Armington aggregator weights. The final good is simply an aggregate of type-H goods produced worldwide.

### 3.1.3 The Ricardian Household

In each region j there are  $N^{j,w}$  Ricardian households. This subsection specifies the general problem faced by a representative saver/consumer. Note that in what follows all variables are expressed not in per-capita terms over the whole population in the region but in per-capita terms defined over the subset of high-wealth households. The representative high-wealth household optimally chooses plans for consumption ( $\{c_t^{j,w}\}_{t=0}^{\infty}$ ), investment in physical capital in sector L ( $\{i_{L,t}^{j,w}\}_{t=0}^{\infty}$ ) and investment in physical capital in sector H ( $\{i_{H,t}^{j,w}\}_{t=0}^{\infty}$ ) to maximize its discounted lifetime utility:

$$\max \sum_{t=0}^{\infty} \beta^t \log(c_t^{j,w} - \bar{C}^j Z_t^j) \quad (8)$$

subject to

$$d_{t+1}^{j,w} = (1+r_t)d_t^{j,w} + p_{R,t}^j [c_t^{j,w} + i_{L,t}^{j,w} + i_{H,t}^{j,w}] - r_{L,t}^j k_{L,t}^{j,w} - r_{H,t}^j k_{H,t}^{j,w} - \Pi_t^{j,w} - T_t^{j,w} \quad (9)$$

$$k_{L,t+1}^{j,w} = (1-\delta)k_{L,t}^{j,w} + i_{L,t}^{j,w} - \left( \frac{\varphi_L}{2} \right) \left[ \frac{i_{L,t}^{j,w}}{k_{L,t}^{j,w}} - (\eta^1 - 1 + \delta) \right]^2 k_{L,t}^{j,w} \quad (10)$$

$$k_{H,t+1}^{j,w} = (1-\delta)k_{H,t}^{j,w} + i_{H,t}^{j,w} - \left( \frac{\varphi_H}{2} \right) \left[ \frac{i_{H,t}^{j,w}}{k_{H,t}^{j,w}} - (\eta^1 - 1 + \delta) \right]^2 k_{H,t}^{j,w} \quad (11)$$

$$k_{L,0}^{j,w}, k_{H,0}^{j,w} \quad \text{given} \quad j = \{2,3\} \quad (P4)$$

for  $1 > (\beta, \delta) > 0$  and  $(\varphi_L, \varphi_H) \geq 0$  for  $\forall j$ .  $\beta$  is the subjective discount factor,  $\delta$  is the depreciation rate,  $\varphi_L$  and  $\varphi_H$  are sectoral adjustment cost parameters, and  $\bar{C}^j > 0$  denotes the minimum level of stationary consumption per period in region  $j$ .  $d_t^{j,w}$  denotes the stock of foreign debt,  $\Pi_t^{j,w}$  is the sum of profits earned by all firms and claimed by high-wealth households and  $T_t^{j,w}$  denotes all types of government transfers, all expressed in terms of the numeraire good per high-wealth household. Equation (9) is the household's budget constraint and equations (10) and (11) are sectoral physical capital accumulation laws with capital stocks subject to adjustment costs along the transition path. The high-wealth household has access to a competitive world capital market for non-contingent one-period real bonds where it can save and borrow at the world interest rate  $r_t$ , expressed in terms of the numeraire. Savings, investments and financial capital flows are all the result of forward looking, intertemporal optimization decisions.

#### 3.1.4 Skilled- and Unskilled-Wage Earners

There are  $N^{j,s}$  skilled and  $N^{j,u}$  unskilled workers and each of them is endowed with one unit of time that is inelastically supplied. Skilled and unskilled wage earners do not borrow or save and have only to decide how much to consume every period. The representative skilled worker solves the following static maximization problem:

$$\begin{aligned}
& \max \log(c_t^{j,s} - \bar{C}^j Z_t^j) \\
& \text{subject to } p_{R,t}^j c_t^{j,s} \leq w_t^{j,s} \\
& c_t^{j,s} \geq \bar{C} Z_t^j \quad j = \{2,3\}
\end{aligned} \tag{P5}$$

On the other hand, some of the unskilled workers suitable for work in sector  $i$ ,  $i = \{L, H\}$ , are employed and some unemployed. Employed workers earn a net wage  $(1 - \tau^{j,u}) w_t^{j,u}$  and unemployed workers receive unemployment benefits  $b_t^{j,u}$ , satisfying  $(1 - \tau^{j,u}) w_t^{j,u} > b_t^{j,u}$  and  $b_t^{j,u} = \zeta^j w_t^{j,u}$  where  $\zeta^j$  is the gross wage replacement ratio. Unemployment benefits are financed by taxes levied on unskilled wage income. Formally, the unskilled worker solves the following problem:

$$\max \log(c_{i,t}^{j,u} - \bar{C}^j Z_t^j)$$

subject to

$$\begin{aligned}
p_{R,t}^j c_{i,t}^{j,u} &\leq (1 - \tau^{j,u}) w_t^{j,u} && \text{if employed} \\
p_{R,t}^j c_{i,t}^{j,u} &\leq b_t^{j,u} && \text{if unemployed} \\
c_{i,t}^{j,u} &\geq \bar{C} Z_t^j \quad i = \{L, H\} \quad j = \{2,3\}
\end{aligned} \tag{P6 and P7}$$

The budget of the unemployment compensation system is balanced:

$$T_t^{j,u} = \tau^{j,u} E_t^{j,u} w_t^{j,u} - \zeta^j (1 - E_t^{j,u}) w_t^{j,u} \tag{12}$$

where  $E_t^{j,u}$  is the average employment rate among the unskilled workers,  $E_t^{j,u} = N_L^{j,u} E_{L,t}^{j,u} + N_H^{j,u} E_{H,t}^{j,u}$ , and  $T_t^{j,u}$  is a government transfer.

### 3.1.5 Union Wage Bargaining

The interaction between firms and unskilled workers to determine wages and employment is based on a version of the right-to-manage bargaining model in which a union, that represents all unskilled workers, is assumed to exercise monopoly power to determine wages so as to maximize the expected utility of its members and firms have the right-to-manage power to determine how many workers to employ once wages have been set.

The industry-L union maximizes total expected utility which is a function of the utility derived by a representative union member under alternative employment/unemployment options. With probability  $E_{L,t}^{j,u}$  the worker will be hired in sector L and earn a net wage  $(1 - \tau_L^{j,u}) w_{L,t}^{j,u}$  and with probability  $(1 - E_{L,t}^{j,u})$  she will not be hired in that sector. Still in this case she has outside options. With probability  $E_{H,t}^{j,u}$  she can be hired in sector H and earn a net wage  $(1 - \tau_H^{j,u}) w_{H,t}^{j,u}$  or with probability  $(1 - E_{H,t}^{j,u})$  she can remain unemployed and receive unemployment benefits for  $b_{H,t}^{j,u}$ . The union maximizes its objective function with respect to  $w_{L,t}^{j,u}$  subject to the constraint that wage-employment outcomes, determined by unions and firms, are on the labor demand curve and taking as given the alternative wage. Formally, the optimal wage solves the union's problem:

$$\max N_L^{j,u} \left[ \begin{aligned} & E_{L,t}^{j,u} \log \left( \frac{(1 - \tau_L^{j,u}) w_{L,t}^{j,u}}{p_{R,t}^j Z_t^j} - \bar{C}^j \right) + \\ & (1 - E_{L,t}^{j,u}) \left\{ E_{H,t}^{j,u} \log \left( \frac{(1 - \tau_H^{j,u}) w_{H,t}^{j,u}}{p_{R,t}^j Z_t^j} - \bar{C}^j \right) + (1 - E_{H,t}^{j,u}) \log \left( \frac{1}{p_{R,t}^j} \frac{b_{H,t}^{j,u}}{Z_t^j} - \bar{C}^j \right) \right\} \end{aligned} \right]$$

subject to

$$E_{L,t}^{j,u} = \left[ \frac{(1-\alpha_L)}{\frac{1}{p_{L,t}^j} \frac{w_{L,t}^{j,u}}{Z_t^j}} \right]^{\frac{1}{\alpha_L}} \left( \frac{K_{L,t}^j}{Z_t^j} \right) \left( \frac{1}{N_{L,t}^{j,u}} \right) \quad j = \{2,3\} \quad (P8)$$

where the constraint is the firm's labor demand determined by the first order condition (problem P1) that the real wage be equal to the marginal product of labor. At a symmetric equilibrium, wages are the same for all bargaining industry unions ( $w_{L,t}^{j,u} = w_{H,t}^{j,u} = w_t^{j,u}$ ).<sup>4</sup> Note that it is a static right-to-manage model because future effects on employment are not internalized when taking today's decisions.

### 3.2 The Developed Region ( $j = 1$ )

Though Region 1 has a similar economic structure, there are by now some obvious differences between the economies in developed and developing regions. This section makes a list of those differing features.

- 1) The growth rate of productivity in Region 1, the technological leader, is exogenous and constant:

$$\eta_t^1 = \eta^1 \quad \forall t \quad (1')$$

- 2) There is no demand for foreign capital from high-tech firms in Region 1. Hence, their maximization problem changes slightly:

$$\begin{aligned} \max \quad \Pi_{H,t}^1 &= p_{H,t}^1 Y_{H,t}^1 - w_t^{1,u} N_H^{1,u} E_{H,t}^{1,u} - w_t^{1,s} N^{1,s} E_t^{1,s} - r_{H,t}^1 K_{H,t}^1 - \sum_{k \in \{1,2,3\}} p_{L,t}^{k,1} Y_{L,t}^{k,1} \\ \text{subject to} \quad & E_{H,t}^{1,u}, E_t^{1,s}, K_{H,t}^1, Y_{L,t}^{1,1}, Y_{L,t}^{2,1}, Y_{L,t}^{3,1} > 0 \end{aligned} \quad (P2')$$

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<sup>4</sup> At the symmetric equilibrium we also have:  $\tau_L^{j,u} = \tau_H^{j,u} = \tau^{j,u}$  and  $b_{L,t}^{j,u} = b_{H,t}^{j,u} = b_t^{j,u}$ .

- 3) Consequently, the production function does not display foreign capital-skill complementarity:

$$VA_{H,t}^1 = A_v (K_{H,t}^1)^{\alpha_H} \left[ \omega_v (Z_t^1 N_H^{1,u} E_{H,t}^{1,u})^{\sigma_v} + (1 - \omega_v) (Z_t^j N^{j,s} E_t^{j,s})^{\sigma_v} \right]^{\frac{(1-\alpha_H)}{\sigma_v}} \quad (4')$$

- 4) And the skill premium does not exhibit a foreign capital-skill complementarity effect:

$$\frac{w_t^{1,s}}{w_t^{1,u}} = \frac{(1 - \omega_v)}{\omega_v} \left( \frac{N_H^{1,u} E_{H,t}^{1,u}}{N^{1,s}} \right)^{1-\sigma_v} \quad (5')$$

- 5) In contrast to other regions, the representative Ricardian household in Region 1 has to decide over FDI outflows and how to allocate them between Regions 2 and 3, since the developed world is modeled as the only net supplier of productivity-enhancing FDI. Thus, the Ricardian household optimally chooses plans for FDI in the two developing regions  $(\{i_{F,t}^2, i_{F,t}^3\}_{t=0}^{\infty})$ . The maximization intertemporal program is now the following:

$$\max \sum_{t=0}^{\infty} \beta^t \log(c_t^{1,w} - \bar{C}^1 Z_t^1) \quad (8')$$

subject to

$$d_{t+1}^{1,w} = (1 + r_t) d_t^{1,w} + p_{R,t}^1 \left[ c_t^{1,w} + i_{L,t}^{1,w} + i_{H,t}^{1,w} + \left( \frac{N^2}{N^{1,w}} \right) i_{F,t}^2 + \left( \frac{N^3}{N^{1,w}} \right) i_{F,t}^3 \right] - r_{L,t}^1 k_{L,t}^{1,w} - r_{H,t}^1 k_{H,t}^{1,w} - r_{H,t}^1 k_{H,t}^{1,w} - \left( \frac{N^2}{N^{1,w}} \right) (R_{F,t}^2 + \psi_t^2) F_t^2 - \left( \frac{N^3}{N^{1,w}} \right) (R_{F,t}^3 + \psi_t^3) F_t^3 - \Pi_t^{1,w} - T_t^{1,w} \quad (9')$$

$$k_{L,t+1}^{1,w} = (1 - \delta) k_{L,t}^{1,w} + i_{L,t}^{1,w} - \left( \frac{\phi_L}{2} \right) \left[ \frac{i_{L,t}^{1,w}}{k_{L,t}^{1,w}} - (\eta^1 - 1 + \delta) \right]^2 k_{L,t}^{1,w} \quad (10')$$

$$k_{H,t+1}^{1,w} = (1-\delta)k_{H,t}^{1,w} + i_{H,t}^{1,w} - \left(\frac{\Phi_H}{2}\right) \left[ \frac{i_{H,t}^{1,w}}{k_{H,t}^{1,w}} - (\eta^1 - 1 + \delta) \right]^2 k_{H,t}^{1,w} \quad (11')$$

$$F_{t+1}^2 = (1-\delta)F_t^2 + i_{F,t}^2 - \left(\frac{\Phi_{F2}}{2}\right) \left[ \frac{i_{F,t}^2}{F_t^2} - (\eta^1 - 1 + \delta) \right]^2 F_t^2 \quad (13)$$

$$F_{t+1}^3 = (1-\delta)F_t^3 + i_{F,t}^3 - \left(\frac{\Phi_{F3}}{2}\right) \left[ \frac{i_{F,t}^3}{F_t^3} - (\eta^1 - 1 + \delta) \right]^2 F_t^3 \quad (14)$$

$$k_{L,0}^{j,w}, k_{H,0}^{j,w}, F_0^2, F_0^3 \quad \text{given} \quad (P4')$$

The stocks of capital built up abroad ( $F_t^2, F_t^3$ ) follow standard laws of motion.

### 3.3 Resource Constraints

Prices and quantities are determined endogenously in the world equilibrium. At the world equilibrium, relative prices must be set so that excess demand must be zero in every good market, in all regions and at each time period. Equality of supply and demand in the primary or low-tech good requires:

$$N^j Y_{L,t}^j = \sum_{k \in \{1,2,3\}} N^k Y_{L,t}^{j,k} \quad j = \{1,2,3\} \quad (15)$$

The equilibrium condition on the high-tech good market in all regions requires:

$$N^j Y_{H,t}^j = \sum_{k \in \{1,2,3\}} N^k Y_{H,t}^{j,k} \quad j = \{1,2,3\} \quad (16)$$

The market clearing condition in each period for the composite final good in all regions is:

$$Y_{R,t}^1 = \left[ c_t^{1,u} + N^{1,s} c_t^{1,s} + N^{1,w} (c_t^{1,w} + i_{L,t}^{1,w} + i_{H,t}^{1,w}) \right] + \left( p_{R,t}^1 \right)^{-1} \left[ \sum_{k \in \{2,3\}} \left\{ \left( N^k (r_{F,t}^k + \psi_t^k) F_t^k \right) - \left( \left( \frac{N^k}{N^1} \right) \left( p_{L,t}^1 Y_{L,t}^{1,k} + Y_{H,t}^{1,k} \right) - \left( p_{L,t}^{k,1} Y_{L,t}^{k,1} + p_{H,t}^{k,1} Y_{H,t}^{k,1} \right) \right) \right\} \right] \quad (17a)$$

$$\begin{aligned}
Y_{R,t}^j = & \left[ c_t^{j,u} + N^{j,s} c_t^{j,s} + N^{j,w} (c_t^{j,w} + i_{L,t}^{j,w} + i_{H,t}^{j,w}) \right] + (p_{R,t}^j)^{-1} N^j i_{F,t}^j + \\
& (p_{R,t}^j)^{-1} \left[ (1 - N^j) (r_{F,t}^j + \psi_t^j) F_t^j - \sum_{\substack{k \in \{1,2,3\} \\ k \neq j}} \left\{ \left( \frac{N^k}{N^j} \right) (p_{L,t}^j Y_{L,t}^{j,k} + p_{H,t}^j Y_{H,t}^{j,k}) - (p_{L,t}^{k,j} Y_{L,t}^{k,j} + p_{H,t}^{k,j} Y_{H,t}^{k,j}) \right\} \right] \\
& j = \{2,3\} \quad (17b)
\end{aligned}$$

Equilibrium in the market for financial capital requires the condition that foreign assets should be in zero net supply worldwide:

$$\sum_{j \in \{1,2,3\}} N^{j,w} d_t^{j,w} = \sum_{j \in \{1,2,3\}} D^j = 0 \quad (18)$$

where  $D^j$  denotes the region  $j$ 's total aggregate debt. As in Baxter and Crucini's (1995) approach, to compute the world's general equilibrium one of the asset accumulation equations has to be dropped since only two foreign debt stocks are independent. In fact, equation (9'), the developed region asset accumulation equation, is dropped.

Finally, the government budget constraint is satisfied in each period in each region:

$$T_t^j = \sum_{\substack{k \in \{1,2,3\} \\ k \neq j}} \left( \tau_{L,t}^{k,j} p_{L,t}^k Y_{L,t}^{k,j} + \tau_{H,t}^{k,j} p_{H,t}^k Y_{H,t}^{k,j} \right) \quad j = \{1,2,3\} \quad (19)$$

The government's role is to levy import tariffs and rebate revenues back to households in a lump sum fashion.

#### 4. Stationary Representation and Solution Method

As the knowledge frontier expands over time macroeconomic (per-capita) aggregates will grow without bound and the world economy will become arbitrarily large. For computational purposes it is convenient to work with the stationary representation which can be derived by normalizing all growing per-capita variables by the corresponding

regional index of technical progress<sup>5</sup>. In what follows, no new notation is introduced but it is assumed that this stationary-inducing transformation has been performed. The transformed economy has a well-defined steady state around which the model's behavior will be analyzed.

To obtain the approximate solution of the model, the 75-equation system of stationary conditions describing the world economy's equilibrium is linearized around the deterministic steady state. The resulting multivariate linear rational expectations equation system can be cast into Binder and Pesaran's (1995, 1997) canonical form, containing only a vector of one-period lagged and a vector of one-step ahead dependent variables:

$$X_t = A X_{t-1} + B X_{t+1} + W_t \quad (20)$$

where  $X_t$  is now a  $150 \times 1$  vector containing all endogenous variables, generally expressed in percent deviation from trend, and the vector  $W_t$  is a function of the exogenous variables (tariff rates and return premiums), expressed in deviation from initial (steady state) levels. The conformable matrices  $A$  and  $B$  are complicated functions of the model's parameters. The equation is solved numerically with the Quadratic Determinantal Equation method developed by Binder and Pesaran (1995, 1997). That is:

$$X_t = C X_{t-1} + \sum_{i=0}^{\infty} F^i W_{t+i} \quad (21)$$

where the matrix  $C$  in the first term on the right-hand side, or the so-called backward component of the solution, is the solution to the quadratic matrix equation:  $BC^2 - C - A = 0$  and  $F$  is obtained from the following expression:  $F = (I - BC)^{-1}B$ . The second term on the right-hand side is the forward component of the solution and requires knowing the evolution of trade policies and risk premiums over the course of the infinite future. In the ensuing experiments the infinite sum is truncated at some finite value (1200 periods). Because in the designed experiments the infinite sum converges, the length of

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<sup>5</sup> Hence, all growing variables are expressed in terms of efficiency units of labor.

the truncated horizon has been chosen so as to achieve a desired degree of precision (adding other 1000 periods increases the sum by less than  $10^{-7}$  in absolute terms).

Given the assumed future trajectory for trade policy and other exogenous variables ( $\{W_{2003-2005+i}\}_{i=1}^{i=1200}$ ) and given the starting point (say,  $X_{2003-2005}$ ), it is possible to compute with the help of equation (21) the equilibrium dynamics of the world economy from 2006 onwards.

## 5. Calibration

The model economy is parameterized in such a way that its baseline long-run features mimic those of the three regions comprising the world economy during the 2002-2005 period. In the steady state of the world model economy, the relative sizes of the regions match the actual world composition and the expenditure side of the national income accounts matches the average regional structures. Total output is normalized to unity and, according to the production side of the model it is equal to the sum of the market value of manufacturing and non-manufacturing activities. Manufacturing output is defined as manufacturing value added plus services value added, relative to GDP, and the rest corresponds to non-manufacturing value added.

The level (relative to GDP) and product composition (manufacturing and non-manufacturing goods) of interregional trade flows match the corresponding average flows over the 2002-2005 period. Bilateral protection rates are defined to include tariffs and NTBs, and are computed as unweighed and trade-weighted averages over the same sample period and for the mentioned product disaggregation (see Table 2).

Given the calibrated structure of the regional economies, the strategy followed to calibrate parameter values is standard in the literature. With the help of economic theory (first order conditions evaluated at the steady state) and some observations (existing microeconomic and macroeconomic estimates of various parameters and the assumed

economic structure) it is possible to calibrate the rest of parameter values. Table 1 summarizes the result of this calibration strategy.

## **6. Experiments and Results**

This section conducts a sequence of experiments intended to shed some light regarding the quantitative effect of economic, trade policy and financial reform developments originated in China and India and transmitted to the rest of the world and in particular to Latin America, which is the focus of this paper.

### **6.1 Experiment Design and Setup**

The first experiment (E1) considers a gradual reduction of tariffs and non-tariff barriers on Region 2 intermediate good imports from actual levels to the average level observed in developed countries. Specifically, this policy experiment involves a reduction over a 15-year period in bilateral composite tariff rates - including tariffs and tariff equivalent barriers to trade (NTBs) - on imports from Region 1 from a level of 10.5% to 1.8% and on imports from Region 3 from a level of 7.5% to the same target rate (see Table 2).

The second experiment (E2) analyses the overall impact of a comprehensive trade policy reform that composes of tariff reduction and NTBs removal on both intermediate and manufactured good imports. In addition to the tariff reduction considered in the preceding experiment, composite tariff rates on manufactured goods are also reduced from 11.8% for imports from Region 1 and from 13.8% for imports from Region 3 to 3.6%, which corresponds to the unweighted average tariff currently observed in Region 1 (see Table 2).<sup>6</sup>

The third experiment (E3) takes into account the fact that trade reforms are taking place at a juncture where China and India have been growing fast. Experiments E1 and E2

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<sup>6</sup> Using trade-weighted average tariffs as reference for trade reforms would yield very similar quantitative experiments. See Table 2.

simulate the adjustment dynamics of the world economy in response to a trade policy change starting from a given initial steady state ( $X_{2003-2005} = 0$ ). Hence, the simulated adjustment path is not being affected by other forces that may eventually matter for off-steady-state dynamics and reflects only the substitution effect of the scheduled tariff reduction. To introduce into the analysis the issue of rapid growth in China and India it suffices to initialize the economy from an off-steady-state position ( $X_{2003-2005} \neq 0$ ) in which case the persistence of the high growth momentum will depend endogenously on the persistence of the policy change and the internal propagation mechanism of the model economy. Obviously a number of initial conditions are feasible and their implications for the world economy are also different. For instance, initial capital stocks (foreign capital, domestic capital in sector L, and/or capital in sector H) below their steady state levels are able to generate higher transitional growth. In the experiment at hand it is assumed that it is transitional productivity growth rather than transitional factor accumulation what accounts for higher growth. Since the rate of technical progress in Region 2 is an endogenous state variable, high productivity growth is introduced by setting a nonzero initial deviation of the technology growth rate from its initial steady state value ( $\eta_1^2 - \eta_1^1$ ).

Existing TFP growth estimates for China and India are very sensitive to the data and estimation method. Hu and Khan (1997) showed that Chinese productivity increased 3.9% yearly during 1979-1984. Ezaki and Sun (1999) reported a TFP growth rate at about 3% to 4% for the 1981-1995 period and Ao and Fulginiti (2003) estimate average productivity growth rates of 3.3% and 4.9% - depending on the estimation technique - over the 1978-1998 period and found that they explain respectively 37% and 55% of the average GDP growth of 8.86%. Over the same sample period Young (2000) estimated non-agricultural TFP growth to be 1.4% per year. On the other hand, total factor productivity in India is estimated to have grown by 1.6% a year during the 1990s by Basudeb and Bari (2003) and by 3.6% from 1991-2 to 2003-4 by Virmani (2004). The IMF (2002) and the World Bank (2000) have reported productivity growth rates around 2.8% by mid- and late 1990s. All in all, a rate of productivity growth of 4% for China-India is adopted as a reasonable compromise among the wide range of estimates for the near future evolution of productivity. This implies that the initial deviation in the

productivity growth rate required to initialize the economy from an off-steady-state position is 2% (i.e.,  $\eta_1^2 - \eta^1 = 0.04 - 0.02 = 0.02$ ).

Finally, the fourth experiment (E4) complements the sequence of experiments by adding to the picture the effect on the Latin America region of financial liberalization efforts in Region 2. As in McKibbin and Tang (2000) financial liberalization reform is modeled as a reduction in the exogenous premium demanded by foreign investors for holding Region 2 assets as compensation for bearing the uncertainty and risk of investment. The risk premium is assumed to fall gradually by 2 percentage points over a two-year time span.

The sequence of experiments is conducted under the specified experimental conditions. However, *in stricto sensu*, China and India only represents 71% (48% and 23% respectively) of our definition of Region 2 measured by aggregate GDP data based on PPP valuation. Though the qualitative nature of the responses is not affected, the following quantitative effects should be appropriately rescaled to account for this difference.

## **6.2 Numerical Simulation Results**

This section draws out some of the key insights learned from the simulation exercises.

### *6.2.1. Relative Price Effects*

The potential transitional effect on international prices of the reduction of Region 2 trade barriers is shown in Figure 1. The tariff reduction plan is assumed to be announced at the beginning of the first period of simulation and governments are able to credibly precommit to future trade policy changes. Prices are expressed in terms of the numeraire - the manufactured good produced in the developed world (Region 1). The substitution effect of tariff reductions promotes relative price adjustment, which ultimately affects resource allocation. The decline in tariffs leads through increased economic efficiency and lower import costs to a fall in the price of both intermediate and manufactured goods

produced in Region 2. Prices come down a little bit further when trade liberalization is accompanied by more rapid productivity growth.

Being a large region in an economic sense, price developments in Region 2 are transmitted, albeit imperfectly, to the world price system because of the fact of competition between imperfect but relatively close substitutes. Region 2 will witness a deterioration in its terms of trade explained by a fall in export prices while import prices remain roughly unchanged. The developed world, which is in complementary relation with Region 2, benefits from an improvement in its terms of trade accounted for unchanged export prices and falling import prices. Terms of trade in the LAC region (Region 3) suffer a slight deterioration with respect to its trend of less than 1% over the next 30 years as both export and import prices, but more so the former, are pushed down by Asian developments.

In sum, trade liberalization efforts in China and India appear to depress relative prices of primary commodities and manufactures produced in the developing world. Stronger growth in China and India is not likely to reverse this trend as long as it is based on higher total factor productivity growth.

#### *6.2.2 Effect on Volume and Product Composition of Trade*

Figures 2 and 3 set forth the likely effects on exports and imports respectively. While the initial effect of a tariff reduction is to reduce exports somewhat in Region 2, the size of the negative initial effect reduces over time and soon translates into positive outcome. Subsequent export growth is weak when only tariffs on intermediate goods are reduced (E1) but with a more comprehensive trade reform (E2) the increase in exports is sizeable. The volume of Region 2 exports will be above its trend level by 33 percentage points over a medium to long-run horizon.

The substitution effect of tariff reductions in the China-India region may boost, in principle, export opportunities in Region 3. Total exports in the LAC region will increase

by 1% to 4% above their trend level as a result. LAC manufactured exports will benefit the most in the event of a comprehensive trade reform though the effect is still small (1.5% to 5% deviation from trend level) and may be dampened by accelerated productivity growth in Region 2.

Figure 3 shows the likely effects on import trade. Total imports in developing countries fall over the medium term following a tariff reduction in Region 2 and therefore, there is a likely trade balance improvement. In Region 2 the initial impact is to raise imports relative to trend but soon imports start falling gradually as the economy converges toward its new balanced growth equilibrium path. Imports in Region 3 fall by 0.5% to 2.5% below their trend level along the dynamic adjustment path.

### *6.2.3 Direction of Trade*

Figures 4 and 5 set forth the effect on the direction of trade flows. Changes in trade protection in Region 2 have relatively large effects on the regional destination of exports and source of imports. On the export side, Region 2 export trade strongly expands in all directions. This is especially true under the conditions of experiments E2 and E3 - in the presence of a comprehensive trade reform and high productivity growth. Region 2 exports to Region 1 increase by 33% from trend levels and exports to Region 3 by 22% over the medium- and long-term.

Destinations for Latin America exports tilt, in relative terms, away from Region 2 and toward Region 1 market. Exports to Region 1 increase by 10% while those to Region 2 fall by 30% over the medium- and long-term. Note however that LAC's exports to developed countries amounted to 17.2% of the region's GDP on average during the period 2002-2004 while exports to Region 2 are small, 1.2% of the LAC region GDP. The net effect, as we have shown before, is likely to be an increase in total exports relative to their steady state trend value.

On the import side, simulation results suggest that Region 1 increases the volume of imports from developing countries as their products become cheaper. In developed economies imports from Region 2 increase by 33% while imports from Latin America increase by somewhat less than 10%, relative to trend levels. This different behavior reflects in part the fact that relative price cuts in Region 2 go deeper than the decline in the prices of merchandises produced by Latin America.

Latin America also shifts import sources. Imports from Region 1 are substituted in relative terms with imports from Region 2 which are relatively cheaper. Imports from Region 1 fall by 5% while imports from Region 2 increase by 22%. However, the net effect is likely to be a reduction in total imports over a medium-term horizon since imports from Region 1 are much bigger than those from Region 2 (11.4% versus 1.4% of the LAC region's GDP over the 2002-2004 period).

#### *6.2.4 Foreign Asset Flows and Returns*

Figure 6 presents the transitional dynamics of international financial and foreign direct investment flows over the next 30 years. The planned tariff reductions tend to create initially in Region 2 a trade balance deficit but after a decade or so it turns into a trade surplus. For a given net factor income, as the trade balance to output ratio improves there will be a build-up of net foreign assets. Thus, Region 2 accumulates claims on the rest of the world.

Figure 6 shows that in the proposed sequence of experiments Region 2 emerges as a net foreign creditor on international capital markets. The change in Region 2's net foreign assets position is reflected in the figure by a reduction in direct investment inflows and by a fall in net foreign debt. Foreign direct investment inflows which are determined by optimizing investors fall as the return in Region 2 falls over a medium-term horizon.

Region 1 foreign debt moves from a somewhat below-trend growth path to a mildly above-trend path of between 0.5 to 1.5 percent. This behavior reflects the tension

between a small trade surplus and the substitution in foreign financing sources away from foreign direct investment whose return slightly falls in the region and in favor of financial capital.

According to experiment results, the concern that trade policy and growth developments in China and India may crowd out FDI inflows to Latin America seems unfounded. According to those experiments, foreign direct investment flows toward Latin America fall by less than 1% relative to trend over the medium term. With the emergence of Region 2 as a marginal net creditor to the rest of the world, the small current account imbalances in LAC are ultimately financed by Region 2. In the model economy these inflows take the form of debt and not of FDI flows, simply because it is assumed that Region 1 is the only FDI exporter. In principle, there is no reason why part of that financing cannot be classified as or take the form of FDI flows, in which case negligible FDI diversion is to be expected.

#### *6.2.5 Effects on Macroeconomic Aggregates*

Figure 7 sets forth the effects of China and India developments on LAC overall macroeconomic behavior. The figure displays the short-run and medium-term impact on GDP, consumption and investment. The deviations from trend of these aggregates are negative but magnitudes are negligible.

As mentioned before, tariff reductions in Region 2 slightly improve the path of the LAC trade balance to output ratio. Since the GDP remains relatively unchanged, the trade balance surplus is accommodated from a macroeconomic point of view by a trivial fall in consumption and a modest fall in investment.

#### *6.2.6 Experiment E4*

The effects of financial liberalization efforts in Region 2 on Latin America are negligible and for this reason simulation results are not reported. The appearance of arbitrage

opportunities leads to small and swift capital inflows into Region 2, imported from Region 1, with no apparent effect on LAC.

## **7. Concluding Remarks**

This paper constructs a perfect foresight dynamic intertemporal general equilibrium model of the world economy to study the nature of the short-run and medium-term adjustment process and the likely quantitative impacts of economic, trade policy and financial reform developments in China and India on the Latin America region as a whole. Overall, a sequence of simulation results suggests that tariff reductions, rapid growth and financial liberalization reform in China and India have minor negative effects on GDP and technological growth, consumption and investment in Latin America and relatively stronger effects, but still small, on trade patterns, financial capital inflows, FDI and relative prices.

The dynamic analysis suggests that trade liberalization and rapid growth in China and India likely depress relative prices of primary commodities and manufactures produced in the developing world, causing a slight deterioration of the LAC region's terms of trade by less than 1% relative to their trend level. The trade balance to GDP ratio improves slightly over the medium term as exports increase by 1% to 4% above their trend while imports fall somewhat. Over the next 30 years, the destinations for Latin America exports tilt away from China and India and toward developed country markets as its export prices fall while imports from the developed world are substituted, in relative terms, with imports from China and India. Furthermore, simulation results suggest that the concern that trade policy and growth developments in China and India may crowd out FDI inflows to Latin America seems unfounded. According to those experiments, foreign direct investment flows toward Latin America fall by less than 1% relative to trend over the medium term. With the emergence of China-India as a marginal net creditor to the rest of the world, FDI inflows in the future may come from this region, competing with developed countries for the role of important FDI source.

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**Table 1**  
**Parameter Values**

	Region 1 $j=1$	Region 2 $j=2$	Region 3 $j=3$	Description
$N^j$	0.62	0.29	0.09	Region size
$N^{j,w}$	0.71	0.38	0.38	Number of Ricardian households
$N^{j,s}$	0.76	0.43	0.37	Number of skilled households
$N_L^{j,u}$	0.21	0.41	0.44	Fraction of unskilled workers in sector L
$N_H^{j,u}$	0.79	0.59	0.56	Fraction of unskilled workers in sector H
$\bar{C}^j$	18.26	23.07	23.34	Minimum required consumption
$\tau^{j,u}$	0.03	0.03	0.05	Payroll tax rate
$\zeta^j$	0.55	0.55	0.53	Gross wage replacement ratio
$A_L$	10.45	12.56	14.93	Scaling factor in sector L technology
$\alpha_L$	0.34	0.38	0.32	Capital share in sector L technology
$A_H$	1.39	1.78	1.74	Scale parameter in CES aggregator in sector H
$\omega_Y$	0.90	0.73	0.75	Share parameter in CES aggregator component in sector H
$\sigma_Y$	0.01	0.01	0.01	Substitution parameter in CES aggregator in sector H
$A_V$	18.53	21.07	26.60	Scale parameter in value added component in sector H
$\alpha_H$	0.34	0.34	0.27	Domestic capital share in value added component
$\omega_V$	0.42	0.52	0.49	Distribution parameter in CES value added aggregator
$\sigma_V$	0.40	0.40	0.40	Substitution parameter in CES value added aggregator
$\omega_\lambda$		0.34	0.46	Distribution parameter in CES value added aggregator
$\sigma_\lambda$		-0.50	-0.50	Substitution parameter in CES value added aggregator
$A_S$	1.53	1.42	1.30	Scale parameter in intermediate input component in sector H technology
$\sigma_S$	0.33	0.33	0.33	Substitution parameter in intermediate input component in sector H
$\omega_{1,S}$	0.83	0.09	0.08	Share parameter in intermediate input CES aggregator component
$\omega_{2,S}$	0.08	0.86	0.02	
$\omega_{3,S}$	0.08	0.04	0.90	
$\alpha_Z$		0.04	0.04	Speed of technology diffusion
$\eta^j$	1.02	1.02	1.02	Gross rate of growth
$\delta$	0.09	0.23	0.14	Depreciation rate
$\sigma_R$	0.33	0.33	0.33	Substitution parameter in final good Armington aggregator
$\omega_{1,R}$	0.88	0.20	0.19	Share parameter in final good Armington aggregator
$\omega_{2,R}$	0.09	0.64	0.05	
$\omega_{3,R}$	0.04	0.02	0.67	
$\beta$	0.96	0.96	0.96	Discount factor
$A_R$	1.35	2.76	2.47	Scale parameter in final good Armington aggregator

**Table 2**  
**Bilateral Composite Protection Rates: Tariffs and NTBs**  
**(%, unweighted averages 2002-2004)**

Importer	Exporter Region					
	Region 1		Region 2		Region 3	
	Primary Products	Manufactured Goods	Primary Products	Manufactured Goods	Primary Products	Manufactured Goods
Region 1			1.77	3.81	1.93	3.37
Region 2	10.48	11.75			7.44	13.78
Region 3	7.19	13.60	9.68	14.59		

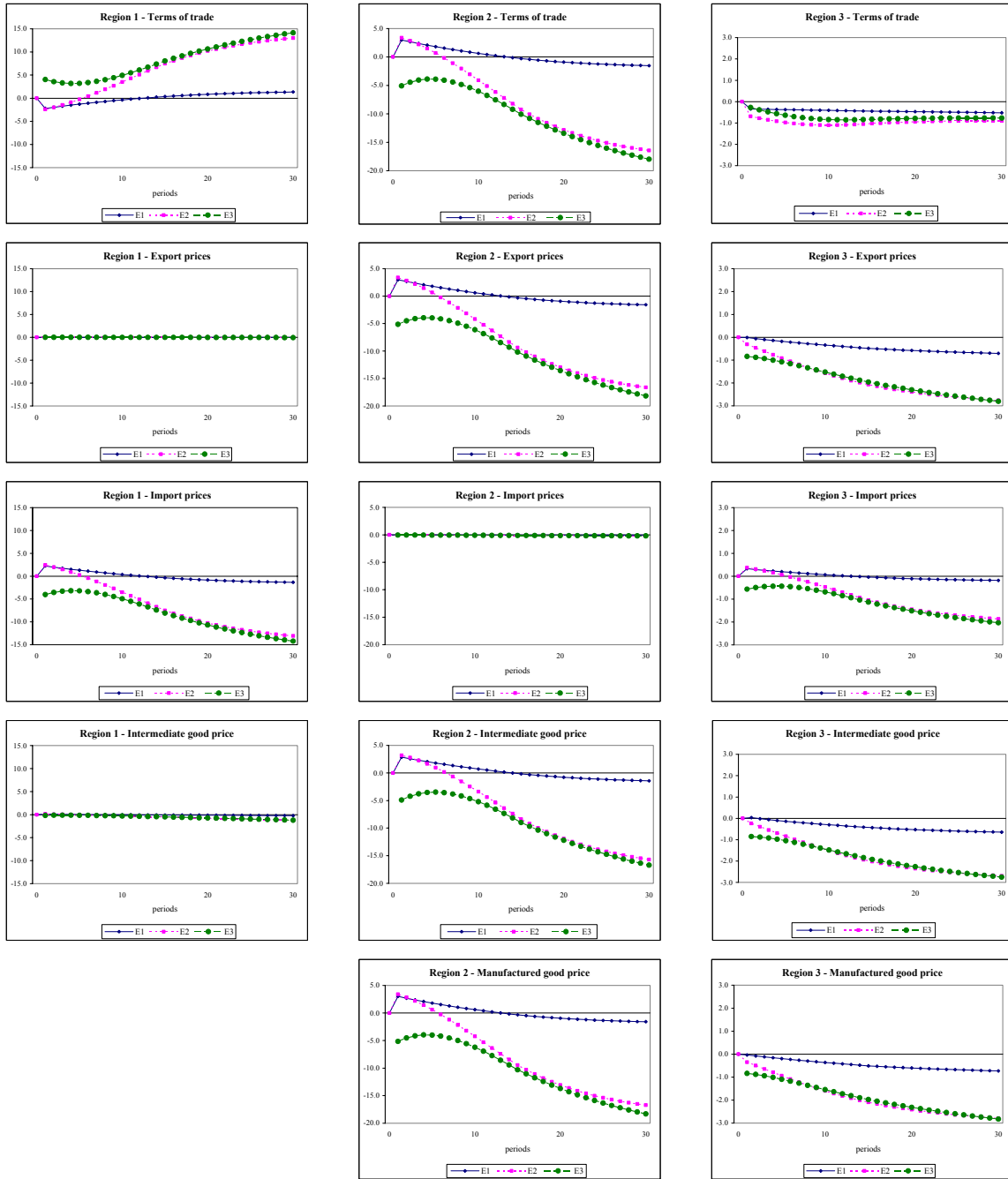
Source: UNCTAD (TRAINS) and WITS

(%, trade weighted averages 2002-2004)

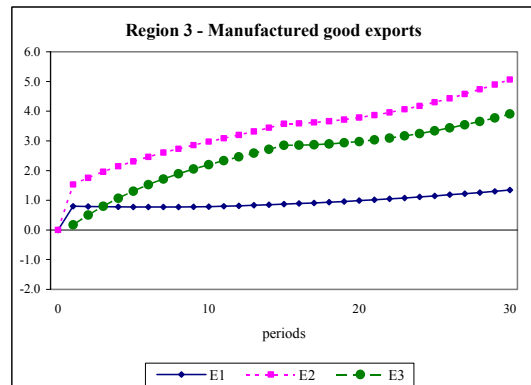
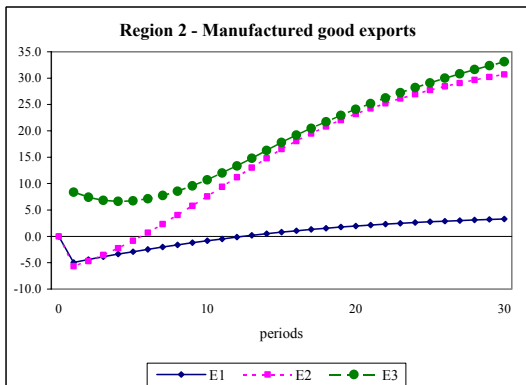
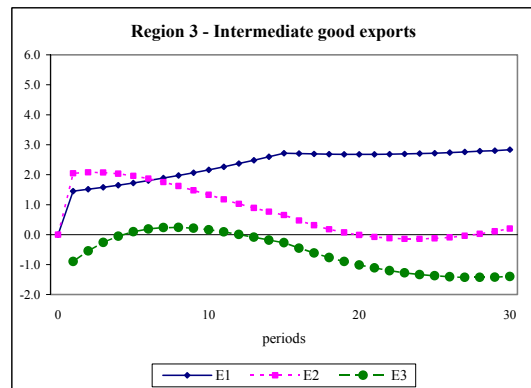
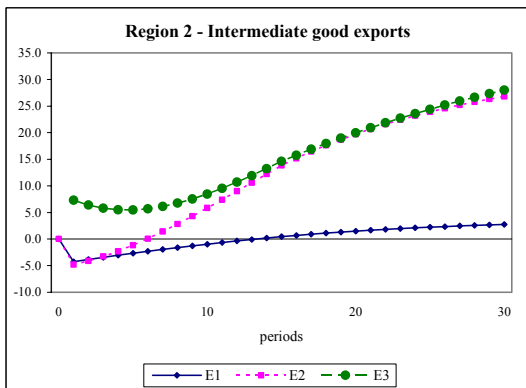
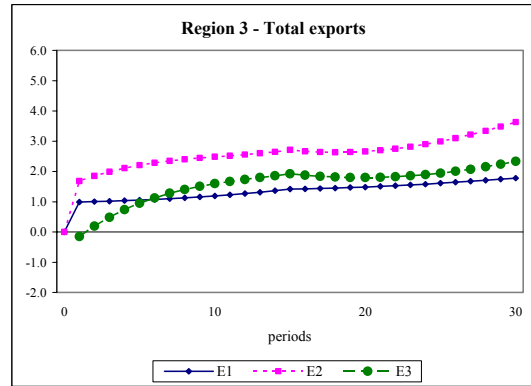
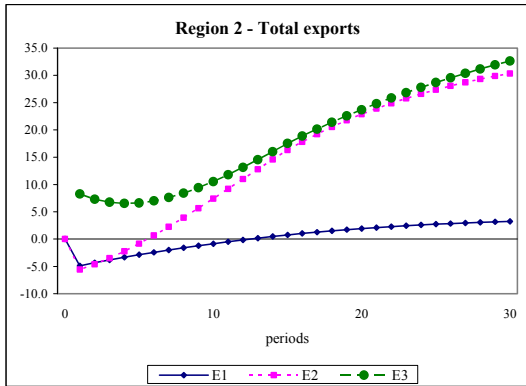
Importer	Exporter Region					
	Region 1		Region 2		Region 3	
	Primary Products	Manufactured Goods	Primary Products	Manufactured Goods	Primary Products	Manufactured Goods
Region 1			2.19	3.87	2.25	3.26
Region 2	10.78	10.02			8.02	13.56
Region 3	6.84	11.83			8.97	13.40

Source: UNCTAD (TRAINS) and WITS

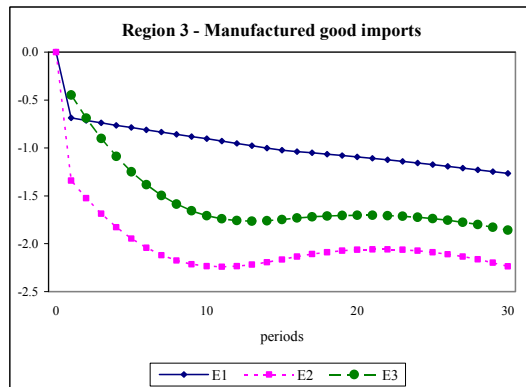
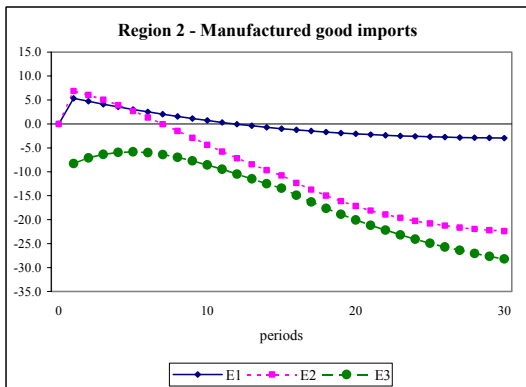
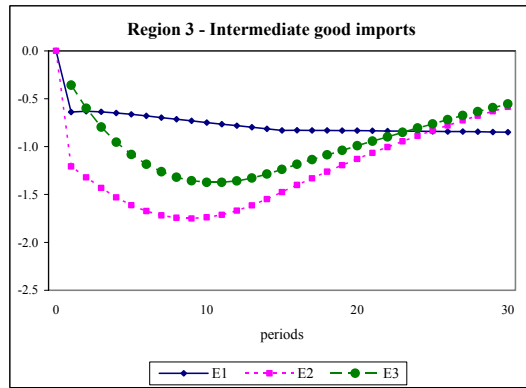
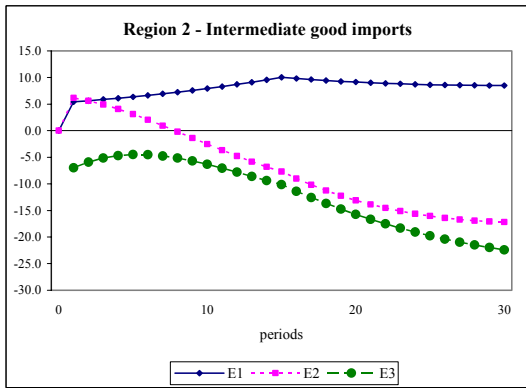
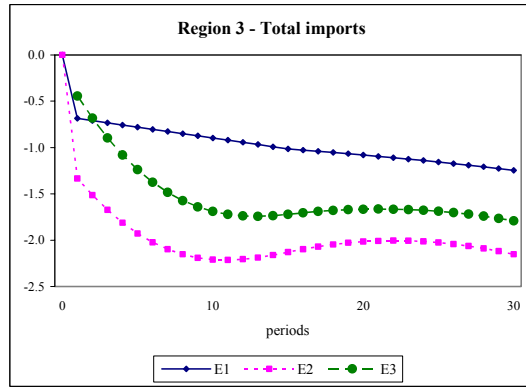
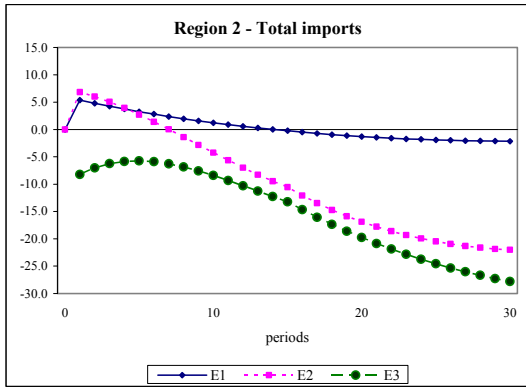
**Figure 1**  
**Relative Prices**  
**(% deviations from trend)**



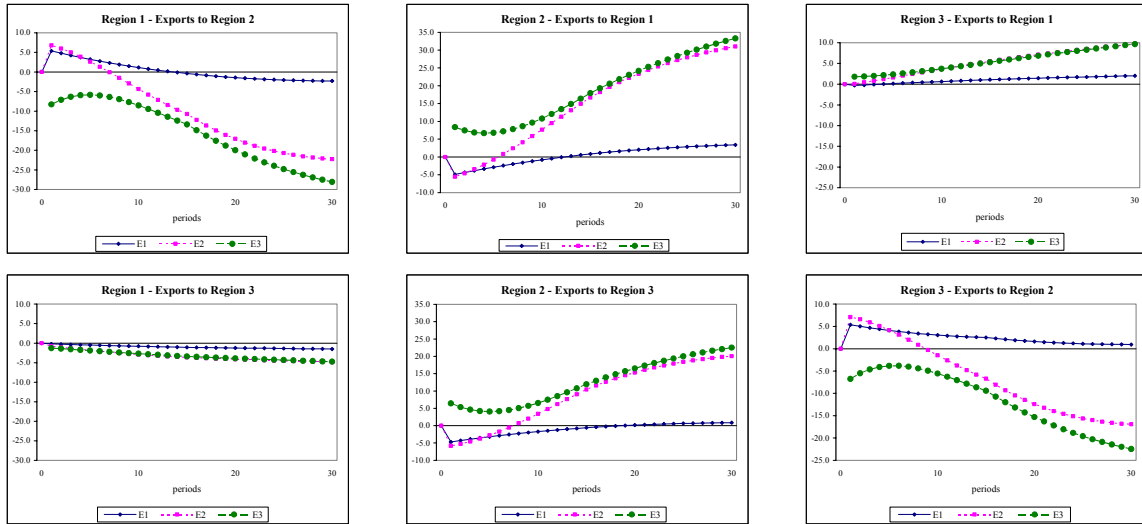
**Figure 2**  
**Exports and Product Composition**  
**(% deviations from trend)**



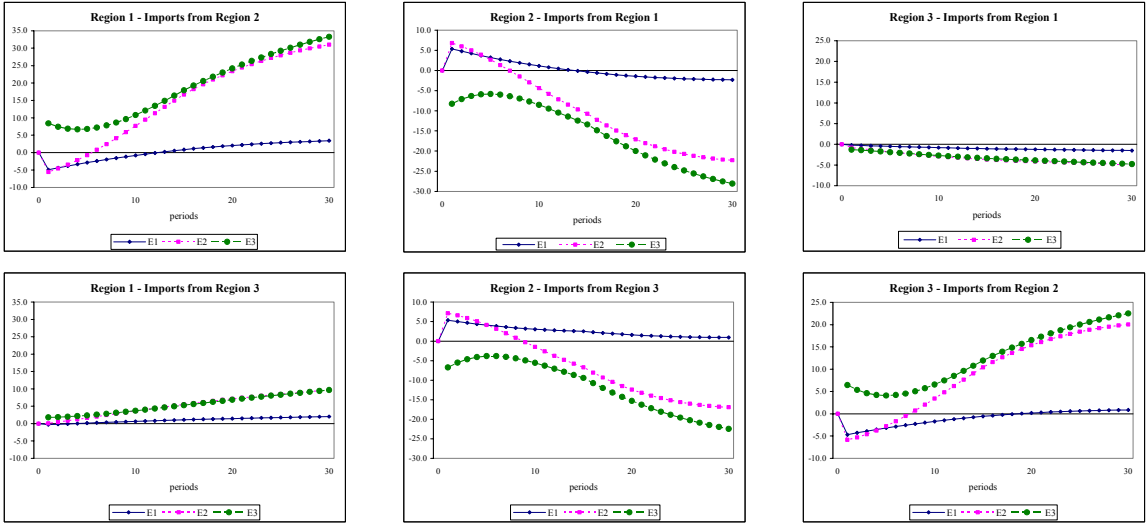
**Figure 3**  
**Imports and Product Composition**  
**(% deviations from trend)**



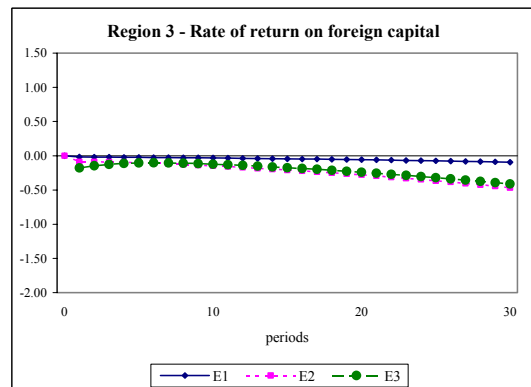
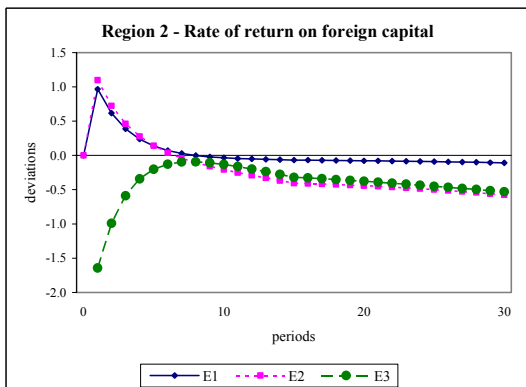
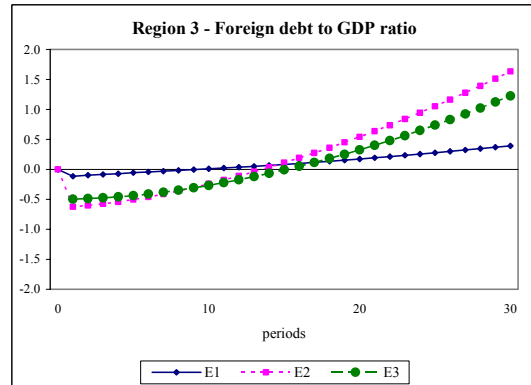
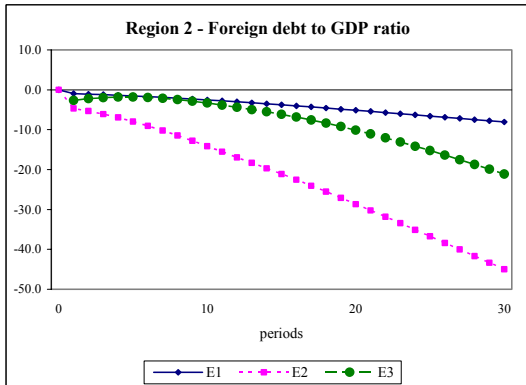
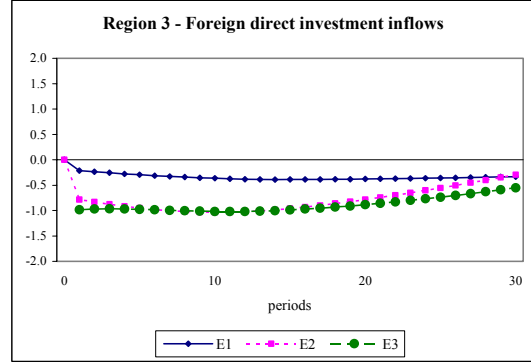
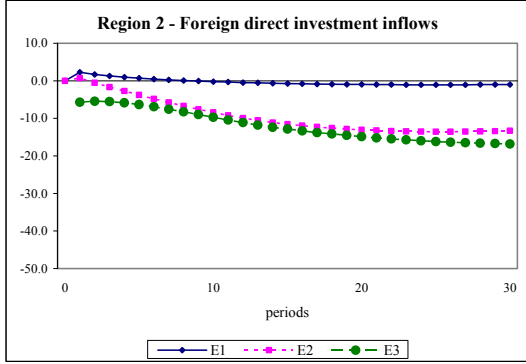
**Figure 4**  
**Directions of Export Trade**  
**(% deviations from trend)**



**Figure 5**  
**Directions of Import Trade**  
**(% deviations from trend)**



**Figure 6**  
**Foreign Asset Flows and Returns**  
**(% deviations from trend)**  
**(deviations from trend for rates of return)**



**Figure 7**  
**Macroeconomic Performance in Latin America**  
**(% deviations and deviations from trend)**

