
June, 1998

I. Introduction

As we approach the close of the twentieth century, the globalization of trade and investments flows relative to global output has recently surpassed previous historical records. Many developing countries have participated in these growing trade and investment flows, with greater benefits accruing to relatively higher wage and higher skilled workers. Enhanced global trade and investment liberalization, as well as higher rates of growth in relatively poorer countries, has led to projections of even higher levels of global trade and financial flows. A growing share of these flows will likely be between many low and middle income countries competing to trade with high income countries, raising concerns about the income effects on the large mass of lower skilled workers worldwide. Indeed, about 99 percent of the 1 billion or so workers projected to join the world's labor force over the next thirty years will live in what are today's low- and middle-income countries. More recently, some observers are wondering if Asia's current crisis and the specter of competitive devaluations has not already begun to

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1 See Maddison, 1991.
accelerate the seemingly inevitable process of global adjustment to Asia's growing export capacity.  

This paper presents a dynamic computable general equilibrium (CGE) framework for analyzing the impact of alternative scenarios on production, real wages, the structure of employment, and inequality within and between countries. The "IDB World CGE model" presented here was designed to simulate various policy measures, exogenous shocks, and economic interactions among nine "country clusters" or key regions of the world. Of particular interest will be the impact on employment and income distribution among skilled and unskilled workers due to enhanced trade and investment competition between Latin America, OECD, former Soviet Bloc, Asia, and other low and middle income regions. The CGE model simulates the dynamic evolution of patterns of trade, total output, factor mobility, and income distribution in each cluster of countries for each production factor. In addition, the model generates dynamic pathways of the behavior of the global system over a 28-year time framework (1992-2020), under alternative assumptions regarding macroeconomic variables, policy decision on education, research and development (R&D), and trade policies. We pay particular attention to both growth and inequality implications of all scenarios, searching for ways to improve growth without worsening income inequality, and to explore if increased growth with improved income distribution is possible on a global scale.

The IDB-World CGE model is also used to analyze the potential impacts of a series of policy interventions that can change the pattern of trade and investment, as well as the productivity path of different factors of production, and thus the pattern of income

\* See Lui, et al., 1998.
and employment adjustments. We specifically focus on the policies and investments that could substantially affect these alternative outcomes. In particular, the model will simulate alternative flows of investment resources for physical capital, human capital, and R&D improvements. First, the comparative statics impacts of trade and liberalization policies are modeled, both through liberalization within particular regional arrangements as well as through global and multilateral approaches. Second, the productivity enhancing externality impacts of trade liberalizations are analyzed. Finally, we analyze the relative dimensions of investment and policy interventions in human capital and R&D enhancements that would be required to redirect the adverse income distribution and employment adjustment trends implicit in current trends of global growth and integration.

The IDB-World CGE model can thus allow one to evaluate within a single framework, the long run relative impacts of different factor supplies (tangibles such as labor and capital), polices designed to increase the efficiency of factor allocation (trade liberalization), as well as improvements in different factor productivities (through investments in human capital and R&D).

We illustrate the future through two major scenarios concerning global growth, integration, and income distribution: a Status Quo/Divergence Scenario and an Integration/Convergence Scenario. The major difference between these two scenarios is the level of investment in human capital improvement, which we find to be the most significant determinate of the pattern of global growth and income distribution. The

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3 This is useful in addressing the long run implications of the current debate on the sources of growth in the so-called "Asian Miracle". See Kim and Lau (1992), World Bank (1993), Krugman (1994), and Young (1994).
Status Quo/Divergence Scenario projects out current regional levels of educational expenditures, paths of skill improvements, and income widening. The Integration/Convergence Scenario simulates the levels of skill improvements and educational expenditures in each region that would be required to close the growth of income inequality for that region. Using each major scenario as a "base," we also run two identical series of alternative "sub-scenarios" dealing with trade liberation and protectionism, resource price shocks, and several others designed to simulate a range of possible policies and investments and their possible impacts on the pattern of global growth and income inequality.

The two major scenarios and their variations tell us much about the possible futures paths of the world economy and income distribution, as well as the relative efficacy of different policy and investment initiatives. The Status Quo and Divergence Scenario is a pessimistic, but probably realistic, scenario in which slow progress is made on the growth in investments in education. This scenario produces moderate growth with widening income inequality in most regions of the world. The effects of other policy measures such as trade liberalization and investment and productivity enhancing R&D improvements does not fundamentally change the basic course of this scenario. Nor are the results much affected by natural resource shocks or a turn to trade protectionism. The Integration and Convergence Scenario, on the other hand, is an optimistic, yet still realistic, scenario in which the vigorous and sustained pursuit of policies and investments which enhance educational levels of workers, particularly in both low and moderate income countries, produces higher rates of growth as well as substantial declines in relative, and in most regions, absolute levels of wage inequality. Within this context,
trade liberalization and investment and productivity enhancing R&D improvements has
the effect of enhancing the closing of income gaps. This is still not a scenario of bliss:
workers have to continue to work hard for their living, and poverty is not eradicated.
But it shows the potential for all groups of workers to share in the benefits of
globalization and for an increase in the labor incomes of the poorest segments of the
populations of even the lowest income countries, leading to a large reduction in global
poverty.

In addition to the two major long run scenarios and their variations, we will
examine the potential effects of a shorter term impacts of the Asian crisis on the world
economy and on each of the various regions of the world. In simulating the current
crisis, we look at the potential impacts of competitive devaluations, a reduction in
international capital flows, and a reduction in domestic levels of investment. We then
compare these shorter term adjustment effects of the current crisis to the more long run
adjustment effects of alternative global integration scenarios.

Part two of the paper proceeds with a detailed exposition of the global database on
trade and financial flows between differently constituted clusters of countries throughout
the world economy that is used in the CGE model. Part three will elaborate on the
assumptions and the specifications of the model, while part four will focus on the
interpretation of the result of the experiments simulating the different scenarios. Part five
offers some conclusions and policy recommendations.

II. Data Base of a Changing World Economy

The construction of the database used in the IDB-World CGE model represents a
major collection and aggregation undertaking. Table 1 presents the data components of the model which includes 9 “country clusters” or regional aggregations, 11 sectors of production, 6 factors, 2 types of labor mobility, and 3 institutions for the distribution of factor income.

Tables 2 to 6 present a summary of some of the components for the base data. Table 2 presents general economic indicators in the base data, revealing some important issues in the position of Latin American countries (LAC) in comparison to other world regions. The LAC region is the second largest of our groupings in terms of GDP and fifth in population, yet still ranks third in per-capita income behind the OECD by nearly 9 to 1 and behind ANICs by more than 2 to 1. One often cited explanation for this difference deals with relative educational performance between these regions⁴. It is interesting to note that while table 2 shows that the LAC region actually displays a slightly higher share of educational expenditures as a percentage of GNP relative to ANICs, table 3 shows that ANICs have been able to produce a better educated workforce. Table 4, meanwhile, shows that LAC region has the highest percentage of workers in the urban unskilled category (42%) among developing regions (non-OECD and Transitional), while the LAC region also has the lowest share of agricultural labor (25%) among developing regions. ANICs have relatively more workers in agriculture (40%) while relatively less urban unskilled workers (32%). Both the LAC and ANIC regions have about the same share of workers in the urban skilled and professionals.

Relative involvement in trade is another commonly noted difference between LAC and LNICs. Table 2 shows that LAC regions ranks sixth in its trade share of GDP,

⁴ World Bank, 1993.
performing at only about a quarter of the ANICs level. Table 5 shows that ANICs exports are also the most diversified of the developing regions, while LACs are very highly concentrated with the OECD. The ANIC region is also a large net exporter to the OECD while the LAC region is a net importer. The tariff data in table 6 tells part of the story. ANICs have higher tariff levels than LACs with all regions of the world. Yet they also face higher tariffs than the LACs do in every region of the world.

Finally, differences in investments rates and quality of investments are also cited to explain recent economic performance. Table 2 shows that the ANICs have the highest rates of investment share of GDP than any other region, with the LACs trailing, yet both are ahead of the OECD. Yet with respect to expenditures on R&D relative to GDP, the OECD ranks highest with ANICs gaining and LACs lagging behind.

Appendix 1 presents information on the sources for this base data as well as information on the data used for future population and education projections.

III. The Construction of a Global Dynamic CGE Model

The Need for a General Equilibrium Approach

Missing in many discussions on income effects of globalization is a balanced analysis that clarifies both the significant benefits that global trade liberalization could have on developing countries, but also the increased risks for greater labor market adjustment problems and income distribution challenges. At the same time, we need a framework that places the costs and benefits of liberalization within a context in which we can compare the relative impacts of other policy interventions and investments in education and technology that directly affect the productivity of different factors of
production.

Computable general equilibrium (CGE) analysis is arguably the most advanced tool available to model and understand these linkages between sectors, countries and factors on a global scale. In CGE analysis, the impact of trade liberalization, market reforms and pro-competitive investments are seen in terms of connections throughout the economy on the cost of goods and services used by all producers and consumers of goods and services. The impact of reducing trade barriers and eliminating subsidies can thus be analyzed simultaneously through the reduction in production in protected and subsidized sectors, the increase in overall efficiency and production in previously unprotected sectors, as well as the possible general equilibrium taxes considerations. The impact of an increase in investments in education and technology can be seen in terms of growth, income distribution, and cost effectiveness. We compare the rates of return to capital (endogenously generated in the model from factor supplies, demands, and technology), with the rate of return to education, by region and level, and the return to R&D spending, to see where societies scarce resource bring the highest returns. We also look at the income distribution consequences of each policy, and attempt to evaluate these alternatives by their overall desirability.

A CGE model, like the one used here, can be used to estimate such overall impacts. Starting from a mapping of the flow of goods and services (including trade flows), factors of production, and payments in an economy (called a social accounting matrix, or SAM), the impact of alternative policies on equilibrium prices and on elements of the SAM can be traced. The CGE model ensures that the estimated outcomes are all consistent with each other. In other words, policies that favor one sector increase demand
for intermediate goods (including imports) used in the sector and generate additional demand for all factors of production used intensively in that sector's production, bidding up their cost. The resulting increase in output is either consumed domestically or exported, depending on demand, which in turn depends on relative incomes and prices. A brief description of the workings of the base model will be given in Appendix 1.

The IDB World CGE model developed for this report is a member of a growing family of trade-focused, multi-country CGE models. Designed to analyze the impact of trading interactions between countries, the model focuses on the trade relations between developed and developing countries. Particular emphasis is placed on the demand for different categories of labor as we use the model to explore the impact of trade liberalization, skill accumulation, and economic growth on wage distributions—both across regions and skill levels. The model includes eight regions (Latin America, Sub-Saharan Africa, Southern Asia, China, Asian NICs, Other Low-Middle Income Countries, Transitional Countries (Former USSR Bloc) and Rich OECD Countries), with the rest of the world treated residually with simple import and export demand functions. For each region, the model includes ten sectors (four primary, five manufacturing, and services) and six factors of production (capital, land, and four skill categories: agricultural, unskilled, skilled, and professional). Each regional economy has a separate CGE model which determines: sectoral supply, demand, exports, imports and market clearing prices; factor supply, demand, and market clearing wages; and the real exchange rate. The regions are linked by trade flows. World prices of all goods are determined within the model, equilibrating sectoral export supply and import demand on world markets. Domestically produced and traded goods are specified as imperfect substitutes,
which provides for a realistic continuum of “tradability” and two-way intra-sectoral trade, rather than assuming that all goods are either perfect substitutes in world markets or are not traded as all.

The model is dynamic, generating solutions for six periods stretching from the base year of 1992 until the terminal year of 2020. It includes rural-urban migration linking agricultural and urban unskilled labor markets within each region. The model captures the links between changes in endowments, including demographics and changes in education and skill levels, protection, and relative wages as specified in neo-classical trade theory. It provides a simulation laboratory for exploring the empirical importance of changes in trade on relative wages, and for comparing the magnitude of these effects to the effects of capital accumulation, productivity growth, skill upgrading, capital flows, and migration patterns.

The model was constructed in such a manner to take into consideration the huge differences in resource allocation among different regions, as well as differences in skills within the labor force. The model will also allow for the consideration of the trade patterns over long periods of time (28 years), and for the assessment of the potential impact of various patterns of integration on factor returns and the distribution of factor income.

Global and regional trade arrangements can be simulated and analyzed as components of the international trend towards increased liberalization among countries and integration within regional blocs. Regarding future perspectives, the model considers alternative new integration initiatives, such as trade agreements between Latin America and OECD, ANICs and OECD, and a trade agreement between all non OECD and
Transitional countries.

Appendix 2 presents the full model which is programmed in GAMS.

IV. Basic Questions and Scenarios:

The IDB-World CGE model is designed to address the potential impacts on income distribution in different parts of the world over time due to alternative scenarios of the liberalization and incorporation of various groups of countries and types of workers into the world economy. We also simulate policies and investment that could substantially affect these alternative outcomes. In particular, the model will simulate alternative flows of investment resources for human capital improvements as well as R&D expenditures linked to total factor productivity growth.

This paper organizes our CGE modeling results around two major scenarios: a Status Quo/Divergence Scenario and an Integration/Convergence Scenario (See Table 7). The major difference between these two scenarios is the level of investment in human capital improvement, which we find to be the most significant determinate of the pattern of global growth and income distribution. The Status Quo/Divergence Scenario projects out current regional levels of educational expenditures, paths of skill improvements, and income widening. The Integration/Convergence Scenario simulates the levels of skill improvements and educational expenditures in each region that would be required to close the growth of income inequality for that region.

Using each major scenario as a "base," we also run an identical set of five alternative trade scenarios, two resource price shock scenarios, and several others designed to simulate a range of possible policies, investments, and external shocks and
their possible impacts on the pattern of global growth and income inequality:

(1) Alternative strategies for regional and global trade policy, including:

(a) full implementation of the recent GATT/WTO agreements;

(b) a further round for the complete global elimination of all tariff barriers;

(c) a Latin American-OECD regional trade accord;

(d) an Asian NICs-OECD trade regional accord;

(e) a developing country only (non-OECD and Transitional economies) trade accord;

(f) a series of projectionist responses by (i) Latin America, (ii) Asian NICs, or (iii) OECD.

(2) The above trade policy sub-scenarios with the addition of “dynamic externality” effects.

(3) Additional investments in R&D that enhance total factor productivity (TFP) growth, including (a) a doubling of investments in every region, (b) the lifting of Latin American investments to Asian NIC levels.

(4) Raising levels of investment rates from GDP in LAC above ANIC levels.

(5) The simulation of different natural resource shocks, particularly the impact on Latin America of the doubling of mining/mineral exports by the rest of the world producers.

(6) Additional investments in education that close the skill gap between Latin America and Asian NICs by (a) 50% and (b) the raising of educational spending in all regions except the OECD by 50%.
In addition to these dynamic long-term (multi-period) scenarios and sub-scenario, we will examine the potential effects (comparative statics impacts) of the Asian crisis on the world economy and on each of the various regions of the world. In simulating the current crisis, we look at the potential impacts of (1) competitive devaluations by ANIC and China, (2) reductions in international capital flows to ANIC and LAC, and (3) a reduction in ANIC levels of investment. We then compare these shorter-term adjustment effects of the current crisis to the more long run adjustment effects of alternative global integration scenarios.

Before proceeding to an analysis of the CGE model results, we first consider the assumptions used in each of these alternative scenarios and sub-scenarios.

*Investments in Human Capital*

The dynamic CGE model developed here can allow for the analysis of alternative scenarios of increased global integration, their impact on income differences within and between regions, and the impact that particular policy interventions may have on these trends in growth and inequality. In the absence of a concerted effort to promote education and improve the human capital of developing country workers, the gap between rich and poorer workers can be shown to widen. However, the model can also show that specific interventions directed at improving the human capital condition of workers, particularly in developing countries, can both enhance global growth and improve within and between region income distributions.

A key reason for using a dynamic global CGE model is to be able to track developments in trade and investments related to the emergence of low wage economies.
like China and South Asia as regional and global economic powers. Our model will be able to trace the interdependence among growth of production and incomes in China and South Asia, and the pattern of production and growth in other low and middle income countries in Latin America, as well as the rich countries of the OECD (Japan, the EU and the United States). A dynamic perspective allows differential investment rates, demographic change, and other inter-temporal phenomena to impact these economic variables. As the majority of the cohorts that will be joining the labor force before 2020 have already been born, the key question is how to model the role of government spending for education and its impact on the skill composition of the labor force.

Using estimated coefficients between government spending and enrollments in primary, secondary and tertiary education, we can model the impacts of increased investment in education on growth, trade and income distribution. This process involves three steps. First, the money to be spent must either be raised through borrowing, raising taxes, or diverting other government spending. This generates costs and distributional implications that must be netted out of the gross gains to yield net gains. Alternatively, one can abstract from these “general equilibrium taxation” concerns by either assuming non-distortionary lump-sum taxes or that funds for the expansion of education are available through foreign borrowing. Secondly, education must be translated into labor market skills and labor productivity. We have estimated conversion factors that translate increased education attainment into skills and productivity, thus we can directly estimate how increases in education results in additional skilled and professional workers. Lastly, there must be sufficient investment to generate employment opportunities in the non-agricultural economy to keep wages and productivity higher and thus provide a strong
positive return to education.

Thus several potential impacts on economies of increased spending on education exist, with a general equilibrium model necessary to sort out their relative strengths and net effects within and across countries. First, higher educational levels will result in higher productivity and higher incomes. Moving workers from agriculture to unskilled industrial employment by improving and enhancing basic literacy will no doubt improve income distribution, while a focus on tertiary education to train professionals is likely to be regressive. Secondly, increasing the number of workers at a higher skill level will directly reduce the average wage at that level, but indirectly increase the rate of return to capital in sectors that use such labor intensive in production, increasing investment output and offsetting the wage decline. Thirdly, countries without a comparative advantage in agricultural goods will see an increase in trade as the inflow of workers to manufacturing sectors generates an exportable surplus, while outflows of workers from agriculture encourages imports of lower cost foreign products. The net result is likely to be a slight rise in agricultural prices and thus an improvement in agricultural sector wages rates and return to land. Countries with a comparative advantage in agriculture will find that increased mechanization will take place in those sectors, as the outflow of workers in those sectors raises wages, encouraging greater use of machinery. Increases in manufacturing sector labor may allow effective import substitution in some areas and overall trade volumes may fall.

Trade Liberalization

Computable general equilibrium models have been used to analyze a wide variety of economic issues and there is a long tradition and literature in the use of CGE models
to estimate the economic impacts of trade liberalization at the national, regional and global level (See Dervis, de Melo, and Robinson (1982); and Devarajan, Lewis, and Robinson (1993)). In the context of regional integration, particularly dealing with the North American Free Trade Area, CGE models have also been widely used, with the work reviewed by Brown (1992) and Hinojosa-Ojeda and Robinson (1992). The CGE model we use here reflects the experience gained through many years of analyzing a variety of regional and global trading arrangements.

The model and scenarios presented in this paper are designed to evaluate the impact of alternative paths of trade and financial liberalization among clusters of countries around the world. The scenario results display the static and dynamic general equilibrium effects of changing the structure of trade protection in the region. By systematically altering only the trade policy variables of the countries in the region, we can evaluate the effects of different patterns of protection on the structure of production and income distribution for each country-cluster or sub-region, the regional structure of trade, the pattern of trade with the rest of the world.

For each alternative scenario, the model generates results concerning the impact on real GDP, output, trade, value added, the real wages paid to each labor category, as well as the rental rate of capital and land. Trade diversion and trade creation impacts will be evaluated through data on total, intra-regional, and extra-regional trade. For each alternative scenario we can therefore evaluate the impacts of a different path of integration on the whole regional pattern of trade and financial interdependence.

These scenarios should be seen as model experiments rather than predictions of the actual pattern of growth that may accompany each of these alternative paths of
integration. The actual growth pattern will be the result of many more factors than just trade policy, especially macro-economic and incomes policies. The CGE modeling framework allows for controlled experimentation to determine the size of the impact that could be strictly attributed to changes in a select set of policy variables, specifically tariff and non-tariff barriers in this paper. Both the comparative statics and dynamic experiments are meant to describe, therefore, the impact of different patterns of trade liberalization in the medium to long run. Dynamics here does not imply the actual path of the transition, but rather the a period to period cumulative effect over time of positive productivity externalities that could potentially result from regional integration.

The CGE model presented here, like other multi-country CGE models, has a medium to long-run focus. We assume, for example, that factor markets adjust. While sectoral employment changes, aggregate employment is assumed to remain unchanged (except for the migration flows discussed above). Later in this paper, we report the results of comparative static experiments in which we shock the model by changing some exogenous variables and then compute the changed equilibrium solution.

The results of each scenario are presented relative to a base calibrated with the pre-liberalization structure of trade and financial protection throughout the region. For each set of sub-scenarios, sub-scenarios (1) represents the comparative statics effects while sub-scenarios (2) additionally measures the potential dynamics effects of the same scenario.

The general gains from trade liberalization fall into two main categories: (1) the "comparative statics" effects which result from one-time enhanced efficiency of resource allocation through increased specialization according to comparative advantage; and (2)
the potential "dynamic" effects that positive externalities to the process of trade liberalization and integration may have on each country and on the region as a whole.

The "dynamic" effects of trade liberalization are model through three mechanisms which are empirically important in export-led development: (i) increased productivity from exploiting economies of scale in production for the larger market; (ii) increased efficiency in production and marketing due to competition in domestic markets; and (iii) technological advances affecting production technologies and factor usage, linked to foreign capital goods inflows.

Additional gains relate to regional trade agreements, of which only a few will be further discussed below.\(^7\) Regional integration can create a positive feedback loop. Trade preferences to neighboring economies can increase economic activity, incomes, trade, and economic growth in a mutually reinforcing way, given strong ties among the countries. These factors could certainly work for many country clusters, which already have strong trade and financial linkages among member countries.

*R&D Expenditures and Factor Productivity*

Numerous studies have linked R&D to total factor productivity (TFP) growth. [Kim and Lau 1992, Young 1994] We present two scenarios for R&D expenditures, in contrast to the status quo, of constant shares of GNP spent on R&D. The first scenario simulates additional investments in R&D that double such investments in every region. The second scenario closes the considerable gap in R&D expenditure as a share of GNP between Latin America and the Asian NICs by lifting the Latin American share (0.37\%) to Asian NIC levels (1.83\%).

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\(^7\) For more details, see McCleery 1998.
Natural Resource Shocks

The simulation of different natural resource shocks poses a few problems in this context. Ordinarily, one might simulate a price shock and national or regional responses. However, in the global CGE context, such a price shock would have to be traced to its origins in a demand increase in some large region. Rather than play with demand parameters in this way, we simulate the impact of a positive productivity shock, first in Latin American agriculture, and second in the mining sector. These productivity shocks result in increased exports and export revenues, which feed back to imports of capital goods, intermediate goods, and consumption goods. We test for the possibility of a "Dutch disease" effect, where additional resources are pulled out of industry into the growing sector. We would expect the former shock to land productivity to improve the distribution of income, and for the latter shock to productivity in the mining and minerals sector to worsen income distribution.

Education Expenditures, Labor Productivity, and Income Distribution

The primary education scenario is the across the board increase in educational expenditure in all regions that constitutes the difference between Status Quo/Divergence and Integration/Convergence. On the one hand, moving from this low to high education scenario would require massive new investments in education. On the other hand, as we show in the next section, such investment would pay off handsomely in terms of both income growth and poverty alleviation. We run two additional scenarios on investments in education in specific regions. The first simulates investments that close the skill gap between Latin America and Asian NICs by 50%, while the second eliminates the skill gap entirely. Again, the additional expenditure required to close the gap is considerable,
but as we shall show, the payoff is large as well.

V. Scenario Results

The two major scenarios and their variations tell us much about the possible future paths of the world economy and income distribution, as well as the relative efficacy of different policy and investment initiatives.

Tables 8 through 10 present the results of the two major Divergence and Convergence Scenarios, as well as the series of 6 sub-scenarios which we run on top of the two major scenarios. Table 8 presents real GDP results by region and scenario. Table 9 presents the results of factor wages and Table 10 presents the results of exports and imports. All results are represented in annual average percent change terms from the base year (1992) data.

Divergence and Convergence Base Scenarios

As was stated before, the principal difference between the two major scenarios is the level of investment in human capital improvements, which we find to be the most significant determinate of the pattern of global growth and income distribution. The Status Quo/Divergence Scenario was projected out from current regional levels of educational expenditures and paths of skill improvements. Using UNESCO data discussed in Appendix 1, we projected the rate of improvement in educational attainment and labor skill category mobility seen over the last 15 years into the next 28 years. In the Integration/Convergence Scenario, we simulated the levels of improvements in
educational attainment and expenditures as well as labor skill category mobility in each region that would be required to reduce or eliminate the growth of income inequality in every region. This exercise yielded the result that educational attainment would have to improve by about 50% from current trends in all regions in order to generate a trend of relative or absolute convergence in factor wages. We also calculated the rate of return of investment to education which, as expected will vary across regions. (See Table 13).

The differences between the Convergence and Divergence Scenarios indicate that movement towards a world wide closing of the gaps in wages between lower and higher skill labor categories also produces increasing growth rates of GDP and trade. As can been seen from Table 8 and Table 11, increasing spending on education as a share of GNP by 50% increases GDP average annual growth in all regions by a range of under .1% in most poorer regions and more than .3% in China, LACs and the Transitional region. These differential positive rates of growth thus reflect different returns to investment of education by region (Table 13). The highest rates of return are in China, LAC and TRANS, while the lowest are SSA and LOW. It is important to note that some of the countries with the lowest rates of return to education also have the highest education expenditures as a share of GDP (Table 2), indicating serious problems in efficiency of their educational systems. China is interesting since it is the country with the lowest share of educational expenditures (2%) but with the highest rate of return.
LACs and Transitional represent good investments.

It is interesting to note that these relatively small improvements in GDP growth rates combined with, and related to, relatively small educational investments as a share of GDP are enough to substantially improve the incomes of poorer people and to close the relative, if not absolute, levels of wage inequality in all regions around the world. Table 9 shows the impact of these increases on educational investments and GDP growth on the average annual growth rates of factor wages by skill labor categories in each region. Note that the Divergence Scenario, which represents current educational investment trends, produces widening and substantial gaps in wage inequality in every region on the globe. The Convergence Scenario, on the other hand, substantially increases the growth of income among poorer workers and produces an absolute decline in inequality in regions that contain the majority of the world's population, as well as a significant relative decline in inequality in all other regions. Notable for absolute declines in inequality are LAC, China, SSA and OECD. Regions showing relative declines in equality are LOW, LMID, TRANS, and ANICS.

Table 12 shows the difference in the Convergence Scenario wage growth rates compared to the Divergence Scenario. Notice that a decline or reversal in inequality trends is achieved primarily though significant increases in the growth rates of relatively less lower wage agricultural and unskilled ranging from 1.7% in LMID (representing an increase in .5% over the divergence scenario) to 3.3% in LAC (representing an increase of 1.4%). AGLAB and USKLAB wages grow at the same rate due to rural to urban migration which is modeled as equalizing relative wage differentials among these two types of workers. Higher wage workers are still gaining in the Convergence Scenario,
although at slightly lower rates than in the Divergence Scenario. This is most notably the

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case in LAC and China, where there are absolute reductions in inequality, but also in
LOW and TRAN, which display only relative declines in inequality.

**Trade Scenarios (1 and 2)**

Trade liberalization has the effect of more efficiently allocating resources based
on the elimination of distortionary tariff barriers and the opening of wider markets. This
can have an impact on both an initial reallocation of resources and thus raise GDP (the
so-called comparative statics effect), and it can have a more lasting impact by raising the
productivity growth of an economy (the so-called dynamic externality effects).

As was stated previously, both effects are modeled here. As is typical in other
large CGE modeling exercises of trade liberalization, the comparative static effects show
either a very small increase in GDP, such as for the OECD in Table 8, or they show
slight net negative results due to negative terms of trade effects as is known to be
common in many CGE models of developed-developing country trade.*

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* See Brown (1987), de Melo and Robinson (1989), and Burniaux (1990) for a discussion on terms
of trade effects in trade based CGE models.
Table 9 presents the wages effects of different trade liberalization scenarios. As is to be expected in the comparative statics versions of the scenarios in this and other world CGE trade models, global trade liberalization should produce the factor returns expected within a Stolper-Samuleson framework and it does. In both the Convergence and Divergence Scenarios, sub-scenarios 1a (GATT) and 1b (full world liberalization), income inequality widens within OECD as the wages of skill workers rise and the wages of the less skilled fall. In the developing regions, however the opposite is true and the wages of the less skilled rise and the higher skilled fall. It is interesting to note that while the comparative statics versions of these sub-scenarios reduce income inequalities in the developing countries, they do so at only a fraction of the effect that educational investments have between the Convergence and Divergence Scenarios. In addition, the Convergence Scenarios reduces income inequality in the OECD, which trade liberalization does not.

With respect to the inter-regional liberalization scenarios 1c, 1d, and 1e, the benefits to wages earners in the developing regions either are diminished compared to more global trade liberalization scenarios or disappear altogether. This is clearly the case for LAC in sub-scenarios 1c and for ANIC in sub-scenarios 1d, as well as for virtually all developing regions in sub-scenarios 1e. The appeal of this inter-regional arrangements also has less appeal to the OECD who either see their growth to high wage workers disappear with continued losses to low wage workers (as is the case with an OECD-LAC arrangement in 1c), or else they see the high wage workers loose income as they face targeted competition from ANIC (in the OECD-ANIC arrangement in 1d) or are shut out from markets in 1e.
R&D Investment Scenarios (3)

These scenarios are based on additional investments in R&D that enhance total factor productivity (TFP) growth, including (a) a doubling of investments in every region, (b) the lifting of Latin American investments to Asian NIC levels.

Table 8 shows that scenario 3a clearly has a positive impact on GDP growth in all regions and in both Scenarios. Interestingly, the effect of the same increase in R&D expenditures produces a slightly better expansion of growth in the Convergence than in the Divergence Scenario, indicating a complementarity between R&D and human capital investment. More significant is that with roughly equivalent increases in R&D and education as a share of GDP, the Convergence Scenario produces much higher rates of growth than the R&D scenario in all regions, but especially the high and middle income regions.

What increase R&D investments does not provide compared to the Convergence Scenario, however, is improvements in income distribution. Income inequality actually increases in all regions due to much more rapid increases in the wages of high skilled workers relative to low skilled workers in both the Convergence and Divergence Scenarios. It should be pointed out, however, that lower skilled workers do also gain in the R&D scenarios, but not as much as they do from human capital improvements.

Physical Capital Investment Scenarios (4)

In this scenario, we raise the rates of investment in LAC to 10% above those of ANIC levels. Relative growth rates of LAC obviously increases in both scenarios. Yet as
we saw in the R&D scenario, growth is further enhanced in the Convergence due to a complementarity with physical and human capital investments. It is also important to note that while the level of physical capital investment in this scenario is roughly equivalent to the increase in human capital investment in the Convergence Scenario, the latter produces a higher rate of growth than the former. The physical capital investment scenario also produces less growth than the R&D scenario for a similar increase in outlays.

With respect to income inequality, it is not surprising that skilled workers in LAC enjoy much faster receive income growth than the lower skilled, although they also enjoy some growth. What is interesting is that the physical capital scenario produces a higher rate of inequality than the R&D scenario, due to both a much higher rate of growth of the more skilled as compared to the less skilled.

**Natural Resource Shock Scenarios (5)**

This scenario similes a major natural resource shocks, particularly the impact on Latin America of the doubling of mining/mineral exports by the rest of the world producers. While this would create rapid rates of growth in regions around the world, it also does produce growth in LAC. Yet LAC would be falling behind at a much more rapid rate than in any other scenario.

This scenario also has the effect of increasing the wages of skilled workers at a much higher rate than either the R&D or the physical capital investment scenario. At the same time, this scenario reduces the wages of the unskilled at roughly the same rate as the physical capital investment scenario.
Additional Human Capital Investment Scenarios (6)

Finally, we run a series of sub-scenarios which simulate additional investments in education. The first (6a) closes the educational and skill gap between Latin America and Asian NICs by 50%. The second (6b) raises educational spending in all regions except OECD by 50%.

The first sub-scenario (6a), not surprisingly, has a bigger impact on GDP growth within the Divergence compared to the Convergence Scenario. In fact, given that educational and skill levels tend to become more similar in the Convergence Scenario, there is virtually no Aggregate GDP effect here.

In both the Convergence and Divergence Scenarios, however, sub-scenario (6a) does have the effect of reducing income inequality within LAC, but more so in the Convergence Scenario. Within the Convergence Scenario, wages of the lower skilled rise much faster while wages of the more skilled do not fall as much as in the Divergence Scenario.

The second sub-scenario (6b) is interesting because it shows us the impact on the rich OECD region of additional educational expenditures in the rest of the world outside of the OECD. Global growth is further enhanced and within region income inequality is further reduced. The effect on the OECD is positive, but not only in terms of GDP growth. The OECD own income inequality if benefited from a complementary improvement in the developing regions towards higher skilled workers, which generate higher growth, but also a relieving of pressure on lower skilled workers both world-wide and at home.
VI. Conclusions and Policy Recommendations

This paper presented a dynamic computable general equilibrium (CGE) framework for analyzing the impact of alternative scenarios on production, real wages, the structure of employment, and inequality within and between countries. The "IDB World CGE model" presented here was designed to simulate various policy measures, exogenous shocks, and economic interactions among nine "country clusters" or key regions of the world. Of particular interest will be the impact on employment and income distribution among skilled and unskilled workers due to enhanced trade and investment competition between Latin America, OECD, former Soviet Bloc, Asia, and other low and middle income regions. We pay particular attention to both growth and inequality implications of all scenarios, searching for ways to improve growth without worsening income inequality, or alternatively improving income distribution without reducing growth.

The IDB-World CGE model is also used to analyze the potential impacts of a series of policy interventions that can change the pattern of trade and investment, as well as the productivity path of different factors of production, and thus the pattern of income and employment adjustments. We specifically focus on the policies and investments that could substantially affect these alternative outcomes. In particular, the model simulates alternative flows of investment resources for physical capital, human capital, and R&D improvements. The IDB-World CGE model can thus allow one to evaluate within a single framework, the long run relative impacts of different factor supplies (tangibles such as labor and capital), polices designed to increase the efficiency of factor allocation
(trade liberalization), as well as improvements in different factor productivities (through investments in human capital and R&D).

Our results shown that growth can clearly be augmented by additional investments in any of several directions, but not that each has different consequences for income inequality. We focus here on three major areas that receive considerable attention in the development literature, namely investments in physical capital (structures, plant and equipment), education, and research and development. Except for the case of R&D, for which we do not directly calculate rates of return, the first thing to notice from Table 13 is that rates of return vary considerably across regions, especially in education. This variance leads to different orderings, implying different policy recommendations. For instance, it appears that OECD countries should be spending relatively more on R&D, given its high return (20% by assumption) relative to returns on investments in education and physical capital in the range of 11-12%. But for middle income countries in Asia, Latin America, and Eastern Europe alike, the big returns are in investments in education. In Latin America and the transitional economies, investments in education yield rates of return more than 50% higher than investments in R&D, and about twice the return of investments in physical capital.

It is troubling to note that the rate of return to education lags behind both the returns to R&D and to physical capital in the poorest regions. With the exception of China, which more closely resembles its transitional cousins in Europe in terms of high returns to education and relatively low returns to physical capital, rates of return on educational investments lag under 10% in Sub-Saharan Africa, South Asia, and North Africa/Middle East.
One explanation for these low rates of return can be found in the relatively poor current state of education in these regions. With poor human resources, institutions, and traditions in the educational systems, rates of return are bound to be lower. A second factor could be gender bias in education, and the inefficiencies this promotes. A comprehensive discussion of the reasons for these differences across regions is beyond the scope of this paper, however.

Thus further education investments can serve as an engine of growth primarily for China and the middle income countries in Latin America, Europe and Asia. We can further conclude that higher overall rates of return to investments of all types in these regions may account for their preeminence in attracting private capital inflows.

This policy recommendation to promote education investment in Latin America and selected other developing regions rests not only on growth, but on income distribution considerations as well. Our simulations show that education (combined with job creation in appropriate sectors of the economy) is the key to convergence in incomes across skill levels in the population, and to lifting the poorest workers out of absolute poverty. While growth based on R&D or increase capital accumulation does raise the wages of agricultural and unskilled urban workers, the majority of the benefits from such growth accrue to skilled and professional workers, who are at the forefront of mechanization, product and process development, etc.

Globalization will clearly be a boon primarily to those best prepared to receive it. Yet we have shown that trade liberalization alone is clearly not a sufficient answer to the joint challenges of faster growth and better income distribution in the developing world. More research remains to be done before the claims made here regarding investments in
education in middle income countries can be fully substantiated. But at this point, trade
liberalization combined with investments in education seem to be the best hope for
Rebecca, Bele and Americas (1974) The Stagnant of Progress in Developing
generating rapid growth with substantial improvements in the distribution of income in
Latin America, in the face of rapid labor force growth, strong competition from other
regions, and other challenges that will emerge before the year 2020.
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