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FREE TRADE AND LONG-RUN GROWTH

by

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ABSTRACT

What is the impact on output of movement towards free trade? Can trade liberalization have a permanent effect on output levels, and more importantly, does it have an impact on steady-state growth rates? The model developed here emphasizes the role that knowledge spillovers emanating from heightened trade can have on long-run growth rates. The model also facilitates an analysis of the dynamic behavior of income *levels* and terms of trade - as well as growth rates - during the transition between steady states. Among the results of the model, unilateral liberalization by one country generates a positive impact on the steady-state growth of all its partners while at the same time inducing a level effect on the liberalizing country that reduces the income gap between it and other, wealthier, countries. In some cases, the liberalizing country may even leapfrog over initially wealthier countries.

I. INTRODUCTION

There has been much discussion in recent years concerning the presumed advantages and disadvantages of enacting trade agreements designed to permit freer trade among countries. NAFTA and the Uruguay Round of GATT have been two of the main focal points of these discussions. At the core of these debates is the question of whether movement towards free trade foster more rapid growth for all parties concerned or just for a subset of the signatories.

Empirical studies by Ben-David (1993, 1994, 1996) show that the elimination of trade barriers and increases in the volume of trade lead to a marked reduction in the income gaps that had existed between trading countries. While this reduction in income disparity may be a desired result for some, it still does not allay the concern of others that the income convergence came at the expense of wealthier countries.

This issue, or more generally, the impact of trade liberalization on the long-run growth paths of countries, is the focus of this paper. We present a theoretical framework that examines how a unilateral reduction in tariffs may affect the reforming country's steady-state growth as well as that of its partner countries. While most models describing the relationship between trade and growth concentrate only on the steady-state behavior of growth rates, the model described below provides an explicit account of the transitional process between steady states – not only for growth rates, but also for income levels and the terms of trade dynamics that accompany the movement to the new steady state path. Such an analysis makes it possible to determine the circumstances in which a fast growing country is in the process of catching up to the leaders or in the process of pulling away from the laggards. It also makes it possible to gauge the impact of unilateral, bilateral, or multilateral trade liberalization programs on the long-run growth rates of countries, be those countries directly or indirectly related to the particular liberalization programs.

The general equilibrium model presented here is based on the premise that (1) knowledge may be characterized as a non-rivalrous public good which is in many cases non-excludable, and (2) trade flows facilitate the diffusion of knowledge among countries. The non-rival aspect implies that ideas may be used concurrently in different places and on different production processes. Non-excludability implies that an idea has public good characteristics that limit the ability of its originators to receive compensation for its creation.

Heightened trade will, in general, lead to greater diffusion and faster knowledge growth and hence, faster per capita output growth. Even though the liberalizing country's tariff reductions also affect relative prices which lead to reductions in trade between other pairs of countries, we show that the overall outcome of tariff elimination, even when it is being carried out by a single country, nevertheless leads to faster steady-state growth for all trading countries. This growth effect is greater the more countries enact tariff-reduction policies.

While all countries experience faster steady-state growth as a result of unilateral tariff reductions, the level effect for the liberalizing country is not negligible, enabling it to leapfrog over other countries during the transition to the new steady state. Since all countries with similar levels of technology grow at the same rate in steady state (in lieu of any additional changes in commercial policy), the relative improvement of one country vis-a-vis the other countries will persist in the long-run.

At this juncture, it is important to clarify the boundaries of this paper and to specify its limitations. The framework developed here is obviously not the only way to characterize international trade's impact on economic growth. In order to focus on the impact of knowledge spillovers, some of the more traditional explanations (such as economies of scale and comparative advantage, as well as sectoral delineations of economies that include R&D sectors) have been omitted. These will be discussed further below.

Also, this paper does not attempt to explain why countries levy tariffs in the first place nor why they continue to impede trade when this may inhibit growth. Trade barriers may exist as a result of

uncertainty regarding the possible level and growth implications of liberalization. Alternatively, political economy considerations, which may differ across countries depending on the distribution of influence of various groups or factions, can lead to varying degrees of protection. In any event, this paper is not about why trade barriers exist, but about what may happen to output when they are removed.

The outline of the paper is as follows. The next section provides some background and discusses related studies. Section three provides a theoretical framework that details the contribution of trade towards the diffusion of knowledge and its subsequent effects on output growth. The impact of tariff reductions on output levels and growth rates in the short and long runs is highlighted by means of numerical simulations in section four. Among other things, these simulations make it possible to examine what occurs during the transition between one steady state and another as a result of changes in tariff policies. Section five concludes.

II. Background and Motivation

The past decade has been witness to a growing number of studies aimed at explaining the impact of international trade on economic growth. The main catalyst for the resurgence of this topic has been the emergence of growth models that endogenize the growth process, and in so doing, have created frameworks that enable an analysis of the growth effects of a host of policy instruments.

This resurgence notwithstanding, the relationship between trade and growth has been studied at least as early as Adam Smith. But as Rodrik (1992) asks, if the positive link between the two is so obvious, then why has it taken so long for the countries of the world to embrace free trade? Part of the answer lies in the fact that this positive relationship has not been particularly obvious.

According to Olson (1982), the political and economic reorganizations that occurred following World War II led to the dissolution of many of the distributional coalitions that had previously existed.

These developments were important aspects of the recovery process which culminated in, among other things, an eventual opening of markets.[1] It is interesting to note that, while the postwar period has been characterized by movement towards freer trade, most countries experienced either growth slowdowns, or no noticeable growth improvements.[2]

For example, Ben-David and Papell (1995a) study the behavior of GDP for 74 countries from 1950 through 1990 and show that 46 of the countries exhibit a break in their growth path during this period. Of these 46 countries, 41 experienced significant slowdowns following their breaks. Only five countries out of the entire sample exhibited significant increases in their rates of growth. From the trade perspective, however, Ben-David and Papell (1996) find that the majority of countries in the postwar period exhibited increases in the volume of their trade. The evidence of heightened trade on the one hand, combined with growth slowdowns on the other, appears to indicate that the relationship between trade and growth, to the extent that one exists, is a negative one (see also Fieleke [1994]).

We claim that this is not the only way to interpret the empirical evidence, however. The postwar period is, by definition, a period following a major upheaval. Standard growth theory tells us that in the aftermath of a negative shock as great as World War II, countries should be expected to exhibit growth rates that initially exceed their steady-state rates. Eventually, as the countries return to their original growth paths, their growth rates should fall back to the original steady-state values. Hence, the fact that growth rates have fallen during the past several decades could very well be due to the return of countries to their long-run growth paths. However, in light of the extensive trade liberalization that has occurred since the war, one might ask whether postwar steady-state paths are the same as prewar paths or are they new paths characterized by faster growth?

Ben-David and Papell (1995b) examine 12 decades of annual GDP data for fifteen OECD

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[1] It should be pointed out that the postwar period has also been characterized by declining transportation costs that supplement the greater mobility of goods brought about the systematic removal of barriers to trade.

[2] These slowdowns are examined in, among others: Griliches (1980); Bruno (1984); Romer (1987); Baumol, Blackman, and Wolff (1989), and De Long and Summers (1992).

countries. Each of these countries was found to have experienced a significant break in their real per capita GDP between 1870 and 1989. In all but one of the cases, the break was characterized by a sharp drop in levels followed by substantially faster growth.[3] For the majority of the countries, the break occurred during World War II.[4] While the standard neoclassical model predicts that the countries should have returned to their earlier steady-state paths after an interim transition period, Ben-David and Papell show instead that each of the countries in the sample rebounded to a new path that transcended its old one. Not only were output levels higher along the new path, but average growth rates for the period *after* the old paths were surpassed were found to be two and a half times higher than the *pre*break steady-state growth rates.

An interesting case in point is that of the founding members of the European Economic Community (EEC). The removal of trade barriers between these countries led to substantial increases in trade and to a significant reduction in income gaps between member countries.[5] The average ratio of exports to GDP in five of the six original member countries (Belgium, France, Germany, Italy, and the Netherlands) during the postwar years exceeds the average ratio for these countries in the seven decades preceding World War II by a factor of 2.11.[6] Although the increased openness of the postwar period is accompanied by higher growth rates, it would be presumptuous to attribute all of the faster growth following World War II to increased trade. Nevertheless, it is still useful to compare results between the relatively free trade years prior to World War I (from 1870-1913) and the years following the postwar slowdown (1973-1989). The average export-output ratio across the five countries for the post-slowdown period exceeds the pre-World War I ratio by a factor of 2.83. Likewise, the five country

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[3] The other country, Switzerland, experienced a positive increase in GDP levels.

[4] World War I and the Great Depression were the primary break periods for the remaining countries.

[5] See Ben-David (1993).

[6] The periods of comparison here are 1870-1939 and 1950-89 using data from Maddison (1991). The sixth original member of the EEC, Luxembourg, is not included in Maddison's data set.

average growth rate of per capita real GDP for the post-slowdown period is higher as well, exceeding the pre-World War I rate by a factor of 1.63.

In the aftermath of World War II, economic policies were affected by two major (and contradictory) strands of influence. On the one hand, American policy makers exerted tremendous pressure on European countries to liberalize trade by making economic support via the Marshall Plan contingent on trade reform. On the other hand, import substitution policies, particularly for developing countries, received a boost from early work by Prebisch (1950), Singer (1950), Myrdal (1957, 1959) and others on the assumption that (1) the impact of terms of trade will be negative for developing countries that primarily produce goods with low income elasticities and (2) infant industries need increased protection in order to become viable. The latter view received support from several important international lending institutions which in turn led many poor countries to adopt more protectionist policies.

Over time, however, these protectionist views were challenged by increasing evidence that more outward-oriented economies seemed to be growing faster than countries that restricted trade. This observation received a variety of possible explanations by, among others, Kindleberger (1962), Caves (1965), Corden (1971), and Johnson (1971) who placed an emphasis on, respectively: the existence of a trade sector as a leading, balancing, or lagging sector; exports as a "vent for surplus"; "factor-weight" effects; and factor price and factor utilization ratios. More recent studies, which include Romer (1990, 1994), Feenstra (1990), Jones and Manuelli (1990), Grossman and Helpman (1991a, 1991b), Rivera-Batiz and Romer (1991a, 1991b), Stokey (1991), Young (1991), Backus, Kehoe, and Kehoe (1992), Baldwin (1992), Ruffin (1993), and Easterly, King, Levine, and Rebelo (1994) emphasize various other aspects of the growth process and how international trade may affect them.

One particular aspect that has received considerable emphasis in much of the recent literature is the sectoral decomposition of economies (and in particular, the existence of an R&D sector). This form of modeling has provided insight into the interaction between the various components that combine to

create growth. One problem with these models, however, has been the difficulty that they pose as far as empirical tractability is concerned, in particular regarding issues relating to the convergence of incomes. For this reason, the model presented here concentrates on the aggregate economy, or more specifically, on aggregate output as well as on bilateral trade among countries.

The notion that the dissemination of ideas is essential to the growth process would seem to be fairly intuitive. Hence, any mechanism which might advance the flow of knowledge from one country to the next should provide a positive, or in the least, a non-negative spur to the development of countries. Parente and Prescott (1994) show how differences in barriers to technology adoption can account for the large income gaps across countries while Rosenberg (1980) provides evidence that the increasing number of ideas has been an important factor in raising modern standards of living.[7]

What spurs the diffusion of these ideas? The primary assumption of this paper, which follows the intuition of Dollar, Wolff, and Baumol (1988), Grossman and Helpman (1991a, 1991b, 1995), and others is that trade between countries acts as a conduit for the dissemination of knowledge.[8] Therefore, to the extent that this is true, the erection of barriers to trade inhibits the transmission of ideas and prevents countries from attaining levels of wealth that might otherwise be possible. Coe, Helpman, and Hoffmaister (1995) show that R&D spillovers from industrial countries to developing countries are substantial and that the extent of openness by LDC's to developed countries significantly impacts the extent of these spillovers which in turn positively affect growth in total factor productivity. Harberger (1984) also provides evidence that the existence of impediments to trade limits the growth of poor countries. Their removal, in the instances that this has occurred, has corresponded to heightened growth. This finding is corroborated and strengthened by empirical evidence presented in Sachs and Warner (1995) that compares growth rates of open and closed economies and finds that the former exhibit

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[7] Eaton and Kortum (1994) show that the number of patents registered abroad - as an indicator of the development of ideas - affects the international diffusion of technology.

[8] Marin (1995) provides empirical evidence showing that Austria's relatively fast growth during the postwar period "has been induced by knowledge spillovers from its trading partners," particularly Germany.

consistently higher growth.[9]

Nevertheless, as Lucas (1988) points out, the removal of trade barriers may be nothing more than a series of level effects disguised as growth effects. Indeed, level effects may be far from inconsequential and may lead a country to leapfrog over initially wealthier countries.[10] The theoretical framework developed here shows that movement towards free trade (or alternatively, movement towards protectionism) produces growth effects as well as level effects. So, while leapfrogging may occur here (as will be shown in the simulations), all countries experience long-term benefits from the trade reforms of even one country.

The last simulation detailed in section four examines a scenario involving the creation of a free trade area by two relatively developed countries and the non-inclusion of a third, less developed, country.[11] The outcome of the simulation indicates that while all three countries exhibit higher, and equal, growth rates in the steady state, the income levels of the developed countries converge to the same growth path, while an income gap exists (and persists) between the top two countries and the LDC. To the extent that this characterizes developed countries with low barriers to trade and developing countries with relatively high rates of protection, the model provides a theoretical explanation for the apparent income convergence among the wealthier countries, and the non-convergence between them and the developing countries.

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[9] This also appears to be consistent with evidence in Balassa (1977), Michaely (1977), Ram (1990), Harrison (1991), Dollar (1992), Edwards (1992), Hansson and Henrekson (1992), Gould, Ruffin, and Woodbridge (1993), and Frankel and Romer (1995).

[10] See for example: Brezis, Krugman, and Tsiddon (1993); Goodfriend and McDermott (1994); and Motta, Thisse, and Cabrales (1995).

[11] In related work, Krugman (1991a, 1991b) and Frankel, Stein, and Wei (1993) examine the welfare implications of having three continental trading blocs while Krugman and Venebles (1994) focus on two regions called North and South.

III. THE MODEL

> "It is plausible to suppose that the foreign contribution to the local knowledge stock increases with the number of commercial transactions between domestic and foreign agents. That is, we may assume that international trade in tangible commodities facilitates the exchange of tangible ideas... It seems reasonable to assume therefore that the extent of the spillovers between any two countries increases with the volume of their international trade (Grossman and Helpman [1991a, 166-167])."

Intuition of this kind, namely that international trade acts as a conduit as well as an impetus for the flow of knowledge across international borders, provides the underlying basis for the model to be developed here. Specifically, the goal of this section is to construct an open economy version of the neoclassical growth model which includes knowledge as a factor of production. When all countries are identical, with the exception of initial endowments, their behavior over time is similar to the predicted behavior of countries in the Solow-Cass-Koopmans model, namely convergence to identical long-run growth paths. The model developed in this paper departs from the usual neoclassical conclusions with regard to the impact of trade policy and the relative openness of countries. Here, the extent of openness not only affects output levels, but also has an impact on steady-state growth rates.

A. *The Set-up*

The model that we propose follows Romer (1990) by focusing on the importance of knowledge accumulation in the production of output. Physical capital is assumed here to be constant and is normalized to equal unity.[12] Like Romer, we assume that growth in per capita output is due to the

[12] In a separate study (Ben-David and Loewy [1995]), we allow for the accumulation of both physical capital and knowledge. We find that the addition of the former leads to no substantive qualitative differences as far as steady-state outcomes are concerned. The inclusion of physical capital does, however, considerably constrain the examination of transitional dynamics and, in particular, issues related to convergence in income levels. This in turn makes its inclusion less useful for the analysis conducted below.

accumulation of knowledge. However, in contrast with his model, we make no distinction between firm specific knowledge and the aggregate stock of knowledge that an economy possesses.

Consider a world with J countries, each of which produces a distinct good, with good i being the output of country i. Let n_i be the population growth rate in country i and $c_{ij}(t)$ be the per capita quantity of good j consumed in country i at time t. Assuming that each agent in country i is identical, the aggregate preferences of the agents in country i are given by

$$\int_0^{\infty} e^{-(\rho - n_i)t} L_i(0) \sum_{j=1}^{J} \alpha_{ij} \ln c_{ij}(t)\, dt \tag{1}$$

where $\sum_{j=1}^{J} \alpha_{ij} = 1$ and the discount rate, ρ, is common across all J countries. In what follows, we normalize the initial population level in each country to one and, in order to avoid additional notation, assume that population size and labor force are equal. Note that the form of the utility function implies that country i will trade with each of the remaining J - 1 countries at every point in time. Since the same is true of all other countries, there will exist bilateral trade between every pair of countries.

Good i is produced using labor and knowledge. Assuming that the production function is linear homogeneous in labor, this relationship may be written in per capita terms as

$$y_i(t) = A H_i(t)^{\varepsilon_i} \tag{2}$$

where $y_i(t)$ is per capita output, $H_i(t)$ is the aggregate stock of knowledge in country i at time t, and $0 < \varepsilon_i$. Note that as was the case with population growth rates, n_i, we permit the production parameter, ε_i, to differ across countries, although there is no requirement that this be the case. While the existence of such differences in ε implies that countries' per capita incomes will grow at different rates in the steady state, as we show below, their steady-state rates of knowledge accumulation nevertheless will be the same.

Per capita income in country i is the sum of per capita output plus per capita government tariff revenue. This income is then used to finance the consumption of both domestic and foreign goods. Let

good 1 be the numeraire good, $p_i(t)$ be the time t price of good i, and τ_{ij} be country i's tariff on imports from country j ($\tau_{ii} = 0$ by definition). Tariffs are set exogenously and are assumed to be constant over time. Hence, country i's budget constraint is

$$\sum_{j=1}^{J} \frac{p_j(t)\cdot(1+\tau_{ij})}{p_i(t)} c_{ij}(t) = AH_i(t)^{\varepsilon_i} + g_i(t) \tag{3}$$

where

$$g_i(t) = \sum_{j \neq i} \frac{p_j(t)\,\tau_{ij}\,c_{ij}(t)}{p_i(t)} \tag{4}$$

represents government revenues from the imposition of import tariffs which are transferred back to agents lump sum.

Following Lucas (1988), per capita growth in the steady state is obtained by positing that the technology of knowledge accumulation for country i is constant returns to scale in the level of knowledge of country i. It is assumed further here that this technology is also constant returns to scale in the level of knowledge of all other countries. Moreover, the share of country j's knowledge that affects country i's rate of knowledge accumulation depends upon (i) the fraction of country j's knowledge to which country i has access through trade and (ii) country i's ability to absorb and utilize the accessible part of country j's knowledge.

As the quotation at the beginning of the section suggests, the share of country j's knowledge to which country i has access (and therefore is the source of any potential knowledge spillovers) is likely to be an increasing function of the volume of trade between the two countries. To make matters concrete, let $v_{ij}(t)$ be the fraction of country j's knowledge that is accessible by country i. In line with what Grossman and Helpman (1991b) propose, $v_{ij}(t)$ is modeled as the ratio of country i's total exports to country j divided by country i's aggregate output, or

$$v_{ij}(t) = \frac{L_j(t)\,c_{ji}(t)}{L_i(t)\,y_i(t)} \quad , \qquad i \neq j \tag{5}$$

where recall that c_{ji} represents country j's real per capita consumption of country i's good and L_i is the size of the population in country i at time t. As the specification of v_{ij} indicates, the simplifying assumption being made here regarding the relationship between knowledge spillovers and trade is that only exports matter. A discussion of the implications of this assumption is postponed until the beginning of the next subsection.

Next, define a_{ij} (where $0 \leq a_{ij} \leq 1$) as a constant representing the share of country j's accessible knowledge that can actually be utilized (or absorbed) by country i as part of its own knowledge.[13] One can view this variable as capturing Abramovitz's (1986) notion of "social capability" that determines the potential of a country to utilize existing technologies. Given these definitions, the accumulation of knowledge in country i may be written as

$$\dot{H}_i(t) = \phi\left[\sum_{j \neq i} a_{ij} v_{ij}(t) H_j(t)\right] + (\phi - \delta_H) H_i(t) \tag{6}$$

where ϕ and δ_H represent a common productivity parameter and rate of depreciation of the knowledge stock (in terms of obsolescence or otherwise).[14]

Note that in the absence of trade (or with no capacity to absorb others' knowledge), domestic knowledge grows at the exogenous rate $\phi - \delta_H$. In such a case, the model reverts to a simple exogenous growth model which is essentially a modified version of the Solow model. Should it also be the case $\phi = \delta_H$, then there is no per capita growth in autarky.

As far as the impact of tariffs on growth is concerned, recall (from equation 5) that tariffs do not directly affect the v_{ij}'s and they do not directly affect the rate of knowledge accumulation. However, as

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[13] The assumption that a_{ij} is a constant is made for simplification purposes only.

[14] In contrast to our approach, Lucas (1993) assumes that the level of knowledge in other countries affects knowledge accumulation in country i through the average level of knowledge worldwide. In his specification, complete openness is assumed.

will be shown below, they do have a direct effect on consumption through their impact on market clearing prices. This in turn has an effect on the trade ratio and hence on $\dot{H}_i$.[15]

To find the equilibrium time path for this economy, the current value Hamiltonian is formed for country i. Letting $\lambda_i(t)$ be the costate variable for knowledge in country i, we have, after dropping the time argument,

$$H(c_{i1},\ldots,c_{iJ},H_i,\theta_i,\lambda_i,t) = \sum_{j=1}^{J} \alpha_{ij}\ln c_{ij} + \theta_i\left[A H_i^{\varepsilon_i} + g_i - \sum_{j=1}^{J}\left(\frac{p_j(1+\tau_{ij})}{p_i}\right)c_{ij}\right]$$

$$+ \lambda_i\left[\phi\left(\sum_{j\neq i} a_{ij}v_{ij}H_j\right) + (\phi-\delta_H)H_i\right] \quad . \tag{7}$$

The first-order conditions for an interior solution to this problem are:

$$\frac{\alpha_{ii}}{c_{ii}} = \theta_i \quad ; \tag{8}$$

$$\frac{\alpha_{ij}}{c_{ij}} = \frac{p_j(1+\tau_{ij})}{p_i}\theta_i \quad , \qquad j\neq i \quad ; \tag{9}$$

$$\dot{\lambda}_i = \lambda_i\left[\rho - n_i - (\phi-\delta_H) + \phi\varepsilon_i\left(\sum_{j\neq i}\frac{a_{ij}v_{ij}H_j}{H_i}\right)\right] - \theta_i\varepsilon_i A H_i^{\varepsilon_i-1} \quad ; \tag{10}$$

plus the budget constraint (5) and the transversality condition

$$\lim_{t\to\infty} e^{-(\rho-n_i)t}\lambda_i(t)H_i(t) = 0 \quad . \tag{11}$$

Given initial conditions for knowledge in each country, the solution to this problem yields the optimal path for country i, taking as given $\{p_j(t)\}_{j=1}^{J}$ and $\{c_{ji}(t)\}_{j\neq i}$, for all $t \geq 0$. Since agents in all other

[15] To the extent that a reduction in tariffs leads to an increase in growth rates, it follows that ad valorem subsidies funded by a lump-sum tax lead to even faster growth. However, if the lump-sum tax is replaced by the more common proportional income tax, then the growth outcome is less clear since the issue converts to an optimal income tax/trade subsidy problem that is beyond the scope of this paper.

countries solve a similar problem, by Walras' Law these prices are determined through the market clearing conditions for J - 1 of the goods. Hence, a vector of prices which at every point in time is consistent with agents in each country solving their respective problem and is consistent with market clearing constitutes an equilibrium for this economy.

B. ***The Static Allocation Problem***

Recall that we define our measure of openness, v_{ij}, to be the ratio of exports to output rather than that of total trade (which would add imports to the numerator) to output. The primary consequence of such an assumption is that each country's problem dichotomizes into a static allocation problem and a dynamic knowledge accumulation problem which simplifies the analysis considerably. Since countries will be shown to maintain balanced trade with their trade partners (on a multilateral rather than on a more limiting bilateral basis), this is not an overly restrictive assumption since changes in bilateral exports are reflected in similar (although not necessarily identical) changes in bilateral imports. For completeness, however, the Appendix provides an extension of the model where v_{ij} is defined as the ratio of total trade between i and j to i's output. While there is no longer a dichotomy between the static and dynamic problems in that case, the results remain qualitatively the same as those presented here. Hence, little is gained from the additional complexity.

Equations (3), (8), and (9) combine to yield the consumption demands

$$c_{ii} = \alpha_{ii}(y_i + g_i) \tag{12}$$

and

$$c_{ij} = \alpha_{ij}\frac{p_i}{p_j(1+\tau_{ij})}(y_i + g_i) \quad . \tag{13}$$

Substituting equations (13) into the expression for g_i, equation (4), and then substituting the resulting expression into equations (12) and (13) produces the closed form expressions

$$c_{ii} = \alpha_{ii} Q_i y_i \tag{14}$$

and

$$c_{ij} = \alpha_{ij} \frac{p_i}{p_j(1+\tau_{ij})} Q_i y_i \tag{15}$$

where

$$Q_i = \frac{\prod_{j \neq i} (1+\tau_{ij})}{1 + \sum_{j \neq i} \tau_{ij}(1-\alpha_{ij}) + \sum_{j \neq i,k} \sum_{k \neq i,j} \tau_{ij}\tau_{ik}(1-\alpha_{ij}-\alpha_{ik}) + \ldots + \left(1 - \sum_{j \neq i} \alpha_{ij}\right) \prod_{j \neq i} \tau_{ij}} \quad .$$

Recalling that good 1 is the numeraire, the prices of goods 2, ..., J are found by substituting equations (14) and (15) for each (i, j) into J - 1 of the following market clearing conditions

$$c_{ii}(t) + \sum_{j \neq i} \frac{L_j(t)}{L_i(t)} c_{ji}(t) = A H_i(t)^{\varepsilon_i} \quad . \tag{16}$$

Solving this system implies that

$$p_i = \pi_i \frac{L_1 y_1}{L_i y_i} \qquad i = 2, \ldots, J \tag{17}$$

where π_i is a function of $\hat{\alpha}_{ij} = \dfrac{\alpha_{ij} Q_i}{1+\tau_{ij}}$ for all i and j $(i \neq j)$. For example, if $J = 2$, then $\pi_1 = 1$ (trivially) and $\pi_2 = \hat{\alpha}_{12}/\hat{\alpha}_{21}$. More interestingly, if $J = 3$, then again $\pi_1 = 1$, while

$$\pi_2 = \frac{\hat{\alpha}_{12}(\hat{\alpha}_{31} + \hat{\alpha}_{32}) + \hat{\alpha}_{13}\hat{\alpha}_{32}}{\hat{\alpha}_{21}(\hat{\alpha}_{31} + \hat{\alpha}_{32}) + \hat{\alpha}_{23}\hat{\alpha}_{31}} \tag{18}$$

and

$$\pi_3 = \frac{\hat{\alpha}_{13}(\hat{\alpha}_{21} + \hat{\alpha}_{23}) + \hat{\alpha}_{12}\hat{\alpha}_{23}}{\hat{\alpha}_{21}(\hat{\alpha}_{31} + \hat{\alpha}_{32}) + \hat{\alpha}_{23}\hat{\alpha}_{31}} \quad . \tag{19}$$

Country i's measure of openness towards country j, v_{ij}, is found by using equation (17) to substitute for p_i and p_j in the c_{ji} version of equation (15) and then substituting this expression into the

definition of v_{ij} (equation 5). Doing so yields

$$v_{ij} = \hat{\alpha}_{ji} \frac{\pi_j}{\pi_i} \tag{20}$$

for all $i \neq j$. Given its significance in what follows, note that each v_{ij} is a constant.

Finally, although there is no requirement that *bilateral* trade be balanced between any two countries i and j, the market clearing conditions (16), national budget constraint (3), and the government budget constraint (4) jointly imply (in the absence of international capital flows) that each country maintains multilateral trade balance at every point in time. In other words

$$L_i(t) \sum_{j \neq i} p_j(t) c_{ij}(t) = \sum_{j \neq i} p_i(t) L_j(t) c_{ji}(t) \qquad \forall\, i \quad .$$

C. *The Rate of Knowledge Accumulation*

The dynamic system comprised of equations (6) for $i = 1, \ldots, J$ may be written in vector notation as

$$\dot{\mathbf{H}}(t) = \mathbf{\Phi} \cdot \mathbf{H}(t) \tag{21}$$

where $\mathbf{H}(t) = (H_1(t), \ldots, H_J(t))'$ and

$$\mathbf{\Phi} = \begin{bmatrix} \phi & \delta_H & \phi a_{12} v_{12} & \cdots & \phi a_{1J} v_{1J} \\ \phi a_{21} v_{21} & \phi & \delta_H & \cdots & \phi a_{2J} v_{2J} \\ \cdot & \cdot & & & \cdot \\ \cdot & \cdot & & \ddots & \cdot \\ \cdot & \cdot & & & \cdot \\ \phi a_{J1} v_{J1} & \phi a_{J2} v_{J2} & \cdots & \phi & \delta_H \end{bmatrix} .$$

Since Φ is a matrix of constants (because each v_{ij} is one), the solution to equation (21) can be written as

$$\mathbf{H}(t) = \sum_{j=1}^{J} \xi_j e^{\mu_j t} \mathbf{x}_j \qquad (22)$$

where $\mu_1,\ldots,\mu_J$ are the eigenvalues of Φ, $\mathbf{x}_1,\ldots,\mathbf{x}_J$ are the associated eigenvectors with $\mathbf{x}_i = (x_{1i},\ldots,x_{Ji})'$, and $\xi_1,\ldots,\xi_J$ are constants determined by the initial conditions $H_1(0)$, ..., $H_J(0)$ and the eigenvectors.

Let μ_1 be the largest eigenvalue of Φ. As long as at least one $a_{ij} > 0$ for each i and because all goods are traded (*i.e.*, $v_{ij} > 0$), it follows that $\mu_1 > \phi - \delta_H$. Since only the largest growth rate applies in the steady state, it follows that in each country i, H_i grows at the rate $\gamma_H^* = \mu_1$ (where the asterisk denotes steady-state values). Furthermore, by the definition of $\mathbf{x}_1$, it follows that in the steady state the levels of *relative* knowledge, H_j^*/H_i^*, are given by x_{j1}/x_{i1} which are also constant. Note that μ_1 is increasing in every v_{ij} since the more open is country i towards country j, the faster it, and hence, every other country that trades with country i grows. Since the utility function guarantees that all countries trade with each other, then even if country i becomes more open only towards country j, *all* countries grow faster in the steady state.

These results, together with those from the previous subsection, imply that the behavior of each country may be characterized by the following steady-state relationships:

$$\gamma_{c_{ii}}^* = \gamma_{y_i}^* = \varepsilon_i \gamma_H^* \quad ; \qquad \gamma_{c_{ij}}^* = \gamma_{p_i}^* - \gamma_{p_j}^* + \gamma_{y_i}^* \qquad (23)$$

where γ_x^* denotes the steady-state rate of growth of any variable x. Therefore, the rate of knowledge accumulation is identical for each country, while the growth rate of per capita output may vary if the production parameters (ε_i's) differ. To the extent that these parameters are the same, so too will be the steady-state growth rate of per capita output in each country.

Finally, solving for the steady-state solution to the Euler equation and substituting it into the transversality condition shows that it is necessary that $\rho > n_i$. This is verified in the Appendix as part of the solution to the modified model.

To better highlight the short and long-run effects that changes in tariff policy may have on the initiating country, as well as on its trade partners, the focus now shifts to a number of simulations of the model. These facilitate a clearer understanding of the impact of the liberalization process on output levels and growth rates by detailing the changes that take place during the transition from one steady state to the next.

IV. SIMULATIONS

The focus in this section will be on a three-country world since this permits an analysis of (among other things) the effects of unilateral trade liberalization on the part of the country with the middle level of income on both its wealthier and poorer trade partner. Within such a scenario, can the liberalizing country catch-up or even surpass the per capita income level of the wealthier country? Would the long-run growth effects of such a policy be different if it were instituted instead (or as well) by the wealthy country or the poor country? The following simulations show that a variety of conclusions are possible.

Simulation 1: Different Initial H (Baseline Case)

The first simulation, which also serves as our baseline case, assumes that all three countries are identical save for their initial levels of knowledge. For simplicity, a_{ij} and the initial values of A and L_i (for $i = 1, 2, 3$ and $j = 1, 2, 3$) are set at unity while $\mathbf{H}(0) = (1, 2, 3)'$, $\phi = 0.1$, $\delta_H = 0.05$, $n_i = 0.02$, $\varepsilon_i = 0.3$, $\alpha_{ii} = 0.6$, and $\alpha_{ij} = 0.2$ where $i, j = 1, 2, 3$ and $i \neq j$. Hence, country 1 is initially the poorest country and country 3 is initially the wealthiest country. Also, consumers in each country give most weight to the utility derived from consuming their own good while giving less, but equal, weight to the utility derived from consuming the two imported goods. Tariffs are set at the rate of 75% by each country i on both partner's imported goods. This relatively high rate is not mandatory and is

primarily used for illustrative purposes in order to yield clearer distinctions in the graphs that follow. The qualitative behavior described below works for lower tariffs as well.

Given these baseline parameters, (the discrete time analog to) equation (22) for this economy is $H_i(t) = 2(1.078)^t + \beta_i(1.036)^t$ where $\beta_1 = -1$, $\beta_2 = 0$, and $\beta_3 = 1$. As is readily apparent, these three countries converge to identical per capita output levels and growth rates (of 2.24% annually) in the steady state. The outcome of this simulation, with respect to levels and growth rates, is similar to that of the standard neoclassical model when countries differ only by their initial endowments. In that model, as is the case here, if countries begin from different starting points, or alternatively, if a country experiences a shock to its inputs, countries eventually return to their original steady-state path.

Simulation 2: Different Initial *H* and a Reduction in a Single Tariff, τ_{23}

Consider once again the baseline economy of Simulation 1. Suppose that starting in period 15, country 2 (the initially middle-income country) unilaterally begins to reduce its tariffs on imports from country 3 (the initially wealthy country) at the rate of 15 percentage points per period. Hence, this tariff is completely eliminated by period 20. Suppose that no other tariff reductions occur.

Panels A-E of Figure 1 include the 14 periods prior to the tariff reduction, the 5 periods of tariff reduction, and 30 post-liberalization periods. The unilateral tariff reduction sets in motion a series of relative price changes and subsequent movements in the bilateral shares of output being traded by the three countries. These combined changes affect the growth paths of the individual countries – both in terms of their relative income levels as well as in their steady-state growth rates.

The decrease in τ_{23} implies that there is a reduction in the gross of tax price of good 3 in country 2, $p_3(1 + \tau_{23})/p_2$, which in turn increases c_{23} and hence v_{32}. Import substitution in country 2 then leads to a reduction in c_{21} and, consequently, in v_{12}. The increase in demand for good 3 increases its price, p_3, and therefore improves country 3's terms of trade. This in turn increases c_{31} and c_{32} and hence both v_{13} and v_{23}. The increase in p_3 also affects country 1's imports from country 3, leading to a decrease in

c_{13} and hence in v_{31}. Last, from equation (6), the increase in v_{23} generates an increase in the knowledge stock of country 2 which, through equation (2), induces an increase in the supply of good 2, and, in turn, decreases the price of good 2. The resultant decline in p_2 increases both c_{12} and v_{21}.[16] These changes in prices and export-output ratios are depicted in Panels A and B. As Panel B indicates, four of the six v_{ij}'s rise while two others fall. However, as the discussion of long-run results below shows, the decreases are more than offset by increases in the remaining v_{ij}'s and a reduction in τ_{23} leads to an increase in the steady-state growth rate that is common to all three countries.

Panel C shows that the main beneficiary in the short run is country 2, the liberalizing country, whose income overtakes that of country 3 to become the wealthiest country. This result is seen more clearly in Panel D, which shows the income gap between country 3 and the other countries, and in Panel E, which displays each country's growth rates. The gap between countries 3 and 2 is eventually eliminated and is replaced with a new gap as country 2 surpasses country 3. While there is eventual income convergence between countries 1 and 3, the gap between them and country 2 continues to exist in the steady state since all countries grow at the same rate in the long run.

As a result of the unilateral liberalization by country 2 on imports from country 3, the steady-state growth rate for each country rises from 2.24% found in Simulation 1 to 2.30%. Because of the similarity in preferences, it turns out not to matter which country embarks on trade reform. Growth rates rise to 2.30% independently of country choice.

If one country decides to eliminate tariffs on *both* of its imports, then long-run growth rates rise to 2.35%. Note that while the choice of liberalizing country is immaterial as far as growth is concerned, this is not the case when the issue is output levels. If any pair of countries moves to completely free trade, then steady-state growth rates rise to 2.46% with an income gap persisting between the two countries that fully eliminate tariffs and the one that does not. If all three countries remove all tariffs,

[16] This pattern of results is by no means unique to this example. Similar results obtain whenever there is a unilateral decrease in a single tariff.

then the steady-state growth rate increases to 2.59% and all three income levels converge along the new, steeper, growth path (see Panel F).

Simulation 3: Liberalization Among Developed Countries

Suppose that new "worldwide" trade agreements mandate that all tariffs must be reduced by a third. At the same time, suppose further that the two wealthier countries sign a free trade agreement stipulating that they must remove all barriers to trade with one another within 5 years. In other words, while countries 2 and 3 completely eliminate their tariffs on trade with each other, they partially reduce their tariffs on trade with country 1, as does 1 on trade with 2 and 3. This example is not particularly different from the agreement that led the European Economic Community to initiate a formal timetable for the complete removal of all remaining tariffs between 1959 and 1968, and the subsequent Kennedy Round Agreements within the GATT framework that led to across-the-board *partial* tariff reductions beginning in 1968. Finally, suppose that in each country greater weight is given to the utility of consumption of the import of the wealthier trade partner, letting the α_{ii}'s equal 0.6 as before and the α_{ij}'s equal 0.266 and 0.133 for the more developed and the less developed partners, respectively.

The effects of these policies are depicted in Figure 2 which shows that the top two countries converge to similar paths while maintaining a gap with the poorer country. Thus, while tariff reductions boost trade (Panel A) and all countries move to faster steady-state growth of 2.47% (as indicated in Panel B), an income gap with the less developed country continues to exist (Panels C and D).

The presence of both income convergence and faster growth appear to describe the major postwar liberalization experiences fairly well. Continuing with the example of the original EEC countries, a trade barrier index that is a composite measure of tariffs and quotas for the EEC between 1950 and 1968 is constructed in Ben-David (1994) and plotted at the bottom of Figure 3, Panel A.[17] Although the

[17] Although 1968 marked the end of the formal period of trade liberalization among the six founding members of the Community, some additional trade impediments, both informal and formal, (most notably regarding trade in agricultural goods) continued to exist.

Community was officially created in the late fifties, member countries began to liberalize trade in varying degrees beginning in the late forties. The removal of trade barriers manifested itself in an increasing ratio of total intra-EEC trade to total EEC output, depicted as v_{EEC} in Panel A. As is evident in Panel B, in the years between 1870 and World War II, the standard deviations of the EEC countries' log real per capita incomes had been relatively constant. However, with the elimination of trade impediments following the war, this measure of income disparity among the countries (labeled σ_{EEC} in Panel A) began to fall.[18]

As the liberalization process tapered off in the late 1960s, so too did the fall in σ_{EEC} and the rise in v_{EEC} (Ben-David [1993, 1994]). Note that the convergence process does not end immediately with the formal end of the EEC's liberalization period. This is consistent with the simulated convergence process (in Panels C and D of Figure 2) which does not immediately end following the complete elimination of tariffs.

Figure 4 provides some visual evidence that this convergence did not come at the expense of slower growth by the initially wealthy countries of the Community.[19] As predicted by the model (and represented by countries 2 and 3 in Figure 2, Panel C), following World War II each one of the EEC countries moved to a new and steeper growth path that exceeded its former path (which is extrapolated into the postwar period to facilitate comparisons).[20] Also included in Figure 4 are long-run plots of each country's total export to GDP ratios which indicate a clear difference in the extent of postwar trade compared to prewar trade – and a similarity to the behavior of v_{23} and v_{32} in Panel A of Figure 2.

Ben-David (1993, 1994) shows how this type of trade liberalization scenario was repeated

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[18] *Data Sources:* Data for standard deviations in Panel A comes from Summers and Heston (1995), while the data for construction of the v's comes from the International Monetary Fund *International Financial Statistics* and *Direction of Trade* data. Data used in Panel B comes from Maddison (1991).

[19] *Data source:* Maddison (1991)

[20] The extrapolations here and in the other figures in this section were done using standard augmented-Dickey-Fuller tests. Since the sole purpose of these extrapolations is to facilitate clearer visual inspections of the postwar and prewar differences, the regression results are not reported here so as not to diffuse the main focus of this paper. However, these results are available from the authors upon request. For a more comprehensive analysis of long-run growth rates, see Ben-David and Papell (1995b).

between the U.S. and Canada as well as between the EEC and EFTA (European Free Trade Association). In each case, these episodes culminated in increased trade and significant income convergence by the liberalizing countries. Finally, the lack of convergence, or catch-up, by the LDC's (also evident in Figure 2, Panels C and D) has been cited by many authors. Examples include Baumol (1986), Romer (1986), Lucas (1988), and Ben-David (1995).

V. CONCLUSION

This paper focuses on the impact of international trade on economic growth. The more open an economy, the greater the competitive pressures upon it and the greater the need for it to incorporate foreign knowledge into its production processes in order to be able to compete with foreign firms. This provides the basis for our assumption that trade flows between countries facilitate the diffusion of knowledge and spur the growth process. The theoretical framework presented here predicts that countries with similar technological parameters exhibit similar per capita growth in the long run. These steady-state growth rates depend upon the rate of knowledge accumulation which in turn is a function of the stocks of knowledge worldwide. Each country accesses foreign knowledge by conducting trade with other countries. The extent of this trade dictates the extent of the knowledge spillovers that will ensue, and hence, the rate of output growth. Countries with identical tariff structures also converge to the same steady-state growth path and to similar per capita outputs in the long run.

Unilateral trade liberalization (in the form of tariff reductions) has two effects. First, there is a level effect captured by the liberalizing country which may enable it to leapfrog over initially wealthier countries. Second, and most important, there is a positive growth effect which affects all countries in the long run. If wealthy countries (in per capita terms) are also the countries with the greatest stocks of knowledge, then the elimination of tariffs on these countries' trade will have the greatest growth effects.

Empirical evidence appears to corroborate the model's predictions. Specifically, the increasing tendency towards trade liberalization during the postwar period has led to a significant convergence in income levels within the EEC, between the U.S. and Canada, and between the EEC and EFTA. The faster growth (by the poorer countries in each group) that caused the convergence in levels did not come about at the expense of their wealthier trade partners. In fact, each of these liberalizing countries moved to growth paths that were higher during the postwar period than during the period between 1870 and the start of World War II.

Finally, while trade liberalization and income convergence characterize many of the world's more developed countries, this is not an apt characterization of what has occurred with the developing countries. These countries tend to surround themselves with greater walls of protection which also, in the context of the model presented here, act as a buffer that limits knowledge spillovers to them. Hence, the income gap between these countries and the developed world continues to exist, and to the extent that this model is correct, will continue to exist until the barriers start to come down.

APPENDIX

Suppose that v_{ij} is now the ratio of country i's total per capita trade with country j (that is, imports by country i from country j plus exports from i to j) to country i's total per capita output, or

$$v_{ij}(t) = \frac{\frac{p_j(t)}{p_i(t)} c_{ij}(t) + \frac{L_j(t)}{L_i(t)} c_{ji}(t)}{y_i(t)} \tag{A1}$$

In this case, the first-order conditions remain the same as before, with the exception of equation (9), which now becomes

$$\frac{\alpha_{ij}}{c_{ij}} = \frac{p_j(1+\tau_{ij})}{p_i}\theta_i - \lambda_i \phi a_{ij} \frac{H_j p_j}{y_i p_i} \tag{A2}$$

The presence of the second term eliminates the dichotomy between the static and dynamic parts of the problem. Nevertheless, as we now argue, the steady-state behavior of the v_{ij}'s and the relationships among the steady-state growth rates of consumption, output and prices will be the same as in the model of Section 3 (although their actual magnitudes may differ).

Assuming for the moment that the steady-state of this economy is indeed similar to that of Section 3, it follows that the v_{ij}^*'s are constant, that all H's grow at the same rate $\gamma_H^* = \mu_1$, and that

$$\gamma_{c_{ii}}^* = \gamma_{y_i}^* = \varepsilon_i \gamma_H^* \quad ; \qquad \gamma_{c_{ij}}^* = \gamma_{p_i}^* - \gamma_{p_j}^* + \gamma_{y_i}^* \quad . \tag{A3}$$

Next, utilizing equations (6), (8) and (14), it is possible to rewrite equation (10) in steady state as

$$\dot{\lambda}_i^* = \lambda_i^* \left[\rho - n_i - (\phi - \delta_H)(1+\varepsilon_i) + \varepsilon_i \gamma_H^*\right] - \frac{\varepsilon_i}{Q_i \kappa_{H_i}} e^{-\gamma_H^* t} \tag{A4}$$

with κ_{H_i} representing a constant. Letting the term inside the square brackets be denoted by R_i^*, which is constant in the steady state, the solution to (A4) is given by

$$\lambda_i^* = e^{R_i^* t}\left[\int_0^t \frac{-\varepsilon_i}{Q_i \kappa_{H_i}} e^{-\gamma_H^* \tau} e^{-R_i^* \tau} d\tau + \kappa_{\lambda_i}\right]$$
$$= z_{\lambda_i}\left[e^{-\gamma_H^* t} - e^{R_i^* t}\right] + \kappa_{\lambda_i} e^{R_i^* t} \qquad \text{(A5)}$$

where $z_{\lambda_i} = \dfrac{\varepsilon_i}{Q_i \kappa_{H_i}(R_i^* + \gamma_H^*)}$. Replacing the $\lambda_i(t)$ in the transversality condition, equation (11), with equation (A5) yields

$$\lim_{t\to\infty} z_{\lambda_i} e^{-(\rho - n_i)t} + (\kappa_{\lambda_i} - z_{\lambda_i})\kappa_{H_i} e^{[R_i + \gamma_H^* - (\rho - n_i)]t} = 0 \qquad \text{(A6)}$$

which implies that (i) $\kappa_{\lambda_i} = z_{\lambda_i}$ and (ii) $n_i < \rho$. Hence, in the steady state,

$$\lambda_i^* = z_{\lambda_i} e^{-\gamma_H^* t} \quad . \qquad \text{(A7)}$$

Since $\gamma_{c_{ii}}^* = \gamma_{y_i}^*$ and H_i^* and H_j^* grow at the same rate (in the assumed steady state), inserting (A7) for λ_i and (8) for θ_i into (A2) and solving for t large gives

$$\frac{\alpha_{ij}}{c_{ij}^*} = \frac{\alpha_{ii}}{c_{ii}^*} \frac{p_j^*(1+\tau_{ij})}{p_i^*}(1 - \kappa_c) \qquad \text{(A8)}$$

where κ_c represents a collection of constant terms. Isolating the consumption by country i of goods from country j on the left-hand side yields

$$c_{ij}^* = \left[\frac{\alpha_{ij}\omega_{ij}}{\alpha_{ii}} \frac{p_i^*}{p_j^*(1+\tau_{ij})}\right] c_{ii}^* \qquad \text{(A9)}$$

where the ω_{ij} equals $1/(1 - \kappa_c)$.

Since ω_{ij} is constant in the steady state, it follows that equation (A9) is qualitatively similar to the expression

$$c_{ij}^{*} = \frac{\alpha_{ij}}{\alpha_{ii}} \frac{p_i^{*}}{p_j^{*}(1+\tau_{ij})} c_{ii}^{*} \qquad \textbf{(A10)}$$

which is derived by combining (8) and (9) in the earlier model. The only difference now is that the levels of consumption are shifted by the ω_{ij}. Once this difference is accounted for, the model can be solved as before. In particular, it follows that the v_{ij}^{*}'s are indeed constant thereby implying that there exists a common steady-state growth rate for knowledge and equations (A3) apply. As these results verify the assumption made above, the steady-state of this economy is as claimed.

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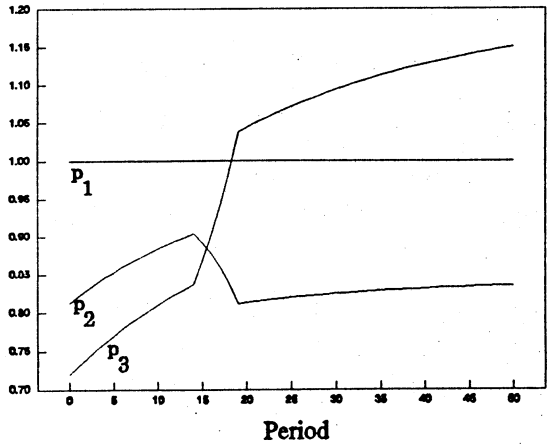
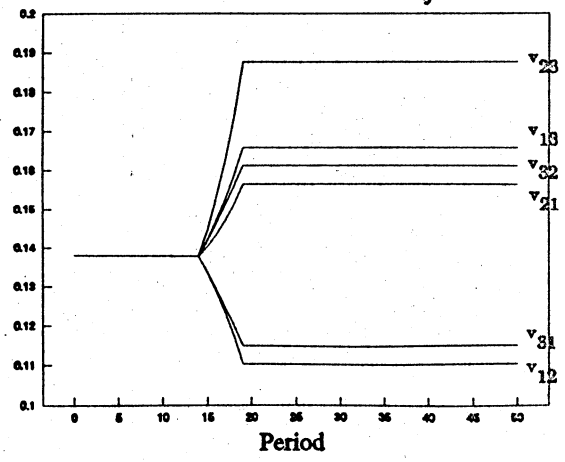
Figure 1: Unilateral Tariff Reductions by Country 2 on Imports from Country 3

1 = Poor Country 2 = Middle Income Country 3 = Rich Country

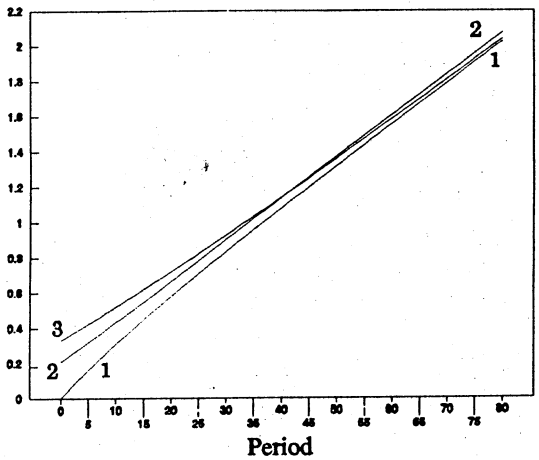
Panel A: Prices



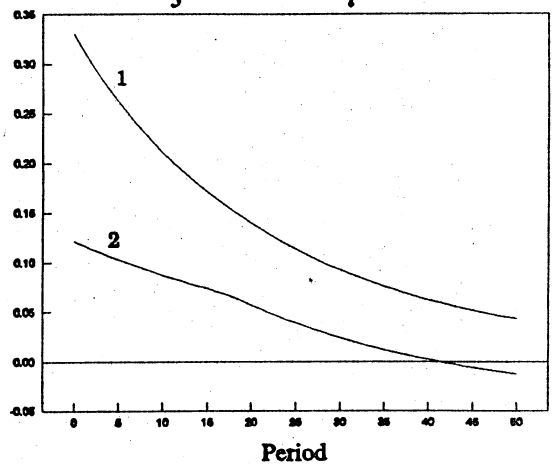
Panel B: Export - Output Ratios (v_{ij})



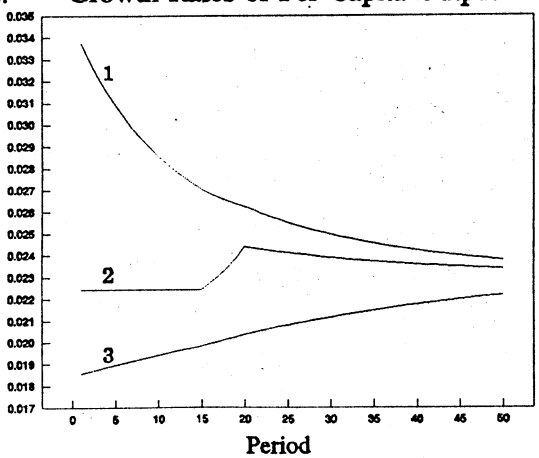
Panel C: Ln y



Panel D: Ln y_3 minus Ln y_i (i = 1, 2)



Panel E: Growth Rates of Per Capita Output



Movement to Free Trade by All Countries

Panel F: Ln y

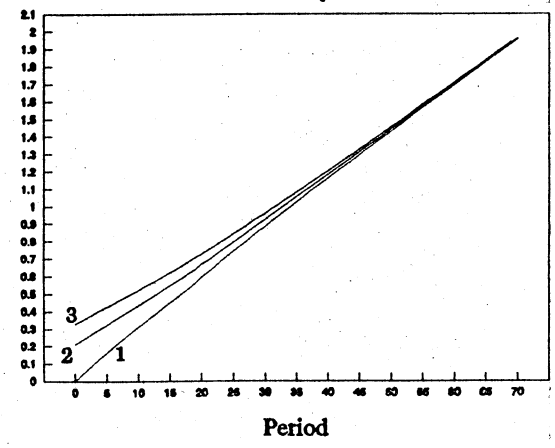
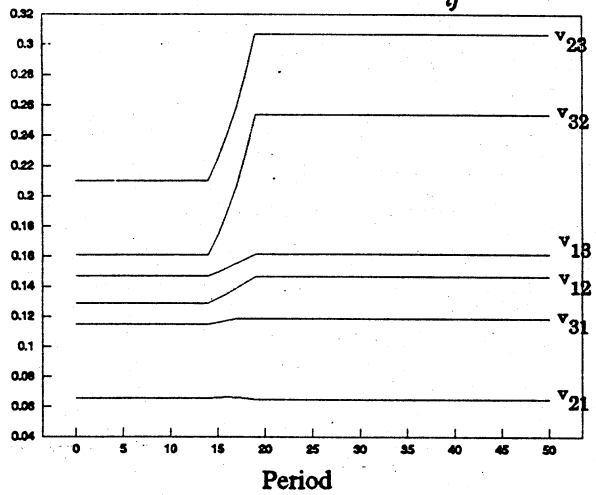


Figure 2: Free Trade Only Among the Developed Countries

1 = Poor Country 2 = Middle Income Country 3 = Rich Country

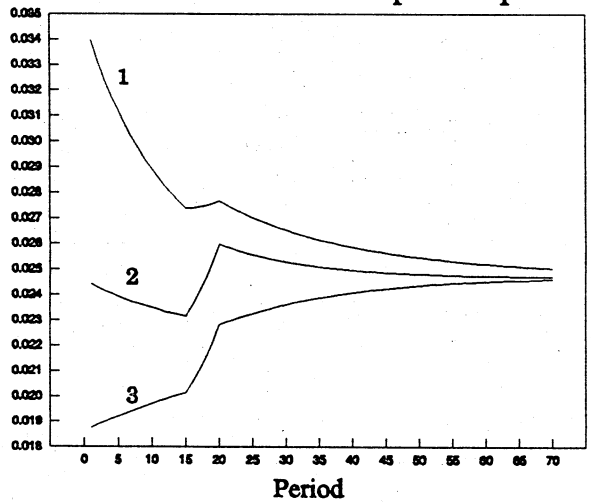
Panel A

Export - Output Ratios (v_{ij})



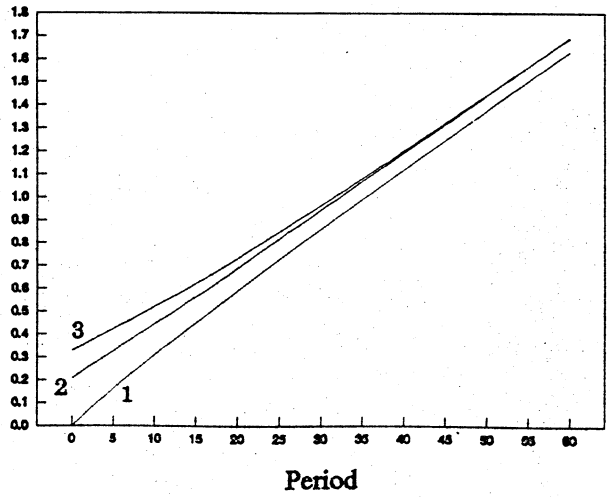
Panel B

Growth Rates of Per Capita Output



Panel C

Ln y



Panel D

Ln y_3 minus Ln y_i (i = 1, 2)

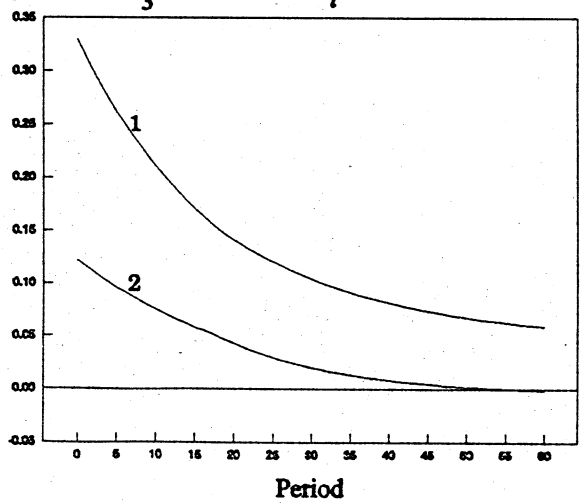
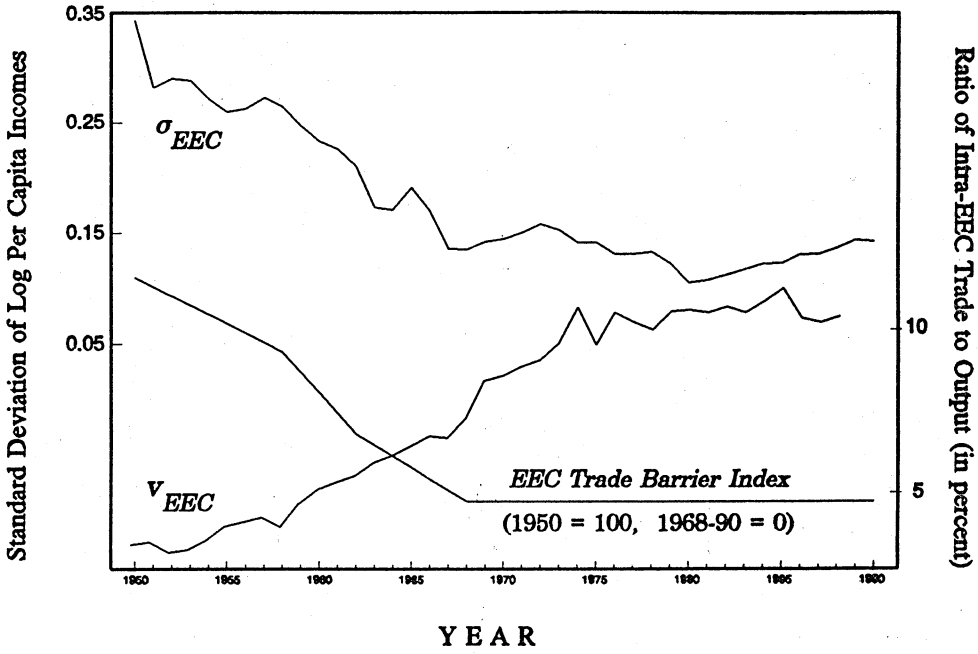


Figure 3

Panel A: EEC Trade Liberalization: Trade Volumes and Income Convergence



Panel B: Long-Run Income Disparity Among Future EEC Founders

(Belgium, France, Italy, Germany, and the Netherlands)

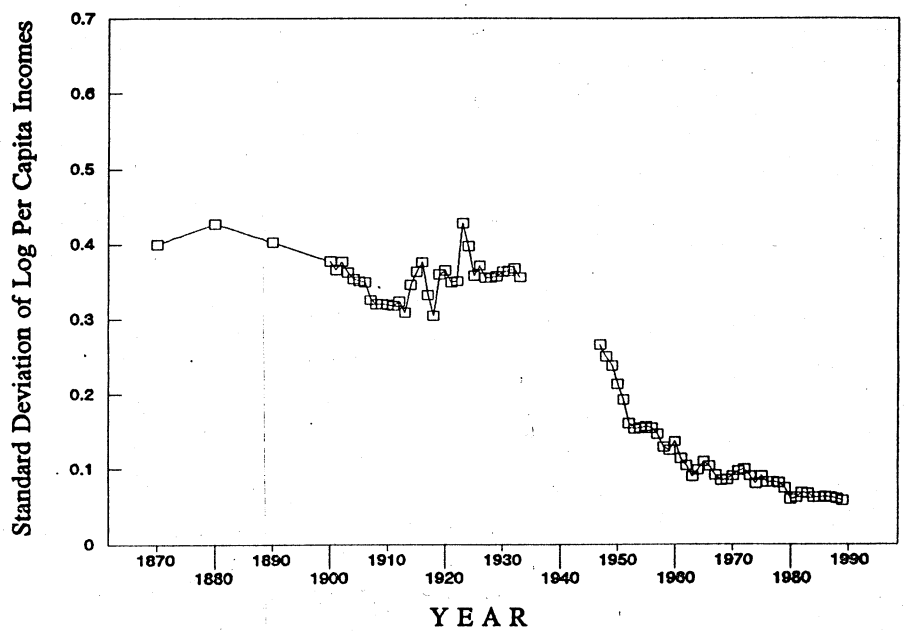
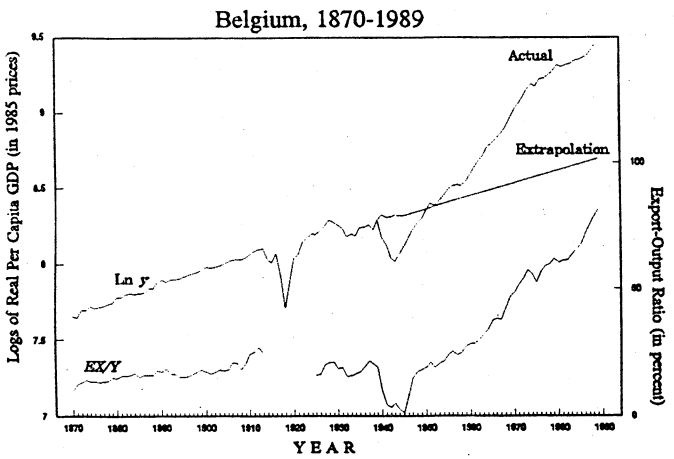
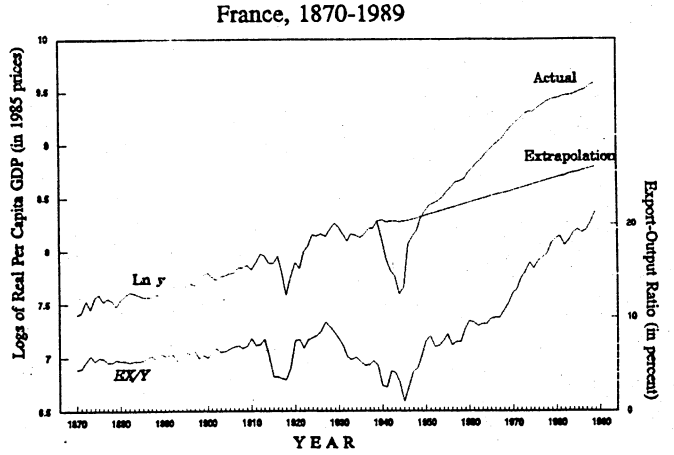
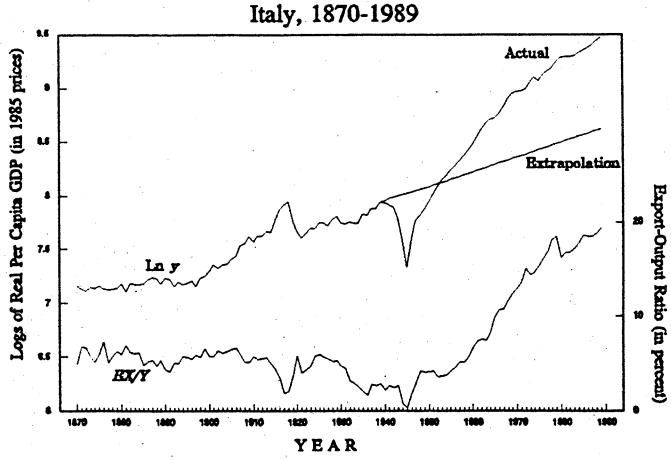
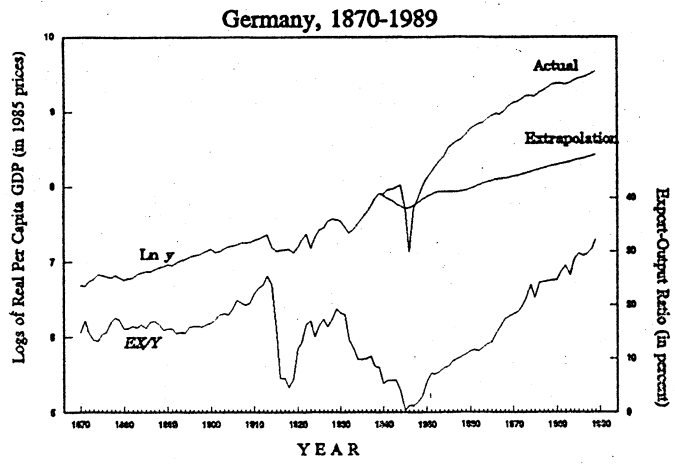


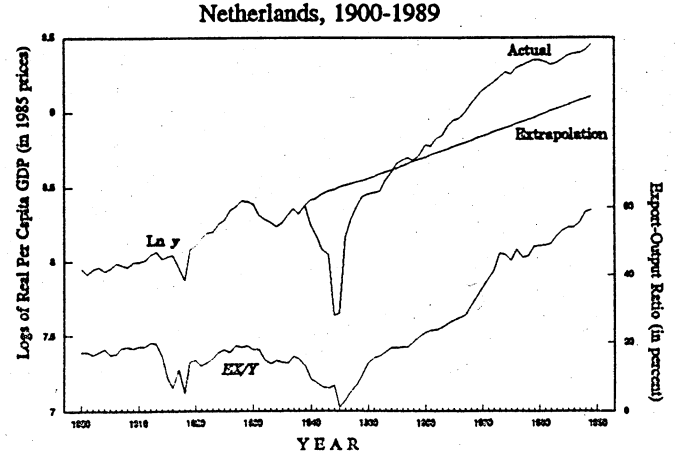
Figure 4: Comparisons of 1940-89 Growth Paths With 1870-1939 Paths











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