

The Impact of Globalization: Banana Republic or Miracle Growth?

David Mayer-Foulkes[†]

CIDE
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[†]División de Economía, Centro de Investigación y Docencia Económicas, Carretera México Toluca 3655, 01210 México, D.F., México, Tel. 52 55 5727 9870, Fax 52 55 5727 9878, E-mail david.mayer@cide.edu

Abstract

This article presents a Schumpeterian theory of development and underdevelopment for an open global economy with technology transfer, trade, and investment. Ceteris paribus, under free trade innovation sectors are allocated across countries in proportion to productive capacity (after technology transfer and innovation). When there are advantages to the concentration of innovation, this implies that small and lagging economies diverge in levels or in growth rates. Foreign direct investment (FDI) obtains supernormal profits that also result in asymmetric incentives for innovation favoring leading countries. Thus, under trade, market forces may induce persistently unequal and divergent steady states. However, strong enough policies for technology transfer that redress innovation imbalances can harness free trade and FDI to yield miracle growth.

1. Introduction

This paper presents a Schumpeterian theory of *development* and *underdevelopment* in an open global economy with technology transfer, trade, and foreign investment. The model shows that, when there are advantages to the concentration of innovation, trade and foreign direct investment (FDI) give rise to asymmetric innovation incentives that can cause divergence in levels and growth rates, even between economies that differ only in their initial conditions. The model thus explains the appearance and persistence of underdevelopment in the context of globalization, both in the historical long-term and in the last few decades. In its worst scenarios, globalization may condemn small and backward countries to the status of Banana Republics, semi-stagnant and completely dominated by FDI. However, when larger or more advanced lagging countries implement policies ensuring that trade and FDI generate enough technology transfer, miracle growth may ensue. Appropriate global governance could generalize this happier outcome.

Most theories of both economic growth and trade imply that free trade and FDI will lead to equalization in growth rates and productivity levels. Yet, these predictions bear fruit unevenly. On the one hand, trade has been associated with the emergence of industrialization and modern growth in Britain, Western Europe and North America since its origins; with convergence episodes such as the development of Japan and the Asian tigers; with rapid convergence in Europe in the second half of the 20th Century; and with recent successes such as growth in China and India. On the other hand, the Great Divergence in incomes¹ took place in the very context of globalization in which modern economic growth took off in the 19th Century. The underdeveloped world's technological levels lagged far behind.² The process of divergence continued through the second half of the 20th Century.³ For whole blocks of countries, for example in Latin America, recent policies for globalization, trade liberalization, and investment, have been far less

¹Pritchett (1997) estimates that the proportional gap in per-capita GDP between the richest and poorest countries worsened by a factor of five between 1870 and 1990. Similarly, according to Maddison (2001) this gap grew from 3 in 1820 to 19 in 1998.

²A large number of empirical studies attribute cross-country differences in per-capita GDP to differences in productivity (Easterly and Levine, 2001; Klenow and Rodríguez-Clare, 1997; Knight, Loayza and Villanueva, 1993; Islam, 1995; Caselli, Esquivel and Lefort, 1996; Prescott, 1998; Hall and Jones, 1999; Feyrer, 2001).

³The proportional per-capita income gap between Mayer-Foulkes' (2006) richest and poorest convergence groups grew by a factor of 2.6 between 1960 and 1995, and between Maddison's (2001) richest and poorest groups by a factor of 1.75 between 1950 and 1998.

successful than economists had expected in light of the theory. The present model accounts for the unequal effects that trade and investment can have on economic growth.

The model uses only hypotheses in endogenous technological change and in trade to show that multiple steady states and divergence (forms of club-convergence⁴) can arise under free trade and FDI. The concepts of development and underdevelopment are modelled as steady states differing in levels and in growth rates. The present paper extends the results of Mayer-Foulkes (2006b), where free trade alone is analyzed using the theory of endogenous technological change. In the present paper FDI is analyzed as well. For mathematical tractability and conceptual simplicity, technological change is modelled semi-exogenously and continuously, in such a way as to reproduce the main properties of endogenous models. Thus, our model's technologically driven growth is reminiscent of Solow's capital driven model of economic growth, with the resources allocated to innovation determined by a constant propensity.

Our semi-exogenous Schumpeterian framework makes the same basic assumptions as theories of endogenous technological change. Innovation, broadly understood to include technological adoption, is costly in both lagging and leading countries,⁵ and responds to the incentives for world market power. The simplest way to represent this is by assuming that innovators are world monopolists. Innovation investment aimed at achieving proportional productivity jumps (which, in principle, are proportionally costly)⁶ obtains higher than proportional returns in lagging countries, because of their access to the advanced contemporary knowledge of the leading countries (technology transfer). This is Gerschenkron's (1952) *advantage of backwardness* in technological change, which constitutes the basic driving force for convergence. It follows that in the autarchic regime identical countries will converge, assuming strong enough convergence forces.

Next, the trade of domestically produced goods is included. A natural mechanism allocates innovation and production between countries. Each country innovates for the sectors it produces in, each producing monopolically to meet aggregate world demand. Given an equilibrium exchange rate, all goods, assumed to be

⁴Baumol, 1986; Durlauf and Johnson, 1995; Quah, 1993, 1997; Mayer-Foulkes, 2002, 2003.

⁵In his survey of international technology diffusion, Keller (2004) finds international diffusion is neither inevitable nor automatic, requiring domestic investments. Cohen and Levinthal (1989) and Griffith, Redding and Van Reenen (2001) have also argued that R&D by the receiving country is a necessary input to technology transfer.

⁶This is the *fishing out* effect.

symmetric, sell at the same price. Therefore, the number of sectors each country supplies is proportional to its productive capacity.⁷ Thus, more advanced and larger countries innovate in more sectors.

Up to here we have no special hypothesis on innovation, only the observation that trade, through specialization, distributes innovative in proportion to productive capacity (after technology transfer and innovation). Could this be a source of divergence? Could the rate of technological change an economy can generate be increasing in the number of sectors it innovates in? Is it easier for an inventor to innovate in a given sector when she has more inventors nearby operating in different sectors? I assume that it is. There are several reasons for this. First, a country with more innovation sectors has higher incentives to establish a scientific infrastructure providing basic knowledge. Second, the use of innovations is unpredictable, and what was intended for one sector can easily be useful for another. Third, innovation in any given sector requires knowledge from all other sectors. The two last points involve knowledge flows that most easily occur within a given country than between different countries, so that innovation will be easier in a country innovating in more sectors than in a country with less sectors.

The assumption that it is easier to innovate where more innovation is taking place is supported by the concentration in a few countries that innovation has exhibited during the knowledge revolution. An approximate idea of the concentration is obtained in Table I, constructed from Kryss Katsiavriades and Talaat Qureshi's listing of the most noteworthy inventions⁸. 70% of the inventions in this listing were carried out in the U.K. and the U.S., with 20% of the remaining inventions carried out in France, Germany and Russia.

Table I. Distribution of inventions by country of origin according to Kryss Katsiavriades and Talaat Qureshi.

While these figures may not represent the most precise measurement of invention, they certainly give an idea of its concentration. A similar picture of the

⁷Mayer-Foulkes (2006) includes fixed productivity factors defining comparative advantage between countries that complete the allocation of sectors between countries. For simplicity, here we simply assume a natural ordering of sectors that completes the allocation, which nevertheless is sufficiently determined for our purposes.

⁸The KryssTal Web Site, a United Kingdom based educational and information web site by Kryss Katsiavriades and Talaat Qureshi in London.

	17th C	18th C	19th C	1900-1949	1950-1999	Average
U.S.	0.0	17.4	32.1	51.5	67.3	33.6
U.K.	55.6	52.2	37.0	20.6	16.4	36.3
Germany	11.1	4.3	9.9	11.8	0.0	7.4
Russia	0.0	0.0	1.2	0.0	9.1	2.1
France	18.5	17.4	12.3	4.4	0.0	10.5
Total (%)	85.2	91.3	92.6	88.2	92.7	90.0

Figure 1.1:

concentration of innovation is painted by the following statistics from the U.S. Patents Office. From 1963 to 2006 a total of 4,065,671 utility patents were granted, of which 41.4% originated in foreign countries. Of these, 75.6% were from Japan (32.9%), Germany (20.3), the U.K. (9.8), France (7.7%) and Canada (4.9%). The next 21.1% came from Switzerland, Italy, Sweden, the Netherlands, Taiwan, South Korea, Australia, Belgium, Austria, Israel, the U.S.S.R., Denmark and Finland, in that order, while the rest of the world accounted for 3.3%. Similarly, five countries accounted for 75% of the international patent applications at the World Intellectual Property Organization during the period 2003-2006: the U.S. (33.5%), Japan (17.8%), Germany (11.6%), Korea (4.5%), France (4.1%) and the U.K. (3.6%).

A scatter diagram for the logarithm of the number of patents obtained by inventors in non-U.S. countries versus the logarithm of GDP of these countries is shown in Figure 1. A linear regression gives a highly significant average slope of 1.55 for this figure, implying an increasing relation between from GDP to patents.

The assumption that there are innovation externalities between sectors in any given country is enough for divergence and multiple steady states to emerge under trade and FDI, explaining divergence in growth rates or levels without making asymmetric assumptions between countries. Thus, considering innovation and trade together can give rise to a theory of development and underdevelopment. Under free trade, efficiency gains are obtained through the allocation of production according to productivity levels determined by comparative advantage and technology. However, small and lagging countries, experience much lower innovation incentives than larger or more advanced countries, and therefore experience lower

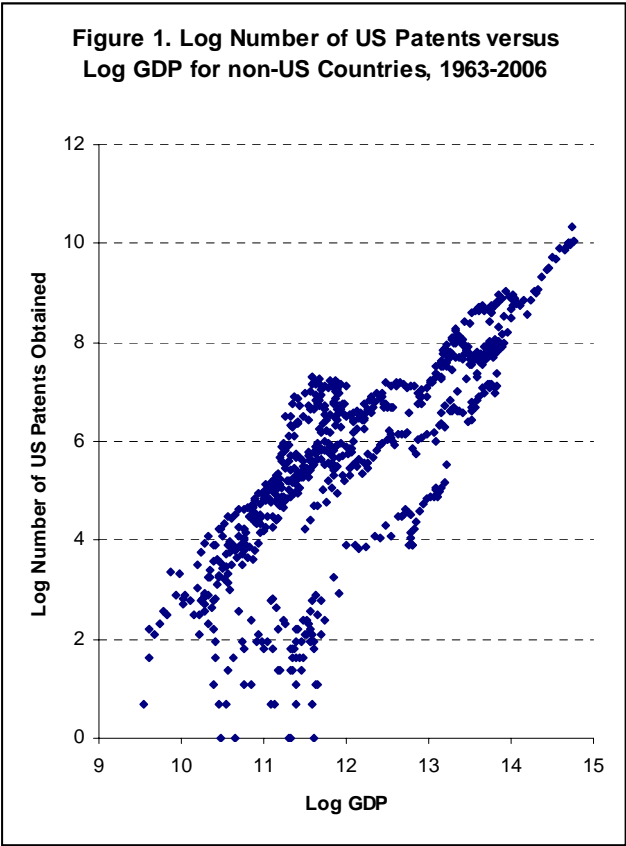


Figure 1.2:

rates of technological change. The model implies that country size plays a strong role: countries only converge under trade if their productive capacity (measured by GDP) is commensurate with the leader's (see Corollary 3 below).

The second step of our framework incorporates foreign direct investment (FDI). I consider only labor-seeking FDI, although market- and resource-seeking FDI would give rise to similar mechanisms. A distinguishing feature of FDI is that, unlike credit or other financial (indirect) investments, its profits constitute incentives for innovation for the original investors. FDI allows leading country innovators to take advantage of lower wages in lagging countries. This yields supernormal innovation profits for leading countries only, and therefore generates *asymmetric innovation incentives* that favor the leading economies and contribute to persistent technological differences. In addition, FDI introduces an asymmetrical element in innovation competition because firms performing FDI can afford higher wages than their local competitors, and can therefore threaten to price them out. This leads to *innovation crowding out* in sectors hosting FDI. In addition, we must add the effect of diminished or absent domestic profits in these sectors.

On the positive side, it is usually assumed that FDI can contribute to economic growth through technological spillovers, even though empirical cross-country studies have shown that these are not too high and tend to depend on the local technological level.⁹ Nevertheless, the history of East Asian and Chinese growth has shown that appropriate policies can ensure significant technological spillovers from FDI. Thus, we assume that the FDI spillover parameters depend on the industrial and trade policies of host countries.

In the case of market-seeking FDI, when products must be sold where they are produced, leading country innovators can produce in lagging countries and enjoy higher profits than at home because of the lower wages, while innovators from countries lagging too far behind do not have the technological level to set up businesses in leading countries because of their high wages. For this class of goods, *unequal innovation incentives* result. Only leading countries can enjoy world profits when they innovate. Again, technological spillovers from FDI tend to depend on policy. Resource-seeking FDI is analogous to labor-seeking FDI.

In conclusion, the model shows that FDI can produce both a negative and

⁹Determinants of the intensity of FDI spillovers include: a sufficiently qualified labor force (Borensztein et al., 1998; Blonigen and Wang, 2004), not too large a technological gap (De Mello, 1997), a sufficient level of economic development (Blomström et al., 1994; Mayer and Nunnenkamp, 2005), sufficient financial development (Alfaro et al., 2001), and openness to trade (Balasubramanyam et al., 1996).

a positive impact on economic growth. When spillovers are low, FDI can contribute to divergence. Countries may specialize in FDI and remain in steady states with permanently lagging incomes while local knowledge stagnates. To the contrary, when the presence of FDI sectors contributes enough to technological change, either in proportion to the local wage bill or, better still, in proportion to their profits, divergence in growth rates is impossible and lags in levels can be diminished.

Although the theory presented here does not consider factors such as human development, institutions and geography, this does not mean they are unimportant for development. They certainly could be included in the model in the simplest way as fixed productivity effects. These factors would then be parameters of the steady states and of the thresholds between convergence and divergence. The role of human capital is discussed in detail in Mayer-Foulkes (2007), where it is shown that investment in human development is essential to achieve the highest steady states and for the human development trap to disappear. Human development deficiencies may lead to divergence.

The model yields a clear comparison between export promotion and import substitution. Under export promotion, innovation enjoys the incentives of world profits rather than being limited to the national market, and can thus lead to higher incomes. On the other hand, at low levels of income, integration to the world market will lead to divergence. Thus, at lower incomes—when export promotion cannot be combined with import protection (the policy adopted by East Asian countries and China, as discussed below)—the second best option is import substitution.

The Schumpeterian analysis presented here builds on a series of papers. The first of these introduce endogenous technological change in the theory of economic growth (Aghion and Howitt, 1988, 1992); while others show that technological transfer can induce convergence (Howitt, 2000); finally, other papers go on to address the problems that generate divergence and underdevelopment. These problems include human capital thresholds for R&D which can separate implementing from R&D countries into convergence clubs and explain long-term divergence (Howitt and Mayer-Foulkes, 2002). Financial development can determine technological absorption rates and also explain long-term divergence (Aghion, Howitt and Mayer-Foulkes, 2005). The present paper not only moves beyond closed economies to include trade and direct investment, it also demonstrates that convergence clubs and divergence can arise based on the standard assumptions of the theory of endogenous technological change, without assuming market failures or

increasing returns.

By analyzing the innovation incentives generated by trade and FDI, the model goes beyond much of the theoretical analysis of the impact of trade on innovation and economic growth (Helpman, 1993; Eaton, Gutierrez, and Kortum, 1998; Eaton and Kortum, 2001, 2003, 2004). Rodriguez and Rodrik (1999) “find little evidence that open trade policies — ... lower ... barriers to trade — are significantly associated with economic growth”. In his survey on international technology diffusion, Keller (2004) finds international diffusion to be neither inevitable nor automatic, requiring domestic investments.

To highlight the historical importance of trade and FDI in the history of development and underdevelopment, I will now summarize some of the main historical features of globalization.

Trade has played a major role in modern economic growth since its origins. It forms a major strand in Maddison’s (2001) description of the economic ascension of Western Europe through Venice, Portugal, the Netherlands, and Britain, from the year 1000 to the present. Cotton exports in late 18th and early 19th Century England, widely recognized as the Industrial Revolution’s leading sector, rose from 6% of total British exports in 1784-6 to a peak of 48.5% in 1834-6 (Chapman, 1999). The growth of this sector and the incentives for its increased productivity were directly linked with imports of cheap raw materials from India at this initial juncture of the Great Divergence (Broadberry and Gupta, 2005). The historical role of trade in generating institutional development prior to 1750, in triggering the Industrial Revolution over the period 1750-1820, and in generating the initial stages of the Great Divergence in the 19th Century, is discussed by Mayer Foulkes (2006b). More recently, the rapid growth of Germany, Israel, Cyprus, Spain, Portugal, Malta, Ireland and Iceland were intimately linked with trade.

The process of globalization is divided by historians into two periods. The “First Great Age of Globalization” proceeded during the 19th and early 20th centuries. With the advent of steam engine-based manufacturing, Great Britain turned to free trade for obtaining raw materials and to sell its industrial products, and became its undisputed champion.¹⁰ Free trade became a more efficient policy

¹⁰Indeed, both Britain and the US espoused Free Trade only *after* they gained industrial supremacy. “... the decision, on the part of Great Britain [with the repeal of the Corn Laws in 1846], to abandon ... colonial policy ... in favor of free-trade, should be understood as resulting from (i) a technology shock, (ii) the escalating cost of imperial wars, and (iii) the emergence of British transnational corporations. The steam engine rendered Great Britain’s 18th century colonial empire redundant” (Beaudreau, 2004).

“US opposition to free trade, a staple of 19th and early 20th century ... foreign policy, meta-

for enrichment than colonialism (Beaudreau, 2004; Semmel, 1970), and was the motive behind gunboat diplomacy. Large scale FDI became a major player by the end of the 19th Century.¹¹ Investments in the colonial and dependent countries were a source of supernormal profits due to extremely cheap labor and raw materials. In his 1916 *Imperialism the Highest Stage of Capitalism*, Lenin criticized the vast accumulations of capital invested abroad at a far higher rate of return than in the home country. In 1914, British assets abroad amounted to between 124 and 180% of its GDP. Taking British investment as a whole, between 1865 and 1914 approximately as much went to underdeveloped Africa, Asia, and Latin America (29.6%) as to the UK itself (31.8%) (Ferguson, 2003). Svedberg (1978) estimates that some 44 to 60% of the \$19 billion of accumulated investment in developing countries in 1913-14 consisted of foreign direct investment.

The process of globalization was broken between 1914 and 1945 by the two world wars and the global depression, as well as by a change in hegemony. A second stage of globalization, headed by the United States, emerged in the post-war period. By 1960, the US owned almost half of the world's outward stock of FDI. Between 1950 and 1970, the stock of US manufacturing direct investment in Europe increased almost fifteen fold, while between 1970 and 1993 both US direct investment abroad and direct investment in the US increased fivefold (Graham, 1995). Foreign investment may be a stronger force for globalization than trade. All modern "free trade" agreements are agreements for free commerce *and* investment, allowing for the full scope of globalization to proceed. FDI has grown enormously since the 1980's.¹² Worldwide outflows have increased nearly 29% a year on average from 1983 to 1998, three times the growth of world exports. Even so, FDI has not reached the relative levels that characterized the first period of globalization. The position of US direct investment abroad was about 13.6% of GDP in 2001,¹³ much less than the corresponding British position in 1914. The

morphosed itself into unwavering support from 1934 on [when Roosevelt signed the Reciprocal Trade Agreements Act]. The latter, like in the United Kingdom a century earlier, was founded on industrial supremacy, specifically on electric power-based mass production, which ... contributed to ... the birth of American industrial supremacy" (Beaudreau, 2004).

¹¹The East India Company was chartered in London in 1600. By 1899, giant corporations such as the United Fruit Company controlled 90 per cent of US banana imports. Royal Dutch/Shell accounted in 1914 for 20 % of Russia's total oil production. Standard Oil of New Jersey, Singer, International Harvester, Western Electric, and by 1914, Ford Motor Company had major producing facilities outside the United States (Beaudreau, 2004).

¹²Data on FDI from UNCTAD (1999), unless stated otherwise.

¹³US Bureau of Economic Analysis data on a historical-cost basis.

following figures give a rough idea of the current relative importance of trade and FDI. Aggregate world exports in 1998 amounted to US \$7 trillion, while aggregate sales from foreign affiliates of transnational corporations (TNCs) amounted to US \$11 trillion.¹⁴ Two thirds of world trade is TNC-related. Intra-firm trade alone amounts to one third. A quarter of global output is produced by TNCs, one third of it in host countries. Approximately 26.3% of US FDI in 2000 and of global FDI in 1998¹⁵ flowed to the underdeveloped world, where approximately 21.2% of world income was generated in 1999.¹⁶ On the other hand, most R&D is undertaken by TNCs at home or in developed countries.

Trade and foreign direct investment have been salient economic features since the advent of industrialization. Production networks form an important component of international exchange and globalization, as stressed by Beaudreau (2004). What is shown in this paper is that the resulting allocation of innovation incentives generates persistent inequality and divergence: *development and underdevelopment*.

Underdevelopment, however, is a diverse phenomenon. The model shows the existence of two types of lower steady states. The lowest type (“divergence in growth rates”) represents lagging economies with lower growth rates than the leading economy, accounting for long-term divergence and for contemporary semi-stagnant economies, as in Sub Saharan Africa. Any policy improving the innovation rate, either directly or indirectly, will have growth effects. The second type (“divergence in levels”) represents middle steady state economies that maintain a fixed relative lag in relation to leading countries, with policy improvements yielding effects in levels. These represent a not sufficiently recognized stylized fact, the persistence of middle income levels. For example, the average per-capita income of 19 Latin American countries relative to the US actually decreased between 1960

¹⁴Today, TNC’s are truly huge. Quoting Anderson and Cavanagh (2000), “Of the 100 largest economies in the world, 51 are now global corporations; only 49 are countries.” “The combined sales of the world’s Top 200 corporations are far greater than a quarter of the world’s economic activity.” “The Top 200 corporations’ combined sales are bigger than the combined economies of all countries minus the biggest 9; that is, they surpass the combined economies of 182 countries.” TNC’s have spread their activities widely across the globe. For example, the Swiss electrical engineering giant ABB has facilities in more than 100 nations. Royal Dutch/Shell has offices in 64 countries and refines in 34. Cargill, the largest US grain company, operates in 59 countries with 105,000 employees. ICI, Britain’s leading chemical company, employs 36,000 people in 55 countries at 200 sites. (Data from the companies’ web pages).

¹⁵The proportions of FDI outflows due to Western Europe, the US and Japan are 68.3, 22.3, and 4.0% (UNCTAD, 1999).

¹⁶Author’s calculation, based on the World Bank database.

and 1999 from 0.25 to 0.20.¹⁷ The relative level 0.20 represents a lag of around 80 years behind the US, assuming what would seem an impossible catch up rate of 2% per year *above* the US growth rate. The importance of this middle income persistence tends to be neglected. It is believed that since these countries grew at an average rate of 1.5% instead of 2.1%, it must be just a matter of fine tuning to get at least parallel growth, which is deemed to be a sufficient objective. The point, however, is that if a trap is maintaining the level difference, or the divergence, unlocking it would lead to miracle growth and enormous welfare gains. Ignoring it, on the contrary, may doom economic policies.

Another salient feature of the history of economic growth is miracle growth. “The acceleration and then deceleration of East Asian growth is one of the mega-events of the 20th Century”, suggesting that “for all developing economies, ... ‘fully developed’ status is within reach”. This remark contextualizes Wan’s (2004) detailed comparative analysis of East Asian growth experiences. His benchmark catch-up path includes a two-decade period of growth rates above 5%, explicitly understood as a transition to a higher steady state. Thus, the experiences of Japan, Korea, Taiwan, Hong Kong, Singapore, and lately China, constitute strong empirical evidence that development and underdevelopment are distinct steady states. The policies these countries applied throw light on the barriers they surmounted and the economic forces they harnessed.

Japan and Korea, the largest countries,¹⁸ concentrated on the creation of large industrial firms with scale economies, and combined export promotion with import protection. They used trade to integrate with the US production chain and were careful to gain technological transfer. Both avoided depending on FDI, and they promoted innovation rather than imitation, attaining dominance in the supply of new product lines. Japan depended on domestic saving. Some separation in government economic powers helped it to maintain efficiency in the support of carefully selected and changing infant industries. Korea was more authoritarian and more dependent on foreign saving, leading to some inefficiencies and financial instabilities. Taiwan concentrated on small and medium enterprises subcontracting from FDI regulated for an emphasis on technology transfer, integrating with

¹⁷Of the 19 countries for which the World Bank database has relevant data, the relative position of Argentina, Belize, Bolivia, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Jamaica, Paraguay, Peru, Trinidad and Tobago, Uruguay and Venezuela worsened, while that of Brazil, Dominican Republic, Mexico and Panama advanced slightly.

¹⁸In 1999, the East Asian populations were, in millions: Japan, 126.6; Korean Republic, 46.8; Taiwan, 21.9; Hong Kong, 6.9; Singapore, 3.2.

the Japan-US production chain. Backward integration with technological absorption was closely promoted. In effect, the local portion of what would be FDI, as well as the backward linkages, were locally owned. This form of ‘subcontracted’ FDI transfers innovation incentives to the local firms. In Japan, Korea and Taiwan, reliance on FDI was avoided. Cheap labor favored, and even subsidized, local firms rather than FDI.

Hong Kong’s manufacturing growth was triggered by trade, itself driven by natural advantages including Hong Kong’s position as an outlet for China and its well located harbor.. Cheap food imports from China also played a role. Singapore, the smallest of these countries, is an exception in that its economic policy was to use low wages and taxes, and an excellent location, to attract FDI. It relies on an authoritarian regime including ‘bonded scholars’ to keep its human capital cheap, with income rising on the basis of human capital accumulation.

China began a process of fundamental reform by introducing market mechanisms into its economy in December 1978. After an initial and successful period of transition, it also established trade and FDI policies to gradually open its economy. In parallel with other Asian countries, China combined export promotion with import protection. Since import protection can raise costs for exporters and make the home market more attractive for producers (Flatters and Harris, 1994), China also neutralized this anti-export bias by allowing exporting sectors to import goods duty free. China’s policy towards FDI (authorized since 1979) as a source of foreign capital, technology and management skills, has also been selective. The Twenty Two Regulations on FDI (1989) promoted export oriented and technologically advanced projects (Bransteeter and Feenstra, 1999). FDI was encouraged in sectors targeted for import substitution, while it was severely constrained in other sectors, especially in its access to the domestic market. The Chinese government has limited the ability of foreign firms to compete in the Chinese market by imposing export, localization, and technology transfer requirements as well as difficulties in recruiting and retaining key personnel (Bransteeter and Feenstra, 1999). China’s policies were extremely successful. Its average annual GDP growth increased from 5.3% between 1961 and 1979 to 9.5% between 1980 and 2003 (Fan and Felipe 2005). Exports rose from 6.4% of GDP in 1979 to 21.8% in 1999. China has become the second largest host of FDI, after the US. Distortions that may be inevitable under any industrial policy have also appeared in China. Since the early 90’s, it has gradually lowered both tariff protection and FDI restrictions.¹⁹

¹⁹This paragraph is based on Lemoine (2000).

In Japan, Korea, Taiwan, Hong Kong, Singapore and China, specific policies or natural advantages were indispensable to harness trade and FDI to drive capital accumulation and technology transfer. It is instructive to compare these experiences with those of countries that did not apply such policies but, instead, opted for straightforward liberalization, such as India, Brasil and Mexico.

India underwent liberalization in 1991 after following a strategy of import-substitution policies since independence in 1947. Following a macroeconomic crisis, a stabilization and structural adjustment program supported by the IMF and the World Bank reformed trade and FDI (Nagesh, 1995). The New Industrial Policy abolished most of the industrial approval system that had existed until then. These policies met with success, and India's growth rate rose between 1981 and 1991 from the "infamous 'Hindu' rate of growth of 3.5%" (Srinivasan, 2002, page 3), to 5.4 %, an then to 6.0% between 1992 and 2003 (Fan & Felipe, 2005). FDI in power generation, telecommunications, petroleum exploration and transportation sectors enjoyed special incentives, given the importance of these sectors for trade and industrial development (Sharma, 2000), although these did not specifically promote technology transfer. The Indian FDI stock increased to almost US\$ 39 billion by 2004 (UNCTAD online database). Nevertheless, India lags behind China in many economic indicators (Chakraborty and Nunnenkamp, 2006). Our model offers a clear explanation for this comparatively mixed success. First, India's GDP (a measure of its productive capacity) in 1991 was the sixth largest in the world, after the US, Japan, China, the USSR (less involved in trade) and Germany (Maddison, 2003). Therefore, its transition could be expected to be one of convergence, tending towards the capture of a sizeable set of export sectors. On the other hand, India did not significantly apply policies supporting technological transfer. Hence, it did not achieve the Chinese rates of growth. It must be said, though, that simultaneously dismantling import-substitution and establishing export promotion might be impossibly difficult to achieve efficiently without allowing for an interim period of liberalization in order to eliminate the distortions of the first policy regime.

The comparison of Brasil and Mexico with India is interesting. These countries have applied similar policies. They have liberalized trade and received relatively large flows of FDI, and have not significantly applied technological transfer policies in relation to trade and FDI (for Brasil, see Rothmuller, 2003; for Mexico see López-Córdova, 2002). Yet, they have been less successful than India, achieving less economic growth. The model suggests that one reason may be that these countries are smaller. In 1995, Brasil's GDP lagged behind the US, China, Japan,

India, Germany, Russia, France, the UK, and Italy, while Mexico also lagged behind Indonesia and Canada. Although Brasil was not too far below these European countries, these also enjoy the incentive benefits of outward FDI flows. Thus, Brasil and Mexico are at a disadvantage in the allocation of innovation sectors through free trade, and, in addition, suffer innovation crowding out through FDI. Nevertheless, since they are not too far in size from these technologically autonomous European countries (for which convergence under trade occurs) perhaps Brasil and Mexico are not situated too far below the convergence threshold under free trade. An additional push through technology transfer policies could lead to the transition to development.

To highlight the plausibility of innovation crowding out and unequal innovation incentives due to FDI, we examine world motor vehicle production and consumption in 1998 (Table 2). Automobiles represent a fairly mature product with a not particularly impressive rate of innovation.²⁰ Many middle income countries are quite capable of engineering and producing a line of automobiles. However, doing so while facing the competition of established and advanced producers may be impossible. What does Table 1 show? Those countries in Europe and North America that developed the automobile continue to produce and trade it, both with each other and with other countries. In contrast, the new producers, mainly Japan and Korea, do not import automobiles. These countries developed their capabilities in automobile production by promoting their exports and performing a full import substitution, eliminating competition from FDI in automobiles. On the other hand, Latin American countries that supposedly “substituted for imports” by allowing FDI in automobiles,²¹ did not develop their own industries.

Discussions on the role of institutions usually place emphasis on how these improve the incentives for investment and innovation through, for example, property rights and effective contractual arrangements. What becomes apparent in the history of development and through the model, though, is the important role that institutions play in recognizing and implementing policies favoring the country’s own *long-term self-interest*. This requires coordination and agreement amongst a country’s various sectors, and has often necessitated manipulating trade incentives in order to access the advantage of backwardness. In the US, the implementation of the American System required a high tariff to protect American industries from British industrial supremacy.²² Similarly, Japan—and later Korea

²⁰Yet, 78% of world sales are due to ten corporations (three from the US) (Najera, 1998).

²¹Since 1916 in Argentina (Ford home page), and since 1920 in Mexico (Soto-Rodríguez, 2002).

²²The American System, advanced by Henry Clay and others after 1812 for industrial-

and Taiwan—were jealously concerned with their technological independence, and devised economic policies that ensured their own technological capabilities and independence. China has clearly designed its policies with a long term view to the independent development of its domestic sector. These governments have taken leading, credible roles in the implementation of appropriate policies for their economic growth. By contrast, in Latin America rent-seeking elites have not been effectively concerned with their technological independence.^{23,24}

However, it is clear that most countries are just too small or lag too far behind to be able to negotiate an appropriate economic environment for their development. What is needed is world trade and investment agreements that ensure not only a “level playing field” in trade and investment, but also balanced innovation incentives across countries through policies (especially those supporting exports) for the technology transfer that market liberalization on its own cannot yield. Export promotion combined with some graduated form of import protection should not be discarded either, since such a policy can reduce the loss of sectors implied by free trade long enough for aggregate productive capacity to rise.

2. The model

For the sake of simplicity, I present a continuous and semi-exogenous Schumpeterian model, reminiscent of the Solow model. The propensity to innovate is modelled exogenously. However, the assumptions we make for production and innovation closely follow the endogenous theory of technological change, thus reproducing the salient features of endogenous models.

Our unit of analysis will be an ‘Economy’, which may consist of several closely integrated countries. What is assumed is that an economy has a single knowledge system, a common knowledge base, and single labor and goods markets. A ‘domestic’ sector is produced within an Economy (in any of its countries, if there

technological progress, promoted trade between North, South and West through transportation improvements. The South, having access to markets for its cotton, had no incentives to join the System, one of the causes of the Civil War (Spannaus and White, 1996; Salisbury, 1992).

²³Political scientists have proposed that countries which have faced the extreme organizational necessities of war have developed stronger institutions. This may be one reason why East Asian and Western European countries, as well as China and the US, have stronger institutions that effectively pursue their self-interest, as compared to, for example, Latin America.

²⁴The degree to which a country puts into place policies that effectively promote its self-interest may be orthogonal to whether it is democratic or autocratic, partly explaining Barro’s (1991) weak findings for democracy as a variable promoting economic growth.

are more than one), and ‘foreign’ means from another Economy. The model will analyze the interaction between Economy 1 and Economy 2. In some contexts, Economy 1 will be thought of as the developed core of countries vis-à-vis either one country or the underdeveloped world as a whole.

2.1. Production and Trade

Suppose Economy 1 and Economy 2 produce a continuum of tradeable goods indexed by $[0, 1]$. We examine three regimes: autarchy, free trade without FDI, and free trade with FDI. I only consider FDI in the context of trade, for several reasons. First, without trade it is impossible to repatriate foreign companies’ profits, except in kind. Second, FDI workers import some of their consumption. Third, FDI has higher institutional requirements. It will turn out that small or more backward economies specialize completely in FDI.

2.1.1. Production sectors: FDI and domestic production

Suppose that on the subset $[0, \bar{\xi}^{FDI}]$ it is possible to separate innovation from production. This is the condition that defines FDI: foreign investors innovate at home and produce abroad in order to benefit from lower wages. We will assume that the product of FDI is consumed in both economies, and will consider technological externalities. Suppose Economy 1 has a higher technological level than Economy 2. We shall confirm below that this implies that it also has higher wages. Then, only Economy 1 can invest competitively in Economy 2. Moreover, any sector for which FDI is possible will be produced in Economy 2, to benefit from lower wages.

Under autarchy each economy produces the full range of goods and there is no FDI.

Under free trade with FDI, let $[0, \xi^{FDI}]$ be the set of sectors produced by FDI. If Economy 2’s population is large enough, then $\xi_t^{FDI} = \bar{\xi}^{FDI}$. Otherwise, FDI will only be possible for a restricted set of sectors with $\xi_t^{FDI} < \bar{\xi}^{FDI}$, employing all of the working population of Economy 2. It is implicitly assumed that there is some natural ordering for selecting a subset of FDI sectors for production. Profits from FDI form part of Economy 1’s national product. As we shall discuss below, this implies that Economy 1 has additional resources for innovation.

To consider free trade without FDI, simply set $\bar{\xi}^{FDI} = 0$.

Under free trade, suppose further that Economy 1 produces and innovates domestically on the set $[\xi_t^{FDI}, \xi_t^{FDI} + \xi_{1t}]$, while Economy 2 produces and innovates domestically on set $[\xi_t^{FDI} + \xi_{1t}, 1]$. The underlying assumption is that there is a single innovator in each economy (we exclude innovation races) that innovates with certainty and becomes a world monopolist (in autarchy it is a national monopoly). Innovation sectors will be assigned endogenously concurrently with the international assignment of production operating through trade. In other words, the variable ξ_{1t} will be endogenously determined. Define $\xi_{2t} = 1 - \xi_t^{FDI} - \xi_{1t}$ so

$$\xi_t^{FDI} + \xi_{1t} + \xi_{2t} = 1. \quad (2.1)$$

2.1.2. Production function

Consider first a domestically produced good in sector $\eta \in [\xi_t^{FDI}, 1]$ in Economy j . Assume the linear production function:

$$y_{jt}(\eta) = A_{jt}l_{jt}(\eta).$$

Here $y_{jt}(\eta)$ is the amount produced in sector η , A_{jt} is the technological level of the given economy, and $l_{jt}(\eta)$ is labor employment. Given wages w_{jt} , the cost of each unit of goods η is $z_{jt}(\eta) = w_{jt}/A_{jt}$. Suppose, as is common in endogenous models of technological change, that each sector produces monopolistically (with a competitive fringe) and thus sells with a mark up at a price:

$$p_{jt}(\eta) = \chi w_{jt}/A_{jt},$$

where $\chi > 1$. Assuming Cobb-Douglas preferences

$$U_{jt} = \exp \int_0^1 \ln(c_{jt}(\eta)) d\eta, \quad (2.2)$$

aggregate expenditure in each sector is some constant b_{jt} , which is common to both economies under trade and economy-specific under autarchy, so

$$p_{jt}(\eta) \times y_{jt}(\eta) = \frac{\chi w_{jt}}{A_{jt}} \times A_{jt}l_{jt}(\eta) = \chi w_{jt}l_{jt}(\eta) = b_{jt}. \quad (2.3)$$

Thus, in each economy, the amount of labor l_{jt} assigned to production in domestic sectors is constant.

Suppose each economy has a fixed population L_j . Under autarchy, with neither trade nor foreign investment, since workers are distributed uniformly across sectors

$l_{jt}(\eta) = \int_0^1 l_{jt}(\eta) d\eta = L_j$. Each sector produces $y_{jt}(\eta) = A_{jt}L_j$. The aggregate product is $Y = \int_0^1 A_{jt}L_j d\eta = A_{jt}L_j$.

Under free trade and FDI, assume that $A_{1t} > A_{2t}$ and define $a_t = A_{2t}/A_{1t}$. Consider any goods in sector $\eta \in [0, \bar{\xi}^{FDI}]$ produced by FDI from Economy 1 firms in Economy 2. Assume that FDI pays Economy 2 wages, but sells as if it had produced at home. The reason is that the producer has a similar monopoly or faces a similar competitive fringe as non-FDI innovators in Economy 1, and therefore sells at the same price²⁵. The cost of production is $z_t^{FDI}(\eta) = w_{2t}/A_{1t}$ and the sales price is $\chi w_{1t}/A_{1t}$. Hence, as in (2.3), the labor l_t^{FDI} demanded in each FDI sector satisfies $\chi w_{1t} l_t^{FDI} = b_t$, so $l_t^{FDI} = l_{1t}$.

We can now complete the solution for production in both economies. Market clearing conditions in the two labor markets are:

$$\xi_{1t} l_{1t} = L_1, \quad \xi_{2t} l_{2t} + \xi_t^{FDI} l_{1t} = L_2 \quad (2.4)$$

Equation (2.3)

$$w_{1t} l_{1t} = w_{2t} l_{2t}, \quad (2.5)$$

The distribution of domestically produced sectors between economies is given by price equalization, a consequence of free trade:

$$\frac{w_{1t}}{A_{1t}} = \frac{w_{2t}}{A_{2t}}.$$

The price of domestically produced goods can now be used as numeraire in both economies, to find

$$w_{jt} = \frac{1}{\chi} A_{jt}.$$

In each FDI sector, profits accruing to Economy 1 firms are

$$\pi_t^{FDI} = \frac{\chi w_{1t} - w_{2t}}{A_{1t}} \times A_{1t} l_t^{FDI} = (1 - \chi^{-1} a_t) A_{1t} l_{1t} \quad (2.6)$$

>From (2.5),

$$a_t^{-1} l_{1t} = l_{2t}.$$

²⁵For example, assume that the FDI producer is large, that it has innovated specifically for production in Economy 2, and finally that its fringe competitors are small and would have to innovate for production in Economy 1. Also, note that if the price were proportional to a_t , or even a positive fractional power of a_t , the level of production would tend to infinity as $a_t \rightarrow 0$, something that seems unrealistic.

Hence

$$l_{1t} = \frac{L_1}{\xi_{1t}}, \quad l_{2t} = \frac{L_2}{\xi_{2t} + a_t \xi_t^{FDI}} \quad (2.7)$$

Let $\lambda = L_2/L_1$. Thus

$$a_t = \frac{l_{1t}}{l_{2t}} = \frac{\xi_{2t} + a_t \xi_t^{FDI}}{\lambda \xi_{1t}} \quad (2.8)$$

Using (2.1), the solutions are:

$$\begin{aligned} \xi_{1t} &= \frac{1 - (1 - a_t) \xi_t^{FDI}}{1 + a_t \lambda}, \\ \xi_{2t} &= \frac{a_t (\lambda - (1 + \lambda) \xi_t^{FDI})}{1 + a_t \lambda} \equiv a_t \tilde{\xi}_{2t}. \end{aligned} \quad (2.9)$$

where we define the bounded auxiliary function

$$\tilde{\xi}_{2t} = \frac{\lambda - (1 + \lambda) \xi_t^{FDI}}{1 + a_t \lambda}.$$

The presence of FDI displaces sectors from domestic production. Also, the further behind Economy 2 lags, the less export sectors it has.

Note that price equalization has determined the measure of sectors allocated to production in Economies 1 and 2. Again, it is assumed implicitly that there is some natural ordering for distributing the individual sectors between economies, subject to the aggregate condition. It is assumed that there is one innovator per sector. Innovators know if their sectors will be engaged in production or not, and innovate with certainty if they will. Thus, we also exclude international innovation races. In a separate paper (Mayer-Foulkes, 2006b), this ordering is established by comparative advantage, and then it seems completely natural that innovators from sector η in Economy j only innovate and then produce if their price will be lower than their sector η counterpart in the other economy. Here, however, comparative advantage would have to be combined with FDI, yielding unnecessary complexity.

Now we have the solutions

$$\begin{aligned} l_{1t} &= \frac{(1 + a_t \lambda) L_1}{1 - (1 - a_t) \xi_t^{FDI}}, \\ l_{2t} &= \frac{(1 + a_t \lambda) L_1}{a_t (1 - (1 - a_t) \xi_t^{FDI})}, \\ l_t^{FDI} &= \frac{(1 + a_t \lambda) L_1}{1 - (1 - a_t) \xi_t^{FDI}}. \end{aligned}$$

Note that employment in FDI is bounded by L_2 , so we must have

$$\xi_t^{FDI} l_t^{FDI} = \frac{\xi_t^{FDI} (1 + a_t \lambda) L_1}{1 - (1 - a_t) \xi_t^{FDI}} \leq L_2.$$

However, equality generates a singular equation in a_t , so

$$\frac{\xi_t^{FDI} (1 + a_t \lambda)}{1 - (1 - a_t) \xi_t^{FDI}} \geq \lambda \Leftrightarrow \xi_t^{FDI} \geq \lambda (1 - \xi_t^{FDI}) \Leftrightarrow \xi_t^{FDI} \geq \frac{L_2}{L_1 + L_2}$$

Thus, Economy 2 supports all desired FDI, or does not, for any value of a_t . The solution for ξ_t^{FDI} that applies in the solutions above for ξ_{1t} , ξ_{2t} , l_{1t} , l_{2t} is:

$$\xi_t^{FDI} = \min \left[\bar{\xi}_t^{FDI}, \frac{L_2}{L_1 + L_2} \right].$$

Note that when Economy 2 specializes in FDI, so $\xi_t^{FDI} = \frac{L_2}{L_1 + L_2} = \frac{\lambda}{1 + \lambda}$, it does not export domestic products. Hence $\xi_{2t} = 0$, and $\xi_{1t} = \frac{L_1}{L_1 + L_2} = \frac{1}{1 + \lambda}$. Also, $l_{1t} = L_1 (1 + \lambda) = L_1 + L_2$, and l_{2t} is irrelevant.

When Economy 2 is not specialized in FDI,

$$\begin{aligned} \frac{d\xi_{1t}}{da_t} &= \frac{d}{da_t} \left(\frac{1 - (1 - a_t) \xi_t^{FDI}}{1 + a_t \lambda} \right) = \frac{\xi_t^{FDI} - \lambda + \lambda \xi_t^{FDI}}{(1 + a_t \lambda)^2} < 0, \\ \frac{dl_{1t}}{da_t} &= \frac{d(L_1 / \xi_{1t})}{da_t} > 0. \end{aligned}$$

The aggregate product of Economy 1 is domestic production plus FDI profits,

$$\begin{aligned} Y_{1t} &= \xi_{1t} A_{1t} l_{1t} + \xi_t^{FDI} (1 - \chi^{-1} a_t) A_{1t} l_{1t} \\ &= \left(1 + \frac{(1 - \chi^{-1} a_t) (1 + a_t \lambda) \xi_t^{FDI}}{1 - (1 - a_t) \xi_t^{FDI}} \right) A_{1t} L_1 \end{aligned}$$

Economy 2's aggregate product is domestic production plus the FDI wage bill,

$$\begin{aligned} Y_{2t} &= A_{2t} \xi_{2t} l_{2t} + w_{2t} \xi_t^{FDI} l_t^{FDI} \\ &= \left(\frac{(\lambda - (1 + \lambda) \xi_t^{FDI})}{1 - (1 - a_t) \xi_t^{FDI}} + \chi^{-1} \frac{\xi_t^{FDI} (1 + a_t \lambda)}{1 - (1 - a_t) \xi_t^{FDI}} \right) A_{2t} L_1 \end{aligned}$$

Economy 2's income is less than $A_{2t} L_2$ because on the FDI sectors profits belong to Economy 1.

Note that if Economy j consists of n_j identical countries, it could be defined that each country produces domestically in ξ_{jt}/n_j sectors, and countries in Economy 1 perform FDI in ξ_t^{FDI}/n_1 sectors.

2.2. Innovation

Assume that each type of income stream (namely wages and profits) from domestic or FDI production is associated with a stream of investment in innovation, each with different propensities. The motivation for this assumption is to be able to perform policy analysis. First, for comparison, let γ_j^w, γ_j^π be the propensities for investment from wages and profits in each economy. When the poor are not credit-constrained and the financial system is well developed, the two propensities might be the same. But in a less developed economy it is quite feasible that the propensity for investment from wages is lower, and would result in lower steady states. Now let $\gamma_2^{w,FDI}$ be the propensity for investment from wages in FDI. In principle, this need not be different than γ_2^w . However, we consider the case when $\gamma_2^{w,FDI}$ also measures a technology externality through employment, or when FDI production is outsourced and includes technology transfer. Finally, let γ_j^{FDI} ; $j = 1, 2$, be the propensities for investment from FDI profits, where j indicates the economy whose knowledge base is benefitted. γ_1^{FDI} represents investment in raising home knowledge A_1 , and it is assumed $\gamma_1^{FDI} \geq \gamma_1^\pi$. γ_2^{FDI} represents investment (or an externality) from foreign firms in raising host knowledge A_2 . It may be that $\gamma_2^{FDI} = 0$ is the normal condition in FDI production. In any case, raising γ_2^{FDI} may be a policy option.

Note that under domestic production, proportions $1/\chi$ and $1 - 1/\chi$ accrue to wages and profits respectively, thus we can write an average propensity of investment in innovation $\gamma_j = \gamma_j^w/\chi + \gamma_j^\pi(1 - 1/\chi)$.

We assume that the rate of technological change in Countries 1 and 2 is given by a formula representing aggregation from sector investments:

$$\frac{\dot{A}_1}{A_1} = \mu \int_0^1 \left(\frac{\gamma_1 y_{1t}^{DOM}(\eta) + \gamma_1^{FDI} \pi_t^{FDI}(\eta)}{A_{1t}} \right)^\sigma d\eta,$$

$$\frac{\dot{A}_2}{A_2} = \mu G(a_t) \int_0^1 \left(\frac{\gamma_2 y_{2t}^{DOM}(\eta) + \gamma_2^{w,FDI} w_t^{FDI}(\eta) + \gamma_2^{FDI} \pi_t^{FDI}(\eta)}{A_{2t}} \right)^\sigma d\eta.$$

Here μ is some constant, $y_{jt}^X(\eta)$, $w_{jt}^X(\eta)$ and $\pi_{jt}^X(\eta)$ are production, wages and profits accrued in sector η , where X can be domestic or FDI production (*DOM* or *FDI*), and $0 < \sigma < 1$ is the elasticity of innovation with respect to investment in the innovation function, which is assumed to have decreasing returns.²⁶ Division

²⁶The innovation function of the form y^σ introduced here leads to scale effects of the same form L^σ . If, instead, a (mathematically more complex) bounded innovation function is used, then bounded scale effects will result.

by A_{jt} represents the fishing out effect. The function $G(a_t)$ is a decreasing function in the technological lag a_t to the leader, reflecting Gerschenkron's (1952) *advantage of backwardness*. Thus, it is assumed that $G(1) = 1$, $G'(a_t) < 0$. This introduces technology transfer (through common knowledge) and convergence. Note that it is implicitly assumed, in defining $a_t = A_{2t}/A_{1t}$, that only research in Economy 1 advances the leading technological edge, and that this knowledge generates convergence. Hence, the model is only valid in the case when Economy 2 lags sufficiently far behind. Above that level we would introduce another variable for the leading edge technology, and a relative technological level a_{jt} would be defined for each economy with respect to it.²⁷

In effect, since this is a simplified model, what we are assuming is that monopoly producers retain their lead through innovation, and that externalities that raise the level of knowledge A_{jt} are generated in the process. Technological change in Economy 2, which might occur through technology adoption, is costly, though the cost is less if Economy 1 is further ahead. Finally, FDI firms conduct their research directly for production in Economy 2, so they have no further adoption costs, they remain owners of this knowledge, and they increase their Economy's knowledge base.²⁸

Performing the integrals and simplifying, the expressions for technological change for each economy are:

$$\frac{\dot{A}_1}{A_1} = \mu l_{1t}^\sigma \left(\gamma_1^\sigma \xi_{1t} + \gamma_1^{FDI\sigma} \xi_t^{FDI} \left(1 - \frac{a_t}{\chi} \right)^\sigma \right) \quad (2.10)$$

and

$$\frac{\dot{A}_2}{A_2} = \mu G(a_t) l_{1t}^\sigma \left(\gamma_2^\sigma a_t^{1-\sigma} \tilde{\xi}_{2t} + \frac{\gamma_2^{w,FDI\sigma} \xi_t^{FDI}}{\chi^\sigma} + \gamma_2^{FDI\sigma} \xi_t^{FDI} \left(\frac{1}{a_t} - \frac{1}{\chi} \right)^\sigma \right). \quad (2.11)$$

FDI unambiguously raises Economy 1's growth rate, for example under the condition $\gamma_1^{FDI} \geq \gamma_1$ (this is proved in the initial section of the Appendix). However, FDI has an ambiguous effect on the growth rate of Economy 2, since the term in $l_{1t}^\sigma \tilde{\xi}_{2t}(a_t)$ is decreasing in ξ_t^{FDI} while the others, with coefficients $\gamma_2^{w,FDI}$, γ_2^{FDI} , are increasing.

²⁷As in other models (Howitt and Mayer-Foulkes, 2005; Aghion, Howitt and Mayer-Foulkes, 2005), we exclude innovation races.

²⁸The propensities for innovation investment might be thought to account for differences in the productivity of each type of research.

It is also apparent that the hypotheses on innovation embody that engaging in research in only a subset of sectors constitutes a disadvantage. Advancing knowledge is most effective when it is advanced on all fronts.

2.2.1. Autarchy

In the case of autarchy (without FDI),

$$\frac{\dot{A}_1}{A_1} = \mu\gamma_1^\sigma L_1^\sigma, \quad \frac{\dot{A}_2}{A_2} = \mu G(a_t) \gamma_2^\sigma L_2^\sigma.$$

Hence

$$\frac{\dot{a}_t}{a_t} = \mu\gamma_1^\sigma L_1^\sigma \left(G(a_t) \left(\frac{\gamma_2\lambda}{\gamma_1} \right)^\sigma - 1 \right).$$

The behavior of this dynamical system is described in the following Proposition.

Proposition 1. Under autarchy, Economy 1's growth rate is $\mu\gamma_1^\sigma L_1^\sigma$. For Economy 2, the following cases arise.

1. Overtake. If Economy 2 is more innovative than Economy 1 (either because of its population size or because it invests more on innovation), that is, if $\gamma_2\lambda/\gamma_1 > 1$, then it eventually overtakes Economy 1: a_t reaches 1 and then the two economies reverse roles.

2. Exact catchup. If the economies are equally innovative, that is, $\gamma_2\lambda/\gamma_1 = 1$, then the unique steady state is $a^* = 1$, at which the economies have identical technological levels.

3. Divergence in levels. If Economy 2 is less innovative than Economy 1, that is, if $\gamma_2\lambda/\gamma_1 < 1$ but $G(0) \left(\frac{\gamma_2\lambda}{\gamma_1} \right)^\sigma > 1$, then there is a unique positive steady state $a^* \in (0, 1)$, and the technological lag of Economy 2 is some fixed, bounded factor.

4. Divergence in growth rates. If Economy 2 is less innovative than Economy 1, that is, if $\gamma_2\lambda/\gamma_1 < 1$ and $G(0) \left(\frac{\gamma_2\lambda}{\gamma_1} \right)^\sigma \leq 1$, then the unique steady state is $a^* = 0$. If $G(0) \left(\frac{\gamma_2\lambda}{\gamma_1} \right)^\sigma = 1$ then Economy 2 diverges ever further behind, although its asymptotic growth rate equals that of Economy 1. If, instead, $G(0) \left(\frac{\gamma_2\lambda}{\gamma_1} \right)^\sigma < 1$, Economy 2 lags even further behind, with an asymptotic growth rate lower than Economy 1's by $\mu L_1^\sigma \gamma_1^\sigma \left(G(0) \left(\frac{\gamma_2\lambda}{\gamma_1} \right)^\sigma - 1 \right)$. ■

All proofs are in the appendix. Note that it is often assumed, perhaps unrealistically, that $\lim_{a_t \rightarrow 0} G(a_t) = \infty$. Then Case 4 above does not arise. I prefer not to assume the impossibility of divergence in growth rates under autarchy.

Observe that if we take the developed world (which, in effect, is integrated by trade) as leading Economy 1, most lagging economies are smaller in population. Thus, even with equal propensities to innovate $\gamma_2 = \gamma_1$, $\lambda < 1$ so Economy 2 will diverge at least in levels. In this sense free trade is a necessary condition for development.

2.2.2. Free trade without FDI

Let us first examine free trade without FDI. Then, using (2.7),

$$\frac{\dot{A}_1}{A_1} = \mu l_{1t}^\sigma \gamma_1^\sigma \xi_{1t} = \mu \gamma_1^\sigma L_1^\sigma \xi_{1t}^{1-\sigma}.$$

But we have shown that ξ_{1t} is a decreasing function of a_t . Thus, Economy 1's growth rate is reduced by the presence of a less developed trading partner, because of the loss of sectors for innovation. This loss might be compensated if the partner's research contributed to the expansion of the technological leading edge, which we have assumed does not happen. The maximal growth rate is the autarchic one corresponding to $a_t = 0$, which yields $\xi_{1t} = 1$.

We can examine a case where Economy 2 is essentially equivalent to Economy 1 by supposing that the knowledge systems become integrated under free trade. Assuming for simplicity that $\gamma_1 = \gamma_2$, in effect the two economies become a single economy with a growth rate $\mu \gamma_1^\sigma (L_1 + L_2)^\sigma$ that is higher than the autarchic growth rate. Thus, in the case of trade with another developed economy whose R&D contributes to the expansion of the technological leading edge, the loss of innovation sectors to this economy will be compensated by its technological contributions to the leading edge.

If comparative advantage is introduced for the case of free trade the results will be identical, except for two effects of comparative advantage (Mayer-Foulkes, 2006b). The first is a level effect due to the increased efficiency of production. The second is a growth effect that arises because more resources are available for innovation. Thus, under certain conditions Economy 1's growth rate may increase when trading with a less developed economy, in spite of the loss of sectors as a result of efficiency gains in production yielding increased resources for innovation.

Now consider the technological dynamics under free trade. Using (2.8) and (2.9),

$$\frac{\dot{A}_2}{A_2} = \mu G(a_t) a_t^{1-\sigma} \tilde{\xi}_{2t} \gamma_2^\sigma l_{1t}^\sigma,$$

so

$$\frac{\dot{a}_t}{a_t} = \mu L_1^\sigma \gamma_1^\sigma \xi_{1t}^{1-\sigma} (H(a_t) - 1),$$

where

$$H(a_t) \equiv G(a_t) a_t^{1-\sigma} \frac{\gamma_2^\sigma \tilde{\xi}_{2t}}{\gamma_1^\sigma \xi_{1t}} = G(a_t) a_t^{1-\sigma} \frac{\gamma_2^\sigma \lambda}{\gamma_1^\sigma}.$$

Proposition 2. Under free trade without FDI there are simple conditions under which $H(a_t)$ is a quasiconcave and $\lim_{a_t \rightarrow 0} H(a_t) = 0$. Under these conditions, there is always a divergent steady state $a^* = 0$. If $H(a_t) < 1$ on $(0, 1]$, this is the only stable steady state. The following are also possible.

1. Overtake. If there is a single solution $H(a_{\text{crit}}) = 1$ on the interval $(0, 1]$, then Economy 2 overtakes Economy 1 if $a_0 > a_{\text{crit}}$, and diverges in growth rates if $a_0 < a_{\text{crit}}$; $a_0 = a_{\text{crit}}$ is an unstable steady state.

2. Convergence in growth rates. If there are two solutions $H(a_{\text{crit}}) = H(a_2^*) = 1$, $0 < a_{\text{crit}} < a_2^* \leq 1$, then Economy 2 converges to a_2^* if $a_0 > a_{\text{crit}}$. It diverges in growth rates if $a_0 < a_{\text{crit}}$. As before, $a_0 = a_{\text{crit}}$ is an unstable steady state, and catchup is exact if $\gamma_2^\sigma \lambda = \gamma_1^\sigma$, a slightly different condition than in autarchy: economy size has a higher exponent. Assuming also that $\left. \frac{d}{da_t} (G(a_t) a_t^{1-\sigma}) \right|_{a_t=1} < 0$, identical economies fall in this case, with $a_2^* = 1$. ■

Proposition 2 shows that the introduction of free trade generates the possibility of divergence in any economy with a sufficiently low initial relative technological level.

Note that quasiconcavity is only introduced for simplicity. More complex functional forms could yield more steady states.

Corollary 3. If Economy 2 opens to free trade at the autarchic steady state it will converge to a higher steady state only when it has a higher productive capacity than Economy 1. ■

Only with a higher productive capacity will Economy 2 not lose innovation sectors and fall into divergence. This condition might hold for China and India, but not for Brasil and Mexico, as discussed in the introduction.

Note that if fixed productivity effects are introduced in the production function to represent institutional development, human development, and other determinants of development, these will intervene in the productive capacity term mentioned in the Corollary. Hence GDP is a good measure of ‘productive capacity’, since it includes the effects of these various factors.

2.2.3. Free trade with FDI

FDI increases the incentives for innovation for Economy 1. Its growth rate

$$\frac{\dot{A}_1}{A_1} = \mu L_1^\sigma \left(\gamma_1^\sigma \xi_{1t}^{1-\sigma} + \gamma_1^{FDI\sigma} \xi_{1t}^{-\sigma} \xi_t^{FDI} \left(1 - \frac{a_t}{\chi} \right)^\sigma \right)$$

is a decreasing function of a_t . Economy 1 grows fastest at $a_t = 0$, when it does not lose innovation sectors through trade, and when FDI occurs with the lowest possible wages. When $\gamma_1^{FDI} \geq \gamma_1$, Economy 1’s growth rate is $\left. \frac{\dot{A}_1}{A_1} \right|_{a_t=0} \geq \mu \gamma_1^\sigma L_1^\sigma (1 - \xi_t^{FDI})^{-\sigma}$, which is higher than the autarchic rate. At higher values of a_t , FDI also compensates, though maybe not fully, for the loss of innovation sectors in trade.

Asymmetries in FDI will also lead to asymmetries in innovation in the case when Economy 2 is essentially equivalent to Economy 1, contributing to the expansion of the leading technological edge.

Let us turn to the dynamics under free trade and FDI. Note that $\frac{\dot{a}_t}{a_t} = \frac{\dot{A}_2}{A_2} - \frac{\dot{A}_1}{A_1}$, $\frac{\dot{a}_t}{a_t} \geq 0 \Leftrightarrow \frac{\dot{A}_2}{A_2} / \frac{\dot{A}_1}{A_1} \geq 1$. Thus we study the function

$$\frac{\frac{\dot{A}_2}{A_2}}{\frac{\dot{A}_1}{A_1}} = F(a_t, \xi_t^{FDI}) \equiv \frac{F_N(a_t, \xi_t^{FDI})}{F_D(a_t, \xi_t^{FDI})},$$

where

$$\begin{aligned} F_N(a_t, \xi_t^{FDI}) &= G(a_t) \left(\gamma_2^\sigma a_t^{1-\sigma} \tilde{\xi}_{2t}(a_t) + \frac{\gamma_2^{w, FDI\sigma} \xi_t^{FDI}}{\chi^\sigma} + \gamma_2^{FDI\sigma} \xi_t^{FDI} \left(\frac{1}{a_t} - \frac{1}{\chi} \right)^\sigma \right), \\ F_D(a_t, \xi_t^{FDI}) &= \gamma_1^\sigma \xi_{1t} + \gamma_1^{FDI\sigma} \xi_t^{FDI} \left(1 - \frac{a_t}{\chi} \right)^\sigma > 0. \end{aligned}$$

Proposition 4. Under free trade and FDI:

- 1) When $\gamma_2^{FDI} > 0$, divergence in growth rates is impossible.
- 2) When $\gamma_2^{FDI} = 0$, divergence in growth rates is impossible if either a) convergence forces are strong enough ($\lim_{a_t \rightarrow 0} G(a_t) = \infty$) and $\gamma_2^{w,FDI} > 0$, or b) convergence forces and $\gamma_2^{w,FDI}$ are jointly large enough, namely,

$$G(0) \gamma_2^{w,FDI\sigma} > \chi^\sigma \left(\gamma_1^\sigma \frac{1 - \xi_t^{FDI}}{\xi_t^{FDI}} + \gamma_1^{FDI\sigma} \right).$$

- 3) Suppose $\gamma_2^{FDI} \leq \gamma_1^{FDI}$ and $\gamma_2^{w,FDI} \leq \gamma_2$. High enough steady states $a^* \leq 1$, will be lowered by additional FDI. That is, FDI will raise Economy 1's growth rate more than Economy 2's.

What this implies is that under policies ensuring technological transfer from FDI (so that γ_2^{FDI} and $\gamma_2^{w,FDI}$ are large enough) the following happens. First, divergence in growth rates will be eliminated for economies lagging far behind, and second, intermediate economies will not lag so far behind in levels.²⁹

The presence of FDI implies innovation crowding because Economy 2 innovators produce in less sectors, and because Economy 2's income is deprived of the profits it would obtain if it produced in the FDI sectors.

The contribution of FDI sectors to Economy 2's knowledge is minimal if their main activity is labor employment. It can be higher when the FDI production chain involves subcontracting and technological transfer, a policy carried out by Taiwan as described above. In the extreme case, when Economy 2 specializes in FDI (the Banana Republic), the absence of a domestic sector implies the question: who is the repository of local knowledge A_2 ? Only unskilled work remains! Subcontracting may provide a route to development, as it did in Taiwan, a small country.

If FDI has the negative effects claimed by Proposition 4, why do countries accept it? First, let it be said that opposition to FDI has occurred frequently. The main point is that FDI has a considerable power of negotiation that derives from its supernormal profits. When it arrives, it can offer higher wages to begin

²⁹Note, of course, that although the proposition asks only for positive γ_2^{FDI} , if the value is too small then the resulting steady state may imply a lag so large that it cannot in practice be distinguished from divergence in growth rates. What is required is that $\gamma_2^{FDI} \left(\frac{\chi}{a_t} - 1 \right)$ be of the order of magnitude that $\gamma_2^{w,FDI}$ must have.

with, offer certain benefits, or bribe corrupt officials. Later, it can use threats to move to another country as leverage. However, negotiation is a two way street. It is indeed possible to regulate FDI, so that it contributes with technology transfer and other benefits, as China has shown. However, for smaller countries such negotiation may only be possible in the context of a global governance of free trade and investment.

3. Conclusions

This paper presents a model of development and underdevelopment in an *open* global economy. The model shows that trade can accentuate advantages in innovation that result from innovating in more sectors. As a consequence of free trade and FDI unequal or divergent steady states may persist between economies differing *only* in their relative status. Miracle growth between these steady states can also arise. Thus, geographic, institutional, and other differences between countries are *not necessary conditions* of backwardness, although they certainly can be aggravating or promoting factors determining steady state levels and membership.

The model incorporates trade and foreign investment in a Schumpeterian model of economic growth with technology transfer. It shows that under free trade innovation and production sectors tend to be allocated across countries in proportion to their productive capacity, and that in these circumstances innovation externalities between sectors can generate divergence. One solution to this problem may be to promote exports in combination with some graduated form of import protection that saves some sectors for further development once aggregate productive capacity catches up. Another solution is technology transfer.

In addition, FDI results in unequal incentives for innovation that favor leading countries and crowd out host innovation. The positive news here is that when trade and FDI have been regulated to achieve technology transfer and protect enough domestic sectors (as in China recently and in East Asia before) they have proved to be powerful instruments for achieving miracle growth leading to development. Moreover, the commercial partners and investor countries have also benefited from the process. Where such regulation has not been applied, the results have not been as good.

In practice, technological adoption is so difficult that high rates of economic growth and convergence have only been sustained through integration with the world economy. Prolonged episodes of high economic growth involve, almost without exception, the controlled use of trade and FDI to favor technological transfer

and independence. These episodes have been a repeated feature of economic history, characterizing most countries' transition to development. The model explains these stylized facts in terms of the underlying incentives for innovation; development and underdevelopment are understood as steady states, and miracle growth episodes as a transition between them.

Theories finding that free trade and investment across countries lead to equalization in growth rates and productivity levels are usually based on competitive markets and on production functions facing diminishing returns. In these situations, the tendency to equilibrium usually generates convergence. Innovation, however, is driven by incentives derived from market power. Only a public global policy can curb the abuses or distortions which can derive from such power. This is the principle behind anti-trust law, and the same principle holds in the case of international trade and investment. Competition between equals — even between huge consortiums — may be beneficial. But when important asymmetries arise, the long-term independence and development of the weak must be safeguarded. Access to markets and cheap labor must be compensated with the transfer of knowledge. Policies guaranteeing technological development in underdeveloped countries are indispensable for globalization to successfully raise incomes and eliminate poverty, and with it, some of the antagonisms that generate terrorism and war.

Unlocking the growth potential of trade and FDI requires global regulation through worldwide trade and investment agreements that correct the inherent innovation imbalances and promote economic development for all countries through technology and other transfers (such as skills and infrastructure).

If underdevelopment consists of a technological trap generated under globalization, as is proposed here, it is vital to recognize this. Unlocking the trap will lead to miracle growth and enormous welfare gains, while ignoring it will doom misjudged economic policies.

4. Appendix

FDI raises Economy 1's growth rate. Assume $\gamma_1^{FDI} \geq \gamma_1$ and let “ \approx ” mean “has the same sign as”.

$$\begin{aligned}
\frac{\partial}{\partial \xi_t^{FDI}} \left(\frac{\dot{A}_1}{A_1} \right) &\approx (1 - \sigma) \gamma_1^\sigma \xi_{1t}^{-\sigma} \left(\frac{-(1 - a_t)}{1 + a_t \lambda} \right) \\
&\quad + \left(\frac{1}{\xi_t^{FDI}} - \frac{\sigma}{\xi_{1t}} \left(\frac{-(1 - a_t)}{1 + a_t \lambda} \right) \right) \gamma_1^{FDI \sigma} \xi_{1t}^{-\sigma} \xi_t^{FDI} \left(1 - \frac{a_t}{\chi} \right)^\sigma \\
&\approx -(1 - \sigma) \gamma_1^\sigma \left(\frac{1 - a_t}{1 + a_t \lambda} \right) + \gamma_1^{FDI \sigma} \left(1 + \frac{\sigma \xi_t^{FDI}}{\xi_{1t}} \left(\frac{1 - a_t}{1 + a_t \lambda} \right) \right) \\
&\quad \left(1 - \frac{a_t}{\chi} \right)^\sigma \\
&> 0,
\end{aligned}$$

since $\left(1 - \frac{a_t}{\chi} \right)^\sigma > 1 - \frac{a_t}{\chi} > 1 - a_t > (1 - \sigma) \left(\frac{1 - a_t}{1 + a_t \lambda} \right)$. Indeed, it is enough if $\frac{\gamma_1^{FDI \sigma}}{\gamma_1^\sigma} > (1 - \sigma) \left(\frac{1 - a_t}{1 + a_t \lambda} \right) \left(1 - \frac{a_t}{\chi} \right)^{-\sigma}$, a number just shown to be less than 1.

Proof of Proposition 1.

$$\frac{\dot{a}_t}{a_t} = \mu L_1^\sigma \gamma_1^\sigma \left(G(a_t) \left(\frac{\gamma_2 \lambda}{\gamma_1} \right)^\sigma - 1 \right).$$

Since $\frac{\dot{a}_t}{a_t}$ is a decreasing function of a_t , and steady states occur when $\frac{\dot{a}_t}{a_t} = 0$, there is at most one steady state. The different cases correspond to when $\frac{\dot{a}_t}{a_t}$ is always positive, when it crosses zero at $a_t = 1$, when it crosses zero on $(0, 1)$, and when it crosses zero at 0 or is negative for all values of a_t . ■

Proof of Proposition 2.

An example of a family of functions $G(a_t)$ satisfying the desired properties is:

$$G(a_t) = 1 + \zeta \left(1 - a_t^\beta \right),$$

with $\zeta \beta > 1 - \sigma$. Note $\left. \frac{d}{da_t} (G(a_t) a_t^{1-\sigma}) \right|_{a_t=1} = -\zeta \beta + 1 - \sigma < 0$, and $\lim_{a_t \rightarrow 0} (G(a_t) a_t^{1-\sigma}) = 0$. Further, note that $\ln(G(a_t))$ is a convex function of

$x = \ln(a_t)$, because

$$\frac{d^2}{dx^2} (\ln(1 + \zeta(1 - e^{\beta x}))) = - (1 + \zeta(1 - e^{\beta x}))^{-2} e^{\beta x} \beta^2 \zeta(1 + \zeta) < 0.$$

But $\ln(a_t^{1-\sigma})$ is a linear function of x . Hence, $\ln(G(a_t) a_t^{1-\sigma})$ is a convex function of x . Therefore, $G(a_t) a_t^{1-\sigma}$ first rises and then falls: it is quasiconcave. The quasiconcavity of $H(a_t)$ now implies that there are at most two solutions to $H(a_t) = 1$. The remainder of the proof is standard. ■

Proof of Corollary 3. Observe

$$\left(G(a_t) a_t^{1-\sigma} \frac{\gamma_2^\sigma \lambda}{\gamma_1^\sigma} \right) \left(G(a_t) \left(\frac{\gamma_2 \lambda}{\gamma_1} \right)^\sigma \right)^{-1} = (a_t \lambda)^{1-\sigma}.$$

Thus, if economy 2 opens to free trade at the autarchic steady state (when $G(a_t) (\gamma_2 \lambda / \gamma_1)^\sigma = 1$) it will only converge to a higher steady state if $\frac{A_{2t} L_2}{A_{1t} L_1} = a_t \lambda > 1$. ■

Proof of Proposition 4.

1) When $\gamma_2^{FDI} > 0$, $\lim_{a_t \rightarrow 0} F_N(a_t, \xi_t^{FDI}) = \infty$ (while $F_D(0, \xi_t^{FDI})$ is bounded), so Economy 2 grows faster than Economy 1 for small values of a_t .

2) What is required is $\lim_{a_t \rightarrow 0} F(a_t, \xi_t^{FDI}) > 1$, or $\lim_{a_t \rightarrow 0} F_N(a_t, \xi_t^{FDI}) > F_D(0, \xi_t^{FDI})$, that is,

$$\lim_{a_t \rightarrow 0} \frac{G(a_t) \gamma_2^{w, FDI \sigma} \xi_t^{FDI}}{\chi^\sigma} > \gamma_1^\sigma (1 - \xi_t^{FDI}) + \gamma_1^{FDI \sigma} \xi_t^{FDI}.$$

This follows either from $\lim_{a_t \rightarrow 0} G(a_t) = \infty$ or from the stated inequality.

3) Write $X = (a_t, \xi_t^{FDI})$ and suppose $F(X) = 1$, so $F_N(X) = F_D(X)$.

$$\begin{aligned} F_{\xi_t^{FDI}}(X) &\approx F_{N \xi_t^{FDI}}(X) F_D(X) - F_N(X) F_{D \xi_t^{FDI}}(X) \\ &= \left(-\frac{\gamma_2^\sigma a_t^{1-\sigma} (1 + \lambda)}{1 + a_t \lambda} + \frac{\gamma_2^{w, FDI \sigma}}{\chi^\sigma} + \gamma_2^{FDI \sigma} \left(\frac{1}{a_t} - \frac{1}{\chi} \right)^\sigma \right) F_D(X) \\ &\quad - F_N(X) \left(-\gamma_1^\sigma \frac{1 - a_t}{1 + a_t \lambda} + \gamma_1^{FDI \sigma} \left(1 - \frac{a_t}{\chi} \right)^\sigma \right) \\ &= \left(\gamma_1^\sigma \frac{1 - a_t}{1 + a_t \lambda} + \frac{\gamma_2^{w, FDI \sigma}}{\chi^\sigma} - \frac{\gamma_2^\sigma a_t^{1-\sigma} (1 + \lambda)}{1 + a_t \lambda} \right) F_D(X) \\ &\quad + (\gamma_2^{FDI \sigma} - a_t^\sigma \gamma_1^{FDI \sigma}) \left(\frac{1}{a_t} - \frac{1}{\chi} \right)^\sigma F_D(X) \end{aligned}$$

At $a_t = 1$, $F_{\xi_t^{FDI}}(X) \approx \frac{\gamma_2^{w, FDI\sigma}}{\chi^\sigma} - \gamma_2^\sigma + (\gamma_2^{FDI\sigma} - \gamma_1^{FDI\sigma}) \left(1 - \frac{1}{\chi}\right)^\sigma < 0$, so this inequality holds for high enough a_t . Hence, if $F(a^*(\xi_t^{FDI}), \xi_t^{FDI}) = 1$ and $F_a(a^*(\xi_t^{FDI}), \xi_t^{FDI}) < 0$, $a^{*'}(\xi_t^{FDI}) = - \left(F_{\xi_t^{FDI}}/F_a\right) \Big|_{(a^*(\xi_t^{FDI}), \xi_t^{FDI})} < 0$. ■

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**Table 2. Consolidated World Motor Vehicle Production by Nationality of Origin and Consumption, 1998
(thousand units)**

		Consumers							
		Developed				LDC's			
Origin		NAFTA	European Union	Japan	S Korea	Other Asia, Pacific	Other Europe and Turkey	South America	Total
Developed	American	9508	3846	0	0	350	52	611	14367
	European	3636	11881	0	0	520	1077	1240	18354
	Japanese	2851	811	10049	0	1251	88	39	15089
	S Korea	0	0	0	1954	28	150	0	2132
LDC's	Pacific	0	0	0	0	756	0	0	756
	Other Europe	0	0	0	0	0	792	0	792
	South America	-	-	-	-	-	-	-	-
	Total	111965	115766	70343	13678	20335	15113	13230	

Data Source: ILO (2000).