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Climbing Up the Technology Ladder? High-Technology Exports in China and Latin America

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DSFLGKFDLG;KDF;LGK

1. INTRODUCTION

To what extent are Latin American and Caribbean countries (LAC) becoming more or less competitive in the global market for high technology products? How does Latin America's performance compare with China's? The purpose of this paper is to conduct a detailed analysis to answer these questions empirically.

Among a wide range of otherwise very different theoretical economic approaches an underlying consensus exists about the importance of technological upgrading for sustainable economic growth and development. Moreover, empirical studies have also shown that the technological sophistication of a country's exports is an important predictor of future growth. The question of whether LAC's high technology exports are becoming more or less competitive is, therefore, critical for understanding the effects of recent policies in the region, as well as to inform a debate about future policy.

Our analysis is based on a detailed analysis of the evolution of both LAC's and China's competitiveness in global high technology markets. We look at the evolution of shares of global exports for the eighteen sectors that have been classified in the literature as "high tech" at the three digit level of the standard international trade classification (SITC) between 1986 and 2005. Our core analytical concept is called *Dynamic Revealed Competitive Position* (DRCP), which we use to track the evolution of LAC and China's competitiveness in high tech markets. In addition to looking at the region as a whole, we focus on a subset of countries that are particularly interesting in terms of their industrial capacities and where technological development has played an important role in their development strategy.

The core finding of this paper is that the competitiveness of LAC in high tech is stagnating or rapidly deteriorating for an overwhelming majority of high tech products, which in many countries represent a significant share of aggregate exports. This finding is particularly striking in comparison with China's impressive performance.

Although we don't speculate about a causal link between the performances of China and Latin America and the Caribbean, our findings undeniably show that China's efforts to develop endogenous technological capacity and competitiveness have been by far more successful than LAC's.

This paper is organized as follows. After presenting the theoretical (Section 2) and empirical (Section 3) arguments on technological upgrading and development, we review the literature on the matter (Section 4) and describe in detail our methodology and data (Sections 5 and 6). Section 7 contains our findings, and Section 8 concludes, advancing suggestions for future research.

2. THEORETICAL PERSPECTIVES ON TRADE, TECHNOLOGY, AND DEVELOPMENT

To what extent is the quality of a country's production and export basket a relevant dimension in the pursuit of economic development? This is a question that has drawn the interests of economists for centuries, and around which a rich body of both theoretical and empirical literature has developed. It is interesting to note that virtually all of the current "schools" of economic thought (except perhaps neo-Marxism) have stressed the importance of increasing the technological sophistication of a country's production and export basket, understood as climbing the technological ladder in the pursuit of economic development. This short and far from exhaustive review simply demonstrates that technological upgrading is considered a key component of sustainable economic growth and development.

Neoclassical trade theory has developed around Heckscher-Ohlin trade theory. Based on this theory, neoclassical economists have long argued that the income maximizing strategy for a country is to export the goods in which it has a comparative advantage. Because technological diffusion is assumed to be instantaneous and costless, a country's comparative advantage is argued to be solely determined by its "fundamentals," that is, its factor endowments (the comparative advantage of a country is argued to be on the good that is produced intensively using a country's relatively abundant production factor). In this sense, standard trade theory is neutral in terms of the technological composition of a country's export basket, as there is no built-in advantage of specializing in physical or human capital intensive goods. However, even within the restrictive assumptions of Heckscher-Ohlin models, technological "upgrading" of a country's exports can take place. Within Heckscher-Ohlin trade theory it is possible, through an exogenous change in factor endowments (brought about, for example, by foreign direct investment) for a country to diversify into trading more capital intensive goods (Jones 1987).

Staying within the boundaries of neoclassical economics but looking at the intertemporal welfare effects of trade patterns, Redding uses a general equilibrium model of endogenous growth and international trade between two large economies to theoretically prove that in some situations developing countries "face a trade-off between specializing according to an existing pattern of comparative advantage (often in low technology industries), and entering sectors where they currently lack a comparative advantage but may acquire such an advantage in the future as a result of the potential for productivity growth (e.g. high technology industries)." Moreover, argues Redding, "selective trade and industrial policies to induce specialization in sectors where an economy currently lacks a comparative advantage, but exhibits a large potential for productivity growth relative to its trading partner, may be welfare improving for the economy that imposes them. A lower initial level of instantaneous utility (resulting from specializing in a sector where no initial comparative advantage exists) may be more than offset by a higher rate of growth of instantaneous utility so that intertemporal welfare rises" (Redding 1999).

Alternatively, some economists have argued that relaxing the assumption of costless technological diffusion in traditional (Heckscher-Ohlin) trade theory changes the outlook significantly. Theoretically, if technological diffusion is not costless, then the technological content of a country's production (and hence, trade pattern) becomes relevant. This is the case because technologically intensive structures have larger spillover effects in terms of creating new skills and generic knowledge that can be used in other activities. This suggests that in the absence of successful interventions to correct this market failure, countries are likely to be trapped at their technological level (Hausmann, Hwang, and Rodrik 2005; Lall 2000). This is not, per se, a statement about the relationship between technological sophistication and economic development. However as Lall, among others, has argued: "Technology intensive structures offer better prospects for future growth because their products tend to grow faster in trade: they tend to be highly income inelastic, create new demand, and substitute faster for older products" in addition, thanks to higher productivity levels, to being less vulnerable to competition from low-wage countries (Lall 2000).

A different variant of this approach is the "new" strategic trade theorists. A classic work by Grossman and Helpman shows that trade increases the technological capacity of a nation by transferring technological information, expanding the market, and thus spurring technological innovation (Grossman and Helpman 1991). Evolutionary economists see technological change and innovation as the core of growth, and trade as no exception (Nelson and Winter 1982). Extensions of their theories to trade hold that international competitiveness is indeed a function of micro-level innovations in technology and increasing technological sophistication (Dosi and Soete 1983).

A different theoretical outlook on this issue was advanced in the late 1950s and 1960s by Raul Prebisch and his intellectual followers and has come to be known as "structuralism." Prebisch's analysis began with the assumption, widely accepted, that the relative size of the primary sector tends to decline during the growth process as a result of the low income elasticity of demand for unprocessed agricultural goods, the substitution of raw by synthetic materials, and the increasing efficiency in the production of primary goods. Prebisch observed that because, for historical reasons, developed countries provide manufactured goods while developing countries (the "periphery") supply raw materials, the changes in productive structures brought about by economic growth generate a systemic bias against developing countries. The contraction in the relative size of primary activities affects less developed countries more than proportionally.

This problem, argued Prebisch, is particularly trying because the redeployment of displaced workers to dynamic economic sectors faces several obstacles. First, there are political restrictions to the international migration of workers. Secondly, late industrializers face significant challenges in developing an industrial sector, associated with the great disparities in technology and capital availability with respect to the leading industrial centers.

> According to Prebisch, if workers displaced from primary sectors in the periphery are not adequately absorbed, labor incomes tend to fall. Simultaneously, workers in central countries are able to raise their incomes during business upswings and protect them during world recessions. Thus, the reduction in the relative size of the primary sector generated by a dynamic world economy tends to depress relative wages in the periphery. The adverse movement in relative wages tends to deteriorate, in turn, the terms of trade of developing countries. Evidently, relative international prices depend also on labor productivity in export activities. In Prebisch's view, however, the joint effect of the trends in wages and productivities implies that, whereas central countries are able to retain productivity improvement through higher real wages, those of the periphery are forced to "export" technological change through a deterioration in the factorial terms of trade (relative prices adjusted by productivity)" (Ocampo 1993).

According to this structuralist argument, then, the export basket of a country is indeed relevant to its economic growth. The analysis, however, it is conducted essentially in terms of primary products and manufacturing and not strictly in terms of technological levels.

In sum, most theoretical perspectives—independently of their widely diverse assumptions—agree on the fact that technological upgrading is a critical element of sustainable economic growth.

3. LITERATURE REVIEW: LATIN AMERICA AND THE GROWTH OF CHINA

Across the world there is increasing concern about the effects of China's emergence on the global economic stage, and Latin America is no exception. As a result, among international organizations, academia, and government a burgeoning literature has emerged that attempts to examine the extent to which such concerns are justified (Lall and Weiss 2005; Dussel Peters 2005; Lederman, Olarreaga, and Perry 2006; Blázquez-Lidoy, Rodríguez, and Santiso 2006; Devlin, Estevadeordal, and Rodriguez-Clare 2006; Mesquita Moreira 2007).

In general, these studies look at the effects of China's growth in Latin America along three dimensions: bilateral trade, competition in third markets, and attraction of foreign direct investment. The literature finds that, with respect to trade and investment flows, China accounts for a significant amount of the boost in LAC exports and foreign investment in recent years. However, China is exporting to LAC more than it is importing from the region. In terms of global competitiveness, there is agreement that LAC is not significantly threatened by Chinese exports in global markets, with the exception of Mexico (A thorough review of this literature is can be found in Jenkins, Dussel Peters, and Mesquita Moreira 2006).

However, these studies—with the exception of Mesquita Moreira's—don't look at the issue of China's growth from a technological sophistication perspective (Mesquita Moreira 2007). A detailed analysis of the impact of China's growth on the technological level of LAC's exports that significantly expands Mesquita Moreira's work is, then, our major contribution.

4. METHODOLOGY AND DATA

In this paper, we build on the earlier research mentioned above by examining the relative competitiveness of Latin America's exports in the world economy between 1980 and 2005. The question we ask is: to what extent are specific Latin American high technology export industries gaining access to the world economy over time and relative to China? In sectors where Latin America may be losing market share, we examine the extent to which such sectors are under threat from China.

A widely used approach to measure the technological content of a country's exports was advanced by Lall who, using the second revision of the Standard International Trade Classification of commodities (SITC) divided all products into five categories: primary products, resource based manufactures, low technology, medium technology, and high technology products (Lall 2000). This classification has proven very useful to analyze the technological level of a country's trade pattern and is the one we use in our analysis.

Figure 1

Commodity Technology Classification		
PP	**Primary Products**	
RB	**Resource Based Manufactures**	
	RB1	Resource Based Manufactures: Agro-Based
	RB2	Resource Based Manufactures: Other
LT	**Low Technology Manufactures**	
	LT1	Low Technology Manufactures: Textiles, Garment and Footwear
	LT2	Low Technology Manufactures: Other Products
MT	**Medium Technology Manufactures**	
	MT1	Medium Technology Manufactures: Automotive
	MT2	Medium Technology Manufactures: Process
	MT3	Medium Technology Manufactures: Engineering
HT	**High Technology Manufactures**	
	HT1	High Technology Manufactures: Electronic and Electrical
	HT2	High Technology Manufactures: Other

Source: Lall 2000

In terms of how to measure LAC's competitiveness, we depart from the widely used concept of "revealed comparative advantage." In a 1965 paper, Balassa introduced this concept to empirically measure the competitiveness of different countries (Balassa 1965). The revealed comparative advantage for sector i in country j was defined as follows:

$$RCA_{ij} = \frac{X_{ij} / \sum_i X_{ij}}{\sum_j X_{ij} / \sum_i \sum_j X_{ij}}$$

The numerator represents the share that any given sector (i) represents of national exports of any given country (j). The denominator represents the percentage share of the same sector in OECD exports. Therefore, the RCA is a comparison between the export structure of any given country and the export structure of the OECD as a whole. When the RCA is greater than one for any given sector, then the country being analyzed is said to be specialized in that sector and vice versa when the RCA is smaller than 1 (Laursen 1998).

We use an alternative empirical measure of competitiveness that, nonetheless, builds on Balassa's seminal idea of inferring competitiveness by looking at observed market shares. However, our index does not compare a country's export structure with the OECD average but traces the evolution, for every sector, of a country's world export market share.

Our central index, the dynamic revealed comparative position, is calculated as follows for country (j) in sector (i) between the years y_1 and y_2:

$$DRCP_{j,i,y_1-y_2} = \left(\frac{X_{j,i,y_2}}{\sum_j X_{j,i,y_2}} - \frac{X_{j,i,y_1}}{\sum_j X_{j,i,y_1}}\right) * 100$$

Where the nominator, X_{j,i,y_2}, represents exports of country (j) in sector (i) in year y_2 and the denominator, $\sum_j X_{j,i,y_2}$, represents world exports for the same sector (i) in the same year y_2.

Following Lall and Weiss (Lall and Weiss 2005), we define the different threat situations for each commodity as follows:

- If $DRCP_{China} > 0$ and $DRCP_{Country\ (j)} < 0$, we say China is "Directly threatening country (j)"
- If $DRCP_{China} > 0$, $DRCP_{Country\ (j)} > 0$, and $DRCP_{China} > DRCP_{Country\ (j)}$, we say China is "Partially threatening country (j)"
- If $DRCP_{China} < 0$ and $DRCP_{Country\ (j)} < 0$, we say the situation is one of "Mutual withdrawal"
- Finally, if $DRCP_{China} < 0$ and $DRCP_{Country\ (j)} > 0$, we say the situation is one of "Reverse Threat"

Figure 2

		China Share of World Exports	
		+	-
LAC Share of World Exports	+	Partial Threat (If China's share is growing faster than LACs)	Reverse Threat
	-	Direct Threat	Mutual Withdrawal

Source: Lall and Weiss 2005

All trade data for this study comes from COMTRADE dataset (United Nations Statistics Division 2007). We worked with data covering the period 1980–2005. The country groups were constructed following the World Bank's classification of regions (The World Bank 2007). However, for analytical reasons we divided the "Europe and Central Asia" group into two different groups, "EU Developing" and "Former Soviet Camp." We also isolated China from other East Asian and Pacific countries, with the purpose of analyzing its performance independently. When we refer to China as a region, we include data from Hong Kong and Macao. When we refer to China as a country, we only include data from continental China (A complete description of the countries in each group is available upon request).

5. OUR STUDY

In this section we compare the competitiveness of Latin America's high tech exports in the world economy between 1980 and 2005 with those of China. More specifically, we demonstrate that the developed countries have lost considerable high technology market share to the developing world and that among developing countries, China has captured the majority of those gains. Then, we compare LAC and selected countries with China's advancement.

Table 1

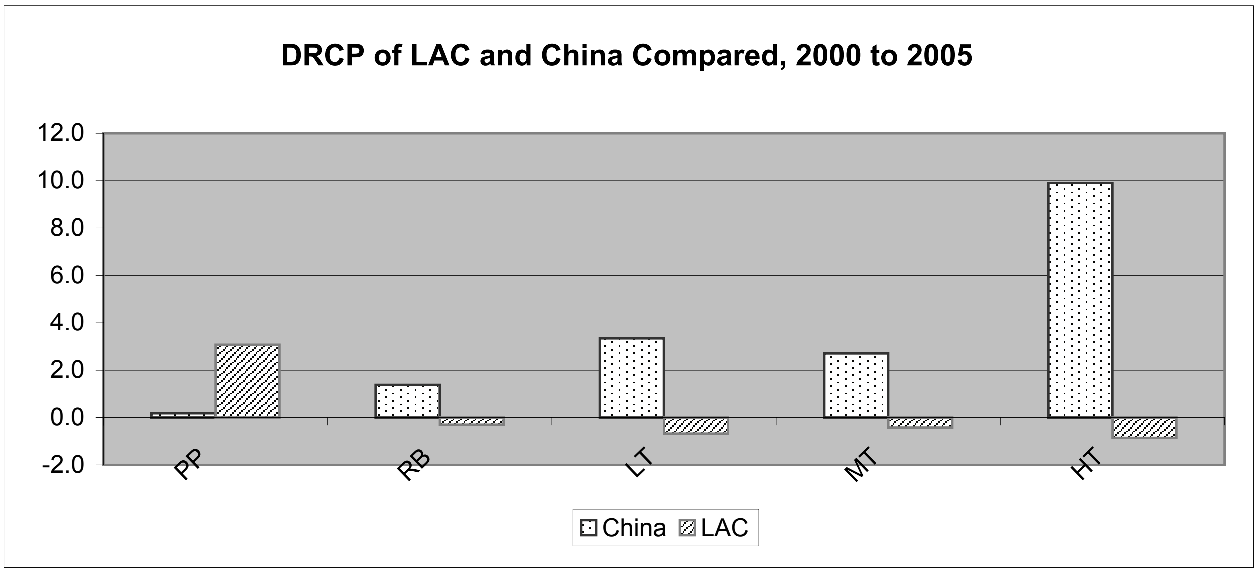
Developed Countries Losing High Tech Market Share

Tech	1980	2005	80-05
	(% of global exports)		DCRP
PP	77.7%	57.2%	-20.5
RB	84.7%	64.9%	-19.7
LT	84.7%	51.7%	-33.0
MT	95.0%	72.6%	-22.4
HT	93.3%	58.2%	-35.1
Total general	**86.3%**	**63.4%**	**-22.9**

Source: Authors' calculations with data from the United Nations Statistics Division 2007

Table 1 exhibits developed country shares of global exports in 1980 and 2005 by level of technology, along with the DRCP for each technology over that time period. The overall change over this period has been fairly dramatic, with the developed countries losing on average 22.9 percentage points in all global markets. Perhaps surprisingly however, these changes are most profound in the high technology sectors. While in 1980 more than 90 percent of global high technology goods were produced and sold from developed countries, in 2005 developed country high technology exports were 58.2 percent of world high technology exports—with a negative DRCP of 35.1.

Figure 3



Source: Authors' calculations with data from the United Nations Statistics Division 2007

Figure 3 exhibits the DRCP in China and LAC between 2000 and 2005 and shows that China "threatens" LAC in all levels of technology except for in primary products. In all the remaining sectors LAC is under "direct" threat according to Lall's classification because China's share increased while LAC's decreased. In primary products China is only "partially threatened" because while both China's and LAC's export share of primary products increased, LAC's increased faster. In no case does LAC directly threaten China.

Table 2

China: Taking the Ladder in High Tech Exports

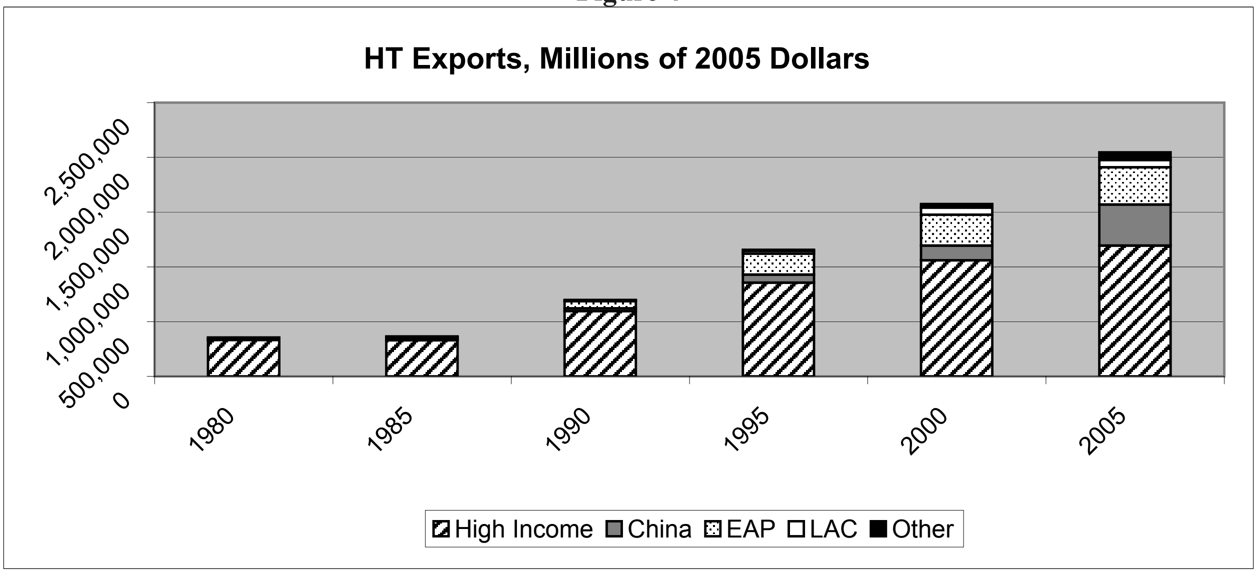
	1980		1985		1990		1995		2000		2005	
	Country	Share	Country	Share	Country	Share	Country	Share	Country	Share	Country	Share
1	USA	27.0%	USA	25.3%	USA	22.3%	USA	18.1%	USA	18.7%	USA	12.6%
2	Fmr Fed. Rep. of Germany	14.1%	Japan	17.3%	Japan	16.1%	Japan	15.2%	Japan	10.8%	China	12.4%
3	Japan	11.8%	Fmr Fed. Rep. of Germany	11.5%	Fmr Fed. Rep. of Germany	11.6%	Germany	8.8%	Germany	7.4%	Germany	9.2%
4	United Kingdom	10.5%	United Kingdom	8.5%	United Kingdom	7.5%	Singapore	6.9%	Singapore	5.8%	Japan	6.9%
5	France	7.7%	France	6.8%	France	6.6%	United Kingdom	6.8%	United Kingdom	5.5%	China, Hong Kong SAR	5.9%
6	Netherlands	4.1%	Italy	3.6%	Singapore	4.0%	France	5.8%	France	5.0%	Singapore	5.6%
7	Italy	3.8%	Netherlands	3.3%	Netherlands	3.6%	China, Hong Kong SAR	4.2%	China, Hong Kong SAR	4.5%	Rep. of Korea	4.9%
8	Switzerland	3.0%	Canada	3.0%	Italy	3.5%	Rep. of Korea	4.2%	Rep. of Korea	4.4%	France	4.5%
9	Canada	2.5%	China, Hong Kong SAR	2.3%	China, Hong Kong SAR	2.9%	Netherlands	3.5%	China	4.0%	United Kingdom	4.5%
10	Belgium-Luxembourg	2.3%	Singapore	2.2%	Rep. of Korea	2.8%	Malaysia	3.3%	Malaysia	3.7%	Netherlands	4.1%
11	Sweden	2.1%	Switzerland	2.2%	Switzerland	2.2%	Italy	2.5%	Netherlands	3.7%	Malaysia	3.0%
12	Singapore	1.7%	Sweden	1.9%	Canada	2.2%	China	2.1%	Mexico	3.4%	Belgium	2.7%
13	China, Hong Kong SAR	1.3%	Rep. of Korea	1.8%	Sweden	1.8%	Canada	2.1%	Canada	2.5%	Mexico	2.6%
14	Rep. of Korea	1.1%	Belgium-Luxembourg	1.6%	Belgium-Luxembourg	1.6%	Mexico	1.8%	Ireland	2.3%	Ireland	2.1%
15	Poland	1.0%	Ireland	1.3%	Malaysia	1.6%	Switzerland	1.8%	Italy	2.0%	Italy	1.9%
16	Austria	0.9%	Malaysia	1.1%	Ireland	1.4%	Sweden	1.7%	Philippines	1.8%	Switzerland	1.8%
17	Denmark	0.9%	Denmark	0.8%	Austria	1.1%	Ireland	1.6%	Belgium	1.5%	Canada	1.6%
18	Malaysia	0.8%	Austria	0.7%	Spain	1.0%	Thailand	1.5%	Sweden	1.5%	Thailand	1.4%
19	Ireland	0.7%	Spain	0.7%	Denmark	0.9%	Belgium-Luxembourg	1.5%	Thailand	1.5%	Philippines	1.3%
20	Spain	0.6%	Poland	0.5%	Thailand	0.7%	Spain	0.9%	Switzerland	1.4%	Sweden	1.3%
21	Australia	0.4%	Israel	0.5%	China	0.7%	Finland	0.8%	Finland	1.0%	Spain	1.1%
22	Finland	0.3%	Czechoslovakia	0.4%	Finland	0.5%	Denmark	0.7%	Spain	0.8%	Hungary	0.9%
23	Norway	0.3%	Brazil	0.4%	Israel	0.4%	Austria	0.6%	Israel	0.7%	Finland	0.9%
24	Portugal	0.2%	Finland	0.4%	Australia	0.3%	Australia	0.4%	Denmark	0.6%	Denmark	0.9%
25	Hungary	0.2%	Norway	0.3%	Norway	0.3%	Israel	0.4%	Hungary	0.6%	Austria	0.7%
26	India	0.1%	Australia	0.3%	Brazil	0.3%	Philippines	0.3%	Austria	0.6%	Czech Rep.	0.6%
27	Argentina	0.1%	Portugal	0.2%	Czechoslovakia	0.3%	Norway	0.2%	Indonesia	0.5%	Brazil	0.5%
28	So. African Customs Union	0.1%	Hungary	0.2%	Fmr Yugoslavia	0.2%	Czech Rep.	0.2%	Brazil	0.5%	Israel	0.4%
29	Indonesia	0.1%	China	0.1%	Mexico	0.2%	Indonesia	0.2%	Australia	0.3%	Indonesia	0.4%
30	Philippines	0.1%	Philippines	0.1%	Poland	0.2%	Brazil	0.2%	Czech Rep.	0.3%	Poland	0.3%
…	…	…										
…	…	…										
99	China	0.0%										

Source: Authors' calculations with data from the United Nations Statistics Division 2007

Table 2 literally shows how China is "climbing up the ladder" in global high technology exports. This table exhibits global market shares in high technology exports by country from 1980 to 2005, listing the top thirty for each year. In 1980 China was in ninety-ninth place among high technology exporters. By 2005 China ranked second to the U.S. The U.S. stood at 12.6 percent of the world share and China at 12.4. If one included Hong Kong, China is the world leader in global high technology exports. Perhaps the most miraculous change is between 2000 and 2005—before and after China's entry into the World Trade Organization (WTO)—when China's DRCP was 8.4, far and away the largest increase in the entire period. However, China's market share has tripled every five years since 1990.

Only three Latin American nations have entered the top thirty at any point since 1980, Argentina, Brazil, and Mexico. In 1980 Argentina ranked twenty-seventh and represented 0.1 percent of global high tech markets, but it has not appeared on the list since then. Brazil entered the top thirty in 1985 at number twenty-three (0.4 percent) and has more or less held that percentage of the market ever since. Mexico has had a fairly impressive trajectory. It did not find itself in the top thirty until 1990, when it snuck in at number twenty-nine with 0.2 percent of the market. It reached number twelve in the year 2000, holding 3.4 percent of global markets, then slid down one position by 2005—to number thirteen with 2.6 percent of the market.

Figure 4



Source: Authors' calculations with data from the United Nations Statistics Division 2007

Figure 4 exhibits China's rise in high technology exports in the context of scale and in comparison to whole geographical regions over the same period. In 1980 global high technology exports stood at $355 billion and increased by close to a factor of six in real terms by 2005 to over $2 trillion. The only other noticeable changes are with East Asian and Pacific (EAP) countries aside from China, which entered the picture in 1990 and together commanded almost 16 percent of global markets in 2005. Latin America, driven by Mexico, also can be seen beginning in 1995. By 2005, China's exports of high technology were roughly $375 billion and Latin America's stood at $67 billion. These figures are up from $133 billion and $65 billion respectively in 2000—an 80 percent increase by China and a 2.8 percent increase by LAC.

Table 3

China's Revealed Competitive Position			
DRCP of China vs. Select LAC Countries in HT			
	86-05	95-05	00-05
Argentina	-0.04	-0.07	-0.09
Brazil	0.02	0.06	-0.13
Chile	0.01	-0.02	0.00
Colombia	0.02	-0.01	0.03
Costa Rica	0.08	0.09	-0.01
Mexico	1.62	0.85	-0.64
LAC	1.42	0.85	-0.88
China (Country)	11.62	9.41	7.51
China (Region)	15.43	10.59	8.66

Source: Authors' calculations with data from the United Nations Statistics Division 2007
(Note: 1986 is the first year for which complete data is available.)

According to Lall's classification, since China's entry into the WTO, China has been directly threatening all of the large LAC countries with significant manufacturing sectors except for Colombia. Looking at the longer term trend from 1986 to 2005 (column 1), most of the region seems to only be under a partial threat, except for Argentina. China's DRCP is 11.62 and all of the LAC nations exhibited were below 1 percentage point except for Mexico, where the DRCP was 1.62. Looking more recently, during the period 2000 to 2005 all countries except Colombia were directly threatened in high technology exports. China's gain was 7.51 percentage points, LAC as a whole and each of the specific countries have lost market share.

Table 4

Percent of High Tech and Total Exports Under Threat From China (00-05)			
	Direct Threat	Partial Threat	Total Threat
Argentina	33.1	16.7	49.8
As share of total 2005 Exports	0.7	0.3	1.0
Brazil	44.8	49.8	94.6
As share of total 2005 Exports	3.6	4.0	7.6
Chile	35.9	22.2	58.1
As share of total 2005 Exports	0.2	0.1	0.3
Colombia	9.9	35.5	45.4
As share of total 2005 Exports	0.2	0.8	1.0
Costa Rica	36.4	51.4	87.8
As share of total 2005 Exports	10.4	14.7	25.1
Mexico	90.0	7.0	97.0
As share of total 2005 Exports	22.6	1.7	24.3
LAC	**88.6**	**6.2**	**94.8**
As share of total 2005 Exports	**10.9**	**0.8**	**11.7**

Source: Authors' calculations with data from the United Nations Statistics Division 2007

Close to 95 percent of all LAC high technology exports are under some type of threat from China, the majority of which are direct threats. These threatened high technology exports are almost 12 percent of all LAC exports. Table 4 presents our calculations of the total volume of exports under threat from China between 2000 and 2005 as a percent of total high technology exports and the total volume of exports under threat as a percent of total exports for LAC and our selection of countries in 2005.

Mexico, the one country in LAC that has made the greatest DRCP progress over the entire 1980 to 2005 period also seems to be the most threatened in the 2000 to 2005 period. Between 2000 and 2005, 90 percent of Mexico's high technology exports were under direct threat, amounting to 22.6 percent of all of Mexico's exports. Seven percent of Mexico's high technology exports are under partial threat and represent 1.7 percent of total exports. Combined, 97 percent of Mexico's high technology exports are under some sort of threat from China, comprising of 24.3 percent of all Mexican exports (Moreover, high technology exports under some sort of threat represent 28 percent all of non-oil Mexican exports). For Mexico the subsectors of HT which are most threatened are office machines, computers, television receivers, telecommunications equipment, electric power machinery, and electrical machinery.

Costa Rica is the second most threatened nation relative to China. In Costa Rica, 87.8 percent of high technology exports are under some threat, which represented 25.1 of all exports in 2005. The vast majority of Brazil's high technology exports are also under threat, at 94.6 percent, but these high technology exports only represent 7.6 percent of all Brazil's exports. For Argentina, Chile, and Colombia, over 40 percent of all high technology exports are under threat, but in no case do such exports represent over 1 percent of total exports.

6. CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

In this paper we calculated what we call the DRCP of nations for high technology exports between 1980 and 2005. We found that the developed world has lost significant market share in high technology and that China has climbed the high technology ladder during this period. In 1980 China was ranked ninety-ninth of all nations in terms of the percentage of global exports in high technology. By 2005 China climbed to second place in the world, first place if high technology exports from Hong Kong are included. We also find that close to 95 percent of all of LAC's exports are under some sort of "threat" from China, comprising almost 12 percent of total exports from LAC. This is most pronounced in Mexico and Costa Rica, where over 87 percent of all high technology exports are under threat and where such exports represent over 24 percent of total exports in both countries. Most of these trends become very accentuated during the period 2000 to 2005, when one could almost make the case that China is "taking away the ladder" from LAC.

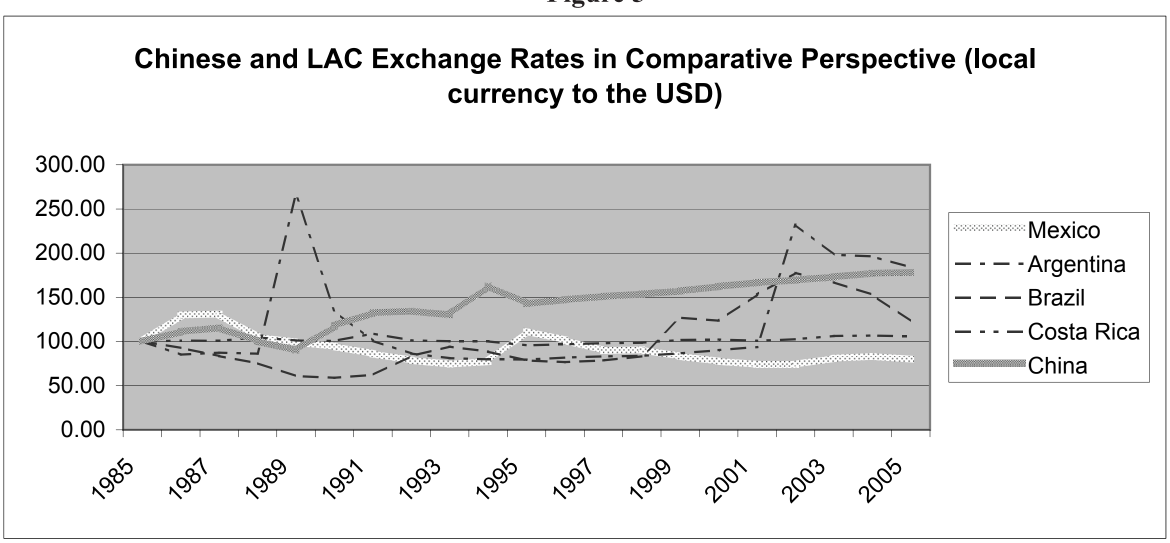
> It is hard to overstate the impact of this development for Latin America and the Caribbean. As, for example, Cimoli and Katz have argued: The present pattern of

> production specialization—strongly biased in favor of industries featuring low domestic knowledge generation and value-added content—and the inhibition of local R&D and engineering activities resulting from the rapid expansion of internationally integrated production systems are pushing Latin American economies into a "low development trap"(Cimoli and Katz 2003).

The aim of this paper has been to identify the level of "threat" between China and LAC, it has therefore been beyond the scope of this particular paper to analyze how and why these trends are occurring. There is considerable debate in the literature and in the popular press concerning China's massive increase in competitiveness in general. Here most studies argue that the changes are due in some part due to China's exchange rate, its productivity growth and wages, and the relative amount of industrial "policy space" that China has and is using relative to LAC.

Figure 5 exhibits the real exchange rate (local currency to the USD) in China and selected LAC countries from 1985 to 2006. In the case of Mexico (where the greatest quantity of high technology exports are under threat) it is clear that the Chinese yuan is depreciating in real terms relative to the U.S. dollar and the Mexican peso is appreciating. For Costa Rica, Brazil, and Argentina an exchange rate argument would be less clear.

Figure 5



Source: Author's elaboration with data from the USDA Economic Research Service 2007

In terms of productivity and wages Mesquita Moreira finds that they are fairly even between China and Mexico for consumer electronics, and that Brazil's productivity is higher (Mesquita Moreira 2007). For personal computers, China lags behind both Brazil and Mexico in terms of productivity. However, productivity growth in the three countries tells a radically different story according to Mesquita Moreira. Since 1990 productivity in manufacturing as a whole in Brazil and Mexico has grown by a factor of approximately 1.4, but manufacturing productivity in China has leaped by a factor of almost 7. In terms of wages in manufacturing as a whole, China's wages are 4 (Brazil) to 7 (Mexico) times lower than their LAC counterparts (Mesquita Moreira 2007).

Another explanation under debate is the shift in the orientation of industrial policies in LAC, away from development programs targeted to promote selected sectors. Up until 1984, LAC's industrial policy was geared to intervene strongly in specific sectors. Since then, the policy has been to let markets largely determine the profile of manufacturing and exports. As Mesquita Moreira puts it:

> Whether or not these [Chinese] interventionist policies are behind China's takeoff or whether or not they guarantee or compromise China's long term growth is already the stuff of a prolific policy debate, which, as it happened to other East Asian tigers, is bound to be inconclusive, not least because economists have yet to find a satisfactory way of dealing with the counterfactual. Yet, from LAC manufacturer's point of view, the omnipresence and generosity of the Chinese state has a very practical and immediate implication, that is to heavily tilt the playing field in favor of their Chinese competitors, either local or foreign affiliates, in a scenario where they already face endowment, productivity and scale disadvantages (Mesquita Moreira 2007).

In terms of high technology exports, Dussel demonstrates that there was significantly more government involvement in spurring high technologies in China than in the Mexican case. Moreover, the growth rates in production and exports for Chinese electronics and computer industries, though strongest for 100 percent foreign owned firms, was fairly similar and quite strong for state-owned firms and joint ventures as well (Dussel Peters 2005). Gallagher and Zarsky point out that even if Mexico had the political will to engage in a similar policy set as China in the high technology sector, existing trade commitments under NAFTA would make it more difficult for Mexico to deploy such policies, whereas China only has to comply to looser WTO rules (Gallagher and Zarsky 2007).

This paper is far from the last word on this subject. First, the methodology we chose to use in this paper has some inherent limitations. The most important of these limitations is that the classification developed by Lall (2000) falls short of capturing the phenomenon of fragmentation in international production. As Lall, Weiss and Zhang have argued: “trade fragmentation weakens the link between core technical characteristics and production processes: some of the largest exporters of hi-tech electronics are low wage countries that only assemble and test final products (advanced design and component manufacture remains in rich countries)” (Lall, Weiss, and Zhang 2005).[1] Furthermore, the quick review in this conclusion of possible causal factors that explain why the trends we identify in this paper are occurring needs to be an explicit focus of study. To what extent do exchange rate policy, productivity and wage differences, and industrial policy explain the differences in technology upgrading? Are there other factors? Perhaps more importantly, if these factors do indeed explain these trends, what are their relative contributions?

Nonetheless, the technology classification we use in this study is still a significant (if not complete) indicator of the qualitative characteristics and technological content of a country’s exports. Considering the theoretical and empirical agreement on the importance that technological upgrading has for development, we consider our findings to be both meaningful and critical for future policy making and research.

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1. Some authors have suggested different ways to attempt to capture when exports are the result of domestic capabilities as opposed to resulting from fragmentation in the production of multinational corporations. As a complementary measure to the technological classification of exports, Lall, Weiss, and Zhang propose a measure of sophistication that, for any given year and any given commodity, is a “weighted average (the weights being each country’s shares of world exports) of exporters income” (Lall, Weiss, and Zhang 2005). A similar approach is undertaken by Hausmann, Hwang, and Rodrik, who construct an income/productivity index for different countries’ export baskets by taking a weighted average of the per capita GDPs of the countries exporting a product, where the weights reflect the revealed comparative advantage of each country in that product (Hausmann, Hwang, and Rodrik 2005).

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