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TRADE LIBERALIZATION, TECHNOLOGICAL CHANGE AND THE WAGE GAP. THE CASES OF CHILE AND MEXICO*

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I. INTRODUCTION

The implications of trade liberalization for income distribution are one of the most important aspects of the current economic debate in Latin America. On the one hand, the countries in the region have increasingly opened their markets to world imports during the 1990s. This at a time when negotiations for a Free Trade Agreement of the Americas (FTAA), including the USA, Canada and all Latin American and Caribbean countries (with the exception of Cuba), are gaining momentum. On the other hand, as a recent study argues income inequality remains "one of the greatest socioeconomic ills" the Latin American region faces today (IDB 1999). Most surprisingly, however, in the negotiations of the FTAA little concern has been placed on income inequality. This can perhaps be blamed on the theory. Certainly, the theory predicts that trade liberalization is more likely to increase income inequality in developed countries than in developing countries. It is argued that since the latter are relatively more abundant in less-skilled labor and they are assumed to use trade barriers to protect home-based production of skill-intensive goods, the removal of these barriers would make the relative prices of these goods decrease. In response to this, less-skill-intensive industries would expand with the result that the demand for less-skilled workers would increase. As a consequence, the wages of the latter would increase relative to the wages of more skilled workers. This ultimately would lead to the reduction of income inequality, since labor income is the major source of household income. In this paper, we analyze these issues in the cases of Mexico and Chile.

Most of the studies on the links between trade liberalization and

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changes in relative wages rely on the Heckscher-Ohlin (H-O) model and the Stolper-Samuelson (S-S) theorem. The present article is not an exception. However, trade is not the only source of shifts in relative wages. As it is argued in the literature, skill-biased technological change is likely to increase the wage gap in both developed and developing countries. Accordingly, theories that focus on the effects of technological change on labor demand will also be considered and their relative importance for the explanation of the relevant issue will be evaluated. Other factors that may influence the wage gap such as changes in the functioning of the labor market are excluded from the analysis. Some references to these alternative sources of wage differentials will be made in the text however.

In accordance with what has been said, this paper focuses on the following questions. In the cases of Mexico and Chile is there a positive, negative or no relationship between trade and wage inequality? To what extent has technological change been associated with the rise in wage inequality between skilled and unskilled workers in the mentioned countries? Is trade, technological change, or both to blame for the recorded increases in wage inequality? In order to answer these questions we ran regression analyses on data from both National and International sources. Depending on data availability, the analysis was limited to the 1984-1999 period in the case of Mexico and to the 1980-1995 period in the case of Chile.

The structure of the paper is as follows. The theoretical approach, relating trade liberalization and wage inequality with the focus placed on the Heckscher-Ohlin-Samuelson model, is discussed in Section II. The relationship between wage differentials and technological change is also explored in this section. Section III gives an overview over the liberalization process in Chile and Mexico while reviewing the results from previous studies on the factors influencing wage differentials in these countries. The econometric model is presented in Section IV, which also gives a brief description of the variables and data sources. Section V summarizes the results of the analysis, and interprets them in light of the theoretical approaches stated in previous sections. Our conclusions are presented in Section VI.

II. THEORETICAL ISSUES

The H-O-S model

The H-O model of international trade considers two countries (H and F), two factors of production, say capital and labor (K and L) and two goods (X and Y). The model further assumes that the production functions of the two goods only differ in the relative usage of capital and labor but

they are identical for the two countries. The functions exhibit diminishing returns for increases in one factor, and constant returns to scale for proportional increases in both factors. It is further assumed that the two factors are homogenous. They are perfectly mobile between sectors within the nation but imperfectly immobile between countries. Additionally, total supply of capital and labor is assumed to be fixed and, since the model presupposes the absence of market imperfections that can distort consumption or production decisions, production factors are fully employed.[1] On the demand side, it is assumed that preferences are homogenous and identical in both countries. Thus, in the context of the H-O model, the only significant difference between the countries relates to their factor endowments. This, in conjunction with the relative factor intensities of commodities determines both comparative advantage and the trade pattern. Starting from these assumptions, it can be demonstrated that if country H is relatively abundant in capital and the production of good X is relatively labor-intensive, then in the absence of trade (autarky) $P_h > P_f$, where P is the price ratio ($P = P_x/P_y$) (Markusen *et al.* 1995). It can also be demonstrated that when the two economies open up to trade and/or eliminate all barriers to the reciprocal exchange of goods, the price ratios in both countries tends to be equalized at some intermediate level P*.

A main conclusion of the H-O model is that a country will export the commodity that intensively uses its relatively abundant factor. Applied to trade between developed and developing countries in skill-intensive vs. less-skill-intensive goods[2], this means that developed countries, which by definition are relatively abundant in skilled labor would have a comparative advantage in producing skill-intensive goods while developing countries would find their comparative advantage in the production of less-skill-intensive goods. As a logical consequence of the H-O model, the Factor Price Equalization (FPE) theorem states that if the ratio of commodity prices is equal in both countries and both goods are produced, then the skilled-unskilled wage ratio will be equalized. Moreover, if relative factor prices are equalized by free trade, the factor ratios employed in industries X and Y will be the same in both countries. In its strongest version the theorem asserts that trade will also equalize absolute factor prices across countries (Ibid.).

A useful supplement to the H-O model is the Stolper-Samuelson theorem. According to this theorem, a relative increase in the price of a commodity due to the reduction of tariffs or alternatively, exogenous changes in the world market, will increase the real return of the factor used intensively in that industry relatively the other factor (Ibid.). As a consequence, it is expected that trade liberalization would influence

relative wages in developed and developing countries in different ways. In the developed country trade liberalization would increase the export of skill-intensive goods, while reducing the home-based production of less skill-intensive goods because of increasing imports from the developing country. Accordingly, the domestic price of the skill-intensive good in the developed country rises in relation to the price of the less skill-intensive good, and with this, the wages of the skilled workers relatively to those of the unskilled workers. In the developing country the picture is the opposite. Since it would export more of less-skill intensive goods, the demand, and therefore the wages of unskilled workers, would increase in relation to the skilled workers. All this means that the wage gap would expand in developed countries and contract in developing countries. Since the skilled-unskilled wage ratio is assumed to be larger in developing countries, the general outcome of these movements in labor demand is the narrowing of the inter-country wage gap, what is consistent with the "weaker" factor price equalization theorem.

Technological change

The issue of wage inequality, or the skill premium as it is also called, has been related not only to trade liberalization but also to technological change. In this case, however, there are a larger variety of models than in the case of trade. Acemoglu (1998), for instance, has developed a model with increasing returns in which an anticipated increase in supply of skilled workers induces the development of a technology that will create a demand for them. In another work, Acemoglu (1999) analyzes the pattern of skill premia over time and among countries. He found that an increase in the relative supply of skills, holding technology constant, reduces the skill premium; but he also found that an increase in the supply of skills over time expands the market for skill-complementary technologies increasing the demand for skills. That is, skill-biased technological change is endogenously determined by an increase in the number of skilled workers.

Note now that it is reasonable to assume that in the case of the United States and other developed countries, technological change could be treated as endogenous since the production of new technologies are often home-based. In the case of most developing countries, however, the evidence suggests that these technologies come from the developed countries, and that trade liberalization stimulates the process of adopting them. Accordingly, Acemoglu's model is not to be tested in this study. However, the possibility of endogenous technological innovations in Mexico and Chile, or in any other middle-income country for that matter, can not be discarded and this leaves an open question for further research.

From another perspective, Aghion *et al.* (1999) argue that technological change can increase wage inequality when it is biased towards certain skills or specialization, or when it reveals and enhances new differences in ability among the workers. The authors draw the conclusion that technological change is the most important factor behind earnings inequality since trade liberalization and organizational change only affect it insofar as they are associated with the former. In the same vein, Zeira (1999) presents a model that combines trade liberalization and skill-biased technological progress. He recalls that according to theory, trade liberalization would increase the wage gap in developed countries and reduce it in developing countries; but, as he argues in recent years, an increase in the wage gap in the developing countries is visible as well. This should be attributed to skill-biased technological change, which he contends, has to be considered even when analyzing the latter countries. In the context of Zeira's model, technological change increases the wage gap in both developed and developing countries when it is combined with trade liberalization. However, Zeira states that for longer periods of time the wage gap depends on shifts in the supply rather than in the demand of labor. According to this author, technological changes in the long-run are induced by the ability of young people to acquire education and skills. Nelson & Phelps (1966), in turn argue that the supply of skills is more important in a period of rapid technological change.

Berman & Machin (2000) investigate the role played by skill-biased technological change in the increasing demand for skills in the manufacturing industries of low-, middle-, and high-income countries. They found strong evidence of increased demand for skilled workers in the 1980's in the manufacturing sectors of middle-income countries such as Venezuela or Spain. According to these authors, this increase is a result of the skill upgrading within industries rather than a reallocation of employment from low-skilled industries to high-skilled ones. O'Connor & Lunati (1999), in turn argue that in developing countries technological change is often caused by the transfer of technologies and capital goods from developed countries where relative skill abundance have skill-biased technological innovation. Focusing on the same issue, Robbins (1996) advances the hypothesis that trade liberalization accelerates technology diffusion from developed to developing countries as technological change in developing countries is "imported" from the developed. He means that trade liberalization combined with exchange rate devaluation increase competition on the local market, thereby stimulating local firms to search for higher productivity. This may increase exports but, at the same time, the pressure to modernize makes local firms to import more state-of-the-art

machinery that is usually bundled with new, skill-biased technologies. In countries that previously applied import-substitution strategies that stifled adoption of foreign technologies, such as Chile and Mexico for instance, trade liberalization will, according to the author, lead to an initial large jump to more modern and skill-intensive technologies. As a consequence, labor demand in these countries would follow the skill-intensive biased trend observed in developed countries. Relative wages would follow a similar path adjusted by changes in supply. The Skill-Enhancing-Trade (SET) hypothesis has been tested by Robbins (1996), who building on previous evidence, finds that technology transfers are frequently associated with trade expansion.

III. TRADE LIBERALIZATION AND THE WAGE GAP

Chile

From the 1930's through the late 1960's Chile implemented a standard import-substitution industrialization strategy. High tariffs and restrictive quotas coupled with an overvalued exchange rate resulted in highly expensive imports. Exports were penalized due to a system of multiple exchange rates. In the early seventies the government presided by Salvador Allende inaugurated a period of state expansion. This led to the highest public deficit in the Chilean economic history, which was financed through monetary issue. As a consequence, the inflation rate increased from 36.1 percent in 1970 to 605.1 percent in 1973. Concomitantly, the government accentuated state control over the economy by nationalizing the copper industry, the banking system, and a number of private enterprises. The unemployment rate decreased from 5.7 percent in 1970 to 3.1 percent in 1972.

The military under the leadership of Augusto Pinochet took power in a bloody *coup d'état* in 1973. A new liberalization program was introduced – an extreme laissez-faire model based on large-scale privatization and rapid tariff reduction, with economic policies that greatly diverged from those driven by the former democratic government. During the Allende government the average nominal tariff was 105 percent ranging from 0 to 750 percent (Beyer *et al.* 1999). In 1975 the average tariff had contracted to 57 percent and by 1979 the government implemented a uniform 10 percent tariff – apart from the automobile industry (Levinsohn 1999). The liberalization program also focused on the privatization of state-owned firms (excluding the copper industry) as well as the national security system. As a consequence of this policy package, the Chilean economy became more open and therefore more exposed to increasing foreign

competition. The new outward-oriented policies led to an increase in the non-traditional export sector, whereas the traditional import- substitution sector was badly hit.

The crisis from the early eighties led to a recession in 1982 and 1983 during which industrial output and employment declined sharply. In order to avoid an economic collapse the government reacted by implementing a major devaluation and temporarily took control over many of the firms and national banks. The industrialists put pressure to increase and differentiate the tariffs causing the average tariff to rise to 35 percent in 1984. However, when the economic crisis was under control the tariff was gradually scaled down to 26 percent in 1985 and to 15 percent in 1988, before it was lowered to its current level of 10 percent. This means that by the end of the 1980s Chile was the country in Latin America that had the lowest tariff. An observation in Table 1 is that economic openness, defined as the percentage share of imports and exports in GDP, increased drastically during the 1980s. It rose from 32.2 percent in 1981 to 52.5 percent in 1990 and decreased thereafter slightly in the 1990s.

Table 1 – Chile: Economic Openness and Average Tariff (percentage)

	Openness	Average Tariff
1975	na	57.0
1979	na	10.0
1981	32.2	10.0
1982	31.7	10.0
1985	42.3	25.7
1990	52.5	15.0
1991	48.2	13.0
1992	47.8	11.0
1993	46.1	11.0
1994	45.8	11.0
1995	49.1	11.0
1996	48.0	11.0
1997	47.8	11.0
1998	46.0	11.0
1999	44.2	10.0
2000	na	10.0

Source: Authors' calculation on Central Bank, IDB and ECLAC

na : not available

The new democratic government presided by Aylwin that took office in 1990 did not introduce substantial changes in economic policy, but it benefited from improved external conditions. Certainly, during the Pinochet era many Western leaders were reluctant to associate themselves with an autocratic government that was known for its Human Rights abuses. Under the leadership of a democratic government, Chile once again

became a player in international financial circles and multilateral institutions. The government also worked to open new markets for Chilean products through bilateral trade agreements with various countries in the Americas. Hence, while under the government of Pinochet trade liberalization was mainly unilateral, under Aylwin it became both unilateral and multilateral.

Wood (1997) holds that from the mid-1970s to the early 1980s, wage differentials by level of education and skill widened in Chile and that increased openness probably was the main factor behind this. However, he advances the hypothesis that labor market liberalization was a plausible alternative explanation. He points in particular to the severe contraction of union activity during the 1970s[3]. Beyer *et al.* (1999) also argue that the economic reforms introduced in Chile contributed to greater wage inequality as reflected in the increase of the premium to skill. The authors found that the hourly wage of college graduates increased by 2.3 percent annually between 1957 and 1996. This figure can be compared to the 0.3 percent increase for high school graduates during the same time. Their econometric analysis shows that openness did rise the premium to skill in Chile under the period 1960-1996. This outcome seems contradictory to the theory since Chile is assumed to be relatively abundant in unskilled labor. The authors give two explanations for this, namely skill-biased technological change and changes in the productive structure. They, however, argue that the growing proportion of college graduates in the labor force is helping to counteract these forces.

Robbins (1994a) found that the skilled-unskilled wage gap in Chile increased over the 1975-1990 period as an effect of the within-industry upgrading of schooling and occupational shifts. In his view, the most likely explanation for this was increasing imports of capital, complementary to skilled labor. In another work, the same author argues that though trade liberalization was accompanied by rapid growth of dispersion in relative wages, the emerging Chilean trade pattern was consistent with the H-O-S model (Robbins 1994b). He means that it reflected the relative abundance of both unskilled labor and natural resources in Chile. However, he found that the pattern of export growth did not bias factor-demand towards unskilled labor and therefore it did not lower the dispersion of wages. His explanation is that higher education may be complimentary to the export process. He means that the production of export goods may well not be skill-intensive but the marketing and the distribution of these goods, which are skill-intensive, have increased its weight in total cost.

From another perspective, Wood (1997) compares the impact of trade liberalization on wage inequality observed in Latin America during the

1980s and the early 1990s to the situation in East Asia in the 1960s. In Latin America, wage inequality increased as a result of increased trade whereas in the East Asian countries a decrease in wage inequality was observed. Wood arrives to the conclusion that even though the regions are endowed with different natural resources, the most probable explanation for divergence in wage inequality is changes in relative factor endowments between the two time periods. On the one hand, the entry of low-income countries into the world market in the 1980s shifted the comparative advantage of middle-income countries such as Chile into medium skill-intensive goods. On the other hand, technological progress between the 1960s and the 1990s was biased against unskilled workers. This argument can be relevant in the case of Chile where economic growth has been capital-biased and therefore probably skill-biased as changes in labor productivity suggest. During the 1985-1989 period, a 10 percent increase in output generated an 8 percent increase in employment; whereas in the period 1987 to 1994, a 10 percent increase in output was only followed by a 3 percent increase in employment (Hojman 1996).

Foreign direct investments increased with trade liberalization. Under the regime of the military government, Chile's foreign investment regulation code progressively evolved into one of the most liberal in the developing world. Limits on foreign ownership of Chilean enterprises were reduced, conditions for the remittance of profits and interest and the repatriation of capital were greatly liberalized and the taxation of profits of foreign investors was simplified. With the exception of access to local credit, foreign investors were given the same rights as domestic ones (Yang 1992). As a result, foreign direct investments increased from USD 0.13 billion in 1985 to USD 1.67 billion in 1993. In the early 1980s these investments were concentrated in the low-risk sectors of services. In the late 1980s, when the political and economic climate began to stabilize, it was the high-risk mining sector that attracted most part of FDI. The continuous growth of FDI in the 1990s can have negatively affected the wage gap, since according to the theory foreign direct investments are bearers of skill-biased technologies. Battisti & Pietrobelli's (2000) analysis of intra-industry technological gaps in Chile, however reveals that technological upgrading has been confined to only some groups of enterprises and that firms with different levels of technological complexity and technological capabilities coexist in the same economic sectors. This makes uncertain the effect of technological changes on relative wage at the aggregate level.

The Chilean liberalization program focused on privatizing the state-owned firms and industries. According to Behrman *et al.* (2000), this could

have contributed to reduce the wage premium for schooling since state enterprises usually have relatively larger numbers of managers (with more schooling) per production worker (with less schooling) than private firms in the same sector have.

Mexico

Mexico's economy was largely closed until the beginning of the 1980s. In the late 1940s the government implemented a number of industrial protection policies raising tariffs and originating a system of import licenses. Mechanisms for export controls where also introduced in order to direct the production towards the domestic market. In the mid-1980s, the government began to liberalize foreign trade in the hope that this would help alleviate some of the problems originating in a severe economic crisis. Trade barriers were gradually reduced between 1983 and 1984, and dramatically lowered in 1986 when the country joined the GATT.

Table 2 - Mexico: Average Tariffs and Import-Licensing Requirements by Manufacturing Sector (percentage)

1985-1989	Tariffs[a]			Import Licensing[b]		
	1985	1989	change	1985	1989	change
Food Products	22.6	11.9	-47	98.1	20.5	-79
Beverages and Tobacco	77.0	19.7	-74	99.5	19.8	-80
Textiles	32.5	14.8	-54	19.7	1.0	-95
Apparel and Footwear	46.8	18.5	-60	99.1	0	-100
Wood products	37.0	16.9	-54	99.9	0	-100
Paper and printing	19.6	6.7	-66	74.5	0.3	-100
Petroleum refining	2.2	4.4	100	94.3	86.4	-8
Chemical products	28.7	13.4	-53	86.8	2.1	-98
Nonmetallic minerals	31.7	14.9	-53	95.6	0	-100
Basic metals	15.1	10.6	-30	86.8	0	-100
Metal products	35.7	14.6	-59	74.0	1.1	-99
Machinery and Equipment	27.4	16.4	-40	19.7	1.6	-92
Transport equipment	39.2	16.0	-59	99.0	41.0	-59
Other manufacturing	58.0	18.0	-69	91.8	0	-100
Total	23.5	12.5	-47	92.2	19.8	-79

Source: Ten Kate (1992, Tables 3,4,5)

a production-weighted average tariff rate
b domestic production value covered by import licenses

The purpose of these reforms were to "reduce the anti-export bias, lessen dependency on traditional exports and external credits, increase the modernization and efficiency of Mexican industry by exposing it to stiffer international competition, and boost the external surplus by reducing

domestic absorption and depreciating the peso in real terms" (IDB 1992). The liberalization process continued throughout the end of the 1980s with additional reductions of tariffs.

An important observation in Table 2 is that, contrary to what could be expected, the most protected sectors before trade liberalization were mainly less-skill-intensive industries such as food products, beverages and tobacco, apparel and footwear, and wood products. As a consequence, the percentage changes in tariffs after liberalization were higher in unskilled sectors even though other less labor-intensive industries were also highly protected. As we shall see, this may have consequences for the wage ratio. The important thing to note, however, is that the average tariff decreased from 23.5 percent to 12.5 percent in a three-year period and the import licensing was also reduced from 92.2 percent to 19.8 percent.

Table 3 - Mexico: Economic Openness (billions of USD and percentages)

Year	GDP	Total Exports	Total Imports	Openness %
1980	227,9	28,2	33,0	27
1981	247,7	32,8	38,3	29
1982	245,1	32,1	22,7	22
1983	233,1	33,3	15,2	21
1984	242,1	35,9	19,5	23
1985	248,9	31,9	21,9	22
1986	238,6	25,4	19,5	19
1987	242,7	31,0	21,1	21
1988	245,9	33,4	30,5	26
1989	254,2	36,6	36,2	29
1990	265,9	40,7	41,6	31
1991	275,6	41,0	48,0	32
1992	283,5	43,2	58,1	36
1993	285,3	47,2	59,4	37
1994	298,5	54,4	70,8	42
1995	279,2	69,2	63,0	47
1996	294,2	81,4	75,8	53
1997	315,6	92,0	91,5	58
1998	331,1	96,3	102,8	60
1999	343,3	110,0	114,5	65

Source: Authors' calculations on IDB and INEGI

As a consequence of the liberalization policies, the performance of imports and exports improved. Exports increased significantly due to the depreciation of the peso and to the lower anti-export bias. As for the

imports, the cut in import licenses did not have an instantaneous impact since Mexico was experiencing an economic crisis at that time. Besides, the devaluation of the peso mitigated the initial impacts of the trade reforms. In the following years the exchange rate appreciated reaching its highest levels between 1986 and 1988 (IDB). During this period imports grew slower than exports. After 1988, imports began to grow with a decline during the 1994-1995 crisis, but increasing again in 1997 as a result of successful stabilization measures and further structural reforms. Table 3 shows the evolution of imports and exports during the 1980s and the 1990s. As the figures in the last column of the table indicate economic openness increased steadily after 1987.

The US is, and has been for the last couple of decades, Mexico's main trading partner. As a result of Mexico's trade liberalization, its trade with US increased significantly. Between 1985 and 1993, Mexican exports to the US increased by 8.6 percent per year in real terms. In 1990, 73 percent of its exports went to the US and 68 percent of its imports came from this country (IDB 1992). The weight of trade with Mexico in total US trade is smaller but nevertheless still significant. In 1990 Mexico announced that it would enter into negotiations with US and Canada to establish a free trade area. Two years later, the three countries signed the North America Free Trade Agreement (NAFTA), which came into force in 1994. The implications of NAFTA for trade between Mexico and the US are of less importance than they appear to be since the reforms implemented in 1985 were substantially larger than those enforced by NAFTA.

A number of authors have linked the increase in the Mexican wage gap to the liberalization of trade. Revenga (1997) and also Hanson & Harrison (1999) find that the trade reform affected the unskilled labor disproportionately and advance some explanations for this. Recall that according to the H-O-S model in the case of Mexico, liberalization of trade should raise the relative prices of the unskilled intensive goods, in relation to the prices of the skilled intensive goods, and that this would contract the wage gap. In order to explain the observed increase in relative wages, the authors mentioned earlier argue that Mexico might be abundant in unskilled labor relative to the US, but it is abundant in skilled labor relative to other countries like China that are increasing their share in world trade. Another explanation is the already noted fact that, prior to liberalization, Mexico used its tariffs to especially protect the less-skilled intensive industries, contradicting the assumptions of the theory. The authors, however, find no conclusive evidence that Mexico has a comparative advantage in skill-intensive goods.

In terms of changes in the Mexico-US trade pattern, Revenga & Montenegro (1994) argue that these are consistent with the predictions of the theoretical model. Using export data at the three-digit level of the International Standard Industrial Classification (ISIC), they show that Mexico is a net exporter of products that employ mostly unskilled labor. Conversely, most of Mexico's imports from the US are from industries that employ skill-intensive labor and, therefore, produce skill-intensive products. However, they note that analyses based on net exports tend to miss the importance of intra-industry trade and much of the Mexican- US trade is of this type. For instance, when looking at exports of individual industries such as transport and non-electrical machinery, considered as fairly capital-intensive industries, they found that from 1985 to 1990 Mexico went from being a net importer to a net exporter relative to the US The important issue however, is that there is a strong trade link between Mexico and the US that may have negative implications for the wage gap in both countries.

Along with the implementation of trade liberalization policies, Mexico reformed its regulations on foreign investment. The government reduced many barriers to foreign investment including limits on foreign share or equity ownership in a Mexican firm. Requirements that foreign firms should obtain government approval before transferring from abroad were also lightened. An example of this is provided by the *maquiladora*[4] industry, which has been the main recipient of FDI. *Maquiladora* firms had been exempted from foreign ownership controls from the start, but at the same time there were subjected to complicated bureaucratic procedures. With the reform, the process of establishing as a *maquiladora* was considerably simplified. After this the boom in FDI began. Between 1993 and 1989, FDI increased from USD 478 million to USD 3 635 million, and the share of FDI in total fixed investment increased from 1.42 percent to 9.68 percent.

Explanations linked to factors that are often internal to specific firms or industries, such as technological change, are also found in the literature. A general argument is that in Mexico most of the new technologies and innovations come from abroad and have developed along with the process of trade liberalization. More specifically, growing FDI and imports of capital goods, mainly from the US, have accelerated technological change. The access to these new technologies, and the adoption, reflects an increasing demand for more skilled and educated workers followed by an increase in their wages. Acemoglu (1998, 1999) states that the Mexican wage gap widened since the growth of FDI and imports of capital goods from the US have increased the demand for more skilled workers in

relation to the demand of unskilled workers. Feenstra & Hanson (1997), in turn, investigate whether the shift from domestic manufacturing to foreign assemblies during the 1980s had an impact in the increasing relative demand of skilled labor. Their findings suggest that foreign capital inflows favored skilled workers and contributed to wage inequality overall in Mexico, but again they found that this effect was particularly strong in the *maquiladora* sector. Hanson & Harrison (1995) also advance the hypothesis of technological change as an alternative explanation for the rise in the Mexican wage gap.

As mentioned before, trade liberalization was implemented when Mexico was experiencing an economic crisis, which continued until 1987. During this period, changes in labor market policies, including the wage concessions made by unions in connection to the Economic Solidarity Pact, and reductions in the real minimal wage may have affected workers in all sectors of the economy (Feliciano 1993). Likewise, the government launched a program to privatize state-owned firms within the manufacturing sector. These policy changes can be accounted as factors other than trade reform and technological change that contributed to the increase in wage dispersion

IV. THE ECONOMETRIC MODEL

Variables

The explanatory variables in our econometric model are selected from those proposed by economic theory as possible determinants of the relative wage between skilled and unskilled workers in developing countries. As proxies for trade liberalization we consider a policy variable, changes in average tariff, and a macroeconomic variable, economic openness. Technological change is incorporated in the study in the form of the share of imports of capital goods, alternatively foreign direct investments in GDP. A third variable used in the study is the real exchange rate. This is assumed to influence relative wages through both changes in the trade pattern and in the direction of technological change.

Skill and Wage Differentials

As stated earlier, the gap wage in this study alludes to the ratio between the wages of skilled and unskilled workers. Nevertheless, the distinction between skilled and unskilled workers is sometimes hard to conceptualize. Skilled workers, that is, those who have higher average education levels and enjoy high positions within companies, are normally identified with the occupational category "white collar workers" or "non-production workers". Unskilled workers in turn are usually identified as

those who are physically engaged in production, and therefore denominated "blue collar workers" or "production workers". This distinction should be made with caution, however. Many "production workers" may have high levels of education while certain "white-collar workers" could have received their position as a consequence of on-the-job-training rather than educational achievements. In addition, difficulties appear when comparing labor categories among countries.

In his work on the labor market implications of trade between developed and developing countries, Wood (1994) considers three categories of labor: One category consists of workers with advanced education and/or substantial training or work experience. The second category includes workers who have a primary or general education. The third category consists of those who have little or no education. In developed countries, the second and the third category can, and often are, included in the group of unskilled workers whereas in a developing country a distinction between these two is necessary. Wood argues that skill-levels are often associated with the wage level of the workers concerned and the amount of education, training and experience the workers possess, which to some extent are reflected in occupational categories. However, Wood claims that this approach has two limitations. First, not all wage differences would reflect differences in skill. Second, wages are not always determined by competitive pressure. In addition, limitations in measuring education, training and experience appear as the length of time acquiring the skills concerned or by the cost of skill acquisition vary.

Because of data constraints, relative wages are defined in this study as the ratio of "white-collar" wage to "blue-collar" wage, that is $RW = W_{wc} / W_{bc.}$

Trade Variables

According to theory, trade liberalization diminishes the wage differential between skilled and unskilled-workers in a developing country, whereas the opposite is true in a developed country. Note, however, that this is true only if the relative price in the market of goods changes in line with the predictions of the classical comparative advantage theory. Recall that a condition for this is that the developing country was protecting the factor in which it is less abundant. Another condition is that the country is effectively endowed with unskilled labor, relative to its trade partners. Moreover, the wage differential can widen if, as a consequence of trade liberalization, the intermediate inputs of a given quality become cheaper and they are substitute for low-schooled workers (Behrman *et al.* 2000).

As stated above, the trade variables used in this study are economic openness and changes in trade liberalization. Economic openness is defined

as the share of total trade in GDP, that is OPEN = (M+X)/GDP. The expected sign is negative. As for changes in trade liberalization, the proxy for this variable in the case of Chile is defined as the average tariff (TARIFF). The expected sign is positive. The lower the tariff, the lower the wage-gap. In the case of Mexico, TARIFF is a dummy variable GATT that takes the value of 1 for the years after 1986 and 0 otherwise. The reason for this is that Mexico's decision of joining the GATT in 1985 represented a great fall in tariffs the year after followed by a smoother decrease in subsequent years. Another reason is the difficulty of finding the appropriate tariff data. The possibility of taking NAFTA as a dummy variable was also considered, but as already noted the reduction of tariffs was more drastic and significant after the GATT than after Mexico joined NAFTA. Because the variable takes the unit value after the year that Mexico joined the GATT, it is expected that the coefficient will have a negative sign.

Real Exchange Rate

Another variable considered is the real exchange rate (RER). Movements in the real exchange rate affect imports and exports in different ways. If the RER appreciates (the index decreases), the wage gap would decrease, as this would facilitate the imports of skill-intensive goods. This would certainly lower the demand of skilled workers and their wages. The expected sign in this case is positive. At the same time, however, the appreciation of the RER would discourage exports that in the case of a developing country are assumed to be less-skill intensive. As a consequence, the demand of unskilled workers and their wages would decrease and the wage gap would increase. In this case, the expected sign is negative.

In practice, however, the effects of the RER are very complex and difficult to predict. Keeping in mind that Mexico and Chile are middle-income countries, the appreciation of RER would also increase imports of unskilled goods from low-income countries such as China. This would lower the demand and, therefore, the wages of unskilled workers. Consequently, the wage gap should increase. On the other hand, exports can also be skill-intensive, and considering that they would decrease due to the exchange rate effect, the demand for skilled workers would decrease and the wage gap would contract as well. Finally there is the fact that, as stated before, the depreciation of the RER would stimulate local firms to increase efficiency and seek for new (foreign) technologies. The expected sign of the coefficient depends therefore on which of these effects dominates.

Technological Variables

The share of imports of capital goods (SHM), alternatively foreign direct investment (SHFDI) in GDP are taken as proxies to changes of technology that can influence wages. Based on the skill-enhancing trade hypothesis, it can be assumed that an increase in the amount of capital imports will result in a wider wage gap, and hence a positive sign will be expected in the equation. Foreign direct investment can be defined as an investment in which the investor, in this case from a developed country, acquires a substantial controlling interest in a foreign firm or sets up a subsidiary in a foreign country. Setting up an enterprise in a foreign country (outsourcing), in this case a developing middle-income country like Mexico or Chile, is assumed to bring skill-biased technologies from the developed one. For this reason, one can assume that an increase in foreign direct investment would lead to a greater wage gap. The expected sign in this case is also positive

Data Sources

The data used have been taken from various sources. In the case of Chile, data on relative wages between skilled and unskilled workers has been taken from Fajnzylber & Maloney (2000). In the case of Mexico, wage statistics for the 1984-1987 period were available from Hanson & Harrison (1995), who collected annual data for the Mexican manufacturing plants from the Secretariado de Comercio y Fomento Industrial (SECOFI). The 1987-2000 wage data are from the Instituto Nacional de Estadistica, Geografica, e Informatica (INEGI). From 1987 until 1994, the data are aggregated at the industrial level of 205 classes of economic activity for white-collar (*empleados*) and blue-collar workers (*obreros*). From 1994 until 2000, the sample is smaller, including only 129 classes of economic activity. A comparison of the figures for overlapping years allowed the combination of these three data sources after some adjustments.

Data on total imports and exports as well as imports of capital goods were also collected from the INEGI in the case of Mexico and from the IDB and ECLAC in the case of Chile. Imports of capital goods were defined as machinery and transport equipment. The US GDP deflator was used in order to convert these data into 1990 US constant prices. Data on GDP in constant US dollars and the real effective exchange rate were available from the Inter-American Development Bank. The real exchange rate was calculated as an index with 1990 as the base year.

Equations

The study uses an additive model[5] with four different specifications. The equations are given below. The expected signs for the variables are showed in Table 4.

Equation 1 $RW = \alpha_0 + \alpha_1 TARIFF + \alpha_2 RER + \alpha_3 SHM$

Equation 2 $RW = \alpha_0 + \alpha_1 TARIFF + \alpha_2 RER + \alpha_3 SHFDI$

Equation 3 $RW = \alpha_0 + \alpha_1 OPEN + \alpha_2 RER + \alpha_3 SHM$

Equation 4 $RW = \alpha_0 + \alpha_1 OPEN + \alpha_2 RER + \alpha_3 SHFDI$

Table 4 - Hypotheses for the Analysis

Variable	Expected sign	Condition
OPEN	-	Compliance with H-O-S assumptions
TARIFF	+	Compliance with H-O-S assumptions
RER	+/-	Depending on the dominant effect
SHM	+	According to the skill-enhancing-trade hypothesis
SHFDI	+	Supported by theories of technological change

V. Regression Results

Chile

Table 5 shows the results from the Chilean regressions. Equation 1 with the variables TARIFF, RER and SHM, has the strongest explanatory power with a high adjusted R^2-coefficient (0.895). Moreover, the Durbin-Watson statistics (2.028) show that the risk of autocorrelation is low. The variables TARIFF and SHMC are significant at the one percent level. The variable SHMC shows a negative sign, conversely to what could be expected whereas the variable TARIFF shows the expected positive sign confirming the hypothesis that lower tariffs contract the wage gap. The third variable RER is not significant, which suggests that it has little or no effect on relative wages in Chile.

Equation 2 also shows a quite high-adjusted R^2 (0,827). The equation includes the variables TARIFF, RER and SHFDI. Again the coefficient of TARIFF is significant at the 1-percent level and shows the expected sign. The technological variable does not get the expected sign but its coefficient is not significant. Note that RER in this equation becomes significant at the 1-percent level and exhibits a negative sign. Note further that according to the Durbin-Watson statistics (1.612) the risk for autocorrelation is higher than in the first equation.

Table 5 - Chile: Regression Results

Equation	1	2	3	4
INTERCEPT	2.570*** (40.205) 0,064	2.472*** (33.999) 0.073	2.688*** (15.774) 0.170	2.931*** (12.772) 0.229
OPEN	-	-	0.337 (0.402) 0.838	1.361 (-1.307) 1.041
TARIFF	0.01312*** (4.178) 0,003	0.01822*** (5.573) 0,003	-	-
RER	-0.0008201 (-0.675) 0.001	- 0.003316** * (-3.157) 0.001	0.001558 (0.646) 0.002	0.002698 (0.764) 0.004
SHM	-4.884*** (-3.230) 1.512	-	-9.643*** (-4.598) 2.097	-
SHFDI	-	-1.814 (-1.287) 1.409	-	-4.401* (-1.887) 2.333
ADJUSTED R^2 DURBIN-WATSON	0.895 2.028	0.827 1.612	0.745 1.858	0.456 0.565

* = significant at the 10 % level

** = significant at the 5 % level

*** = significant at the 1 % level

T-statistics in brackets under coefficient

Standard error in *italics*

When TARIFF is replaced by OPEN, as in Equation 3, the explanatory power of the variables included reduces. Economic openness shows a positive sign contrary to what might be expected, but the coefficient is not significant. The sign of variable RER turns now to the negative but it is not significant. The coefficient of variable SHMC is significant at the one percent level. However, as in Equation 1, its coefficient does not show the expected sign. Finally, Equation 4 has a low adjusted R^2 value (0.456). The correlation matrix shows that OPEN is highly correlated to other variables in the equation and further that RER is also significantly correlated to SHFDI.

This increases the risk of multicollinearity. The risk of autocorrelation also increases, as shown by the low Durbin-Watson statistics (0.565), making it hard to measure the real influence of any of the variables included in this equation.

When taking all variables into consideration, changes in tariffs as well as in the share of capital good imports in GDP seem to be the most important factors behind shifts in relative wages. These two variables seem indeed to explain most of the changes in the dependent variable. An important conclusion is that the liberalization of trade as reflected in the reduction of tariffs has impacted the labor market in a way consistent with H-O-S hypothesis. Apparently the reduction of tariffs made the price of previously protected skill-intensive goods to fall. As a consequence, labor-intensive industries expanded causing the demand for unskilled workers to increase. This in turn raised the wages of unskilled workers relative to the wages of the skilled ones. The econometric analysis also showed that the increased share of imports of capital goods (and to some extent foreign direct investment) in GDP has been associated to decreased wage inequality between skilled and unskilled workers. This is not consistent with the predictions of the theories about skill-biased technological change presented earlier in this study. It can be argued, however, that increased trade and capital flows from other middle-income countries in the region with similar factor endowments can explain this inconsistency. The introduction of many free trade agreements in the Latin American region during the relevant period corroborates this notion. This is particularly true in the case of Chile, which has during the 1990's developed strong links to its neighboring countries that constitute the free-trade agreement MERCOSUR.[6] This suggests that Chile's imports of capital goods are not necessarily transferring skill-biased technology.

Economic openness has been considered as an alternative indicator of trade liberalization. In this case, however, the evidence about the influence of this variable on relative wages is weak and contradictory. As for the real exchange rate, it does not seem to have any important influence on the wage gap, as it is only significant in one of the equations. In this case, the econometric analysis suggests that a real appreciation (depreciation) of the Chilean currency increases (decreases) the wage-gap.

Mexico

The results of the Mexican regressions are given in Table 6. Foreign direct investment (SHFDI) and TARIFF proved to be the most significant variables in Equation 1 (at the one percent level), while the real exchange rate variable (RER) turned out to be significant at the 5 percent level. There is no risk of multicollinearity since the correlation matrix shows that the

variables are not correlated.

Table 6 - Mexico: Regression Results

Equation	1	2	3	4
INTERCEPT	3.236 (6.703) 0.483	2.431 (7.633) 0.319	1.994 (3.867) 0.516	2.082 (4.500) 0.463
OPEN	-	-	2.243*** (5.594) 0.401	1.472* (1.868) 0.788
TARIFF	0.828*** (5.009) 0.165	0.451*** (3.570) 0.126	-	-
RER	-0.009149* (-2.161) 0.004	-0.007449** (-2.495) 0.003	-0.002558 (-0.629) 0.004	-0.003763 (-0.937) 0.004
SHM	-11.890* (-1.859) 6.397	-	-1.382 (-0.246) 5.619	-
SHFDI	-	24.762*** (4.434) 5.585	-	14.122 (1.121) 12.603
ADJUSTED R^2	0.637	0.823	0.689	0.717
DURBIN-WATSON	1.507	2.214	0.299	0.538

*. Significant at the 0,10 level

**. Significant at the 0,05 level

***. Significant at the 0,01 level

T-statistics in brackets under coefficients

Standard error in *italics*

Note further that there is no risk of autocorrelation since Durbin-Watson statistic is close to 2 and that the variables in the equation have a high explanatory power. The equation indeed exhibits a high R^2 (0.82). The coefficient of SHFDI has the expected positive sign, but it is not the case of the coefficient of TARIFF. The coefficient of RER shows a negative sign in all the equations, but it is significant only in Equations 1 and 2.

In Equation 2 TARIFF also shows a positive sign and high significance, while RER and the imports of capital goods variable (SHM) are only significant at the 10 percent level, which is considered very low. In

equation 2 as well as in equation 3 SHM shows a sign contrary to the expected, but note that it is not very significant in equation 2 and non-significant at all in the Equation 3. Note further the relatively low value of R^2 (0.64).

The openness variable (OPEN) appears to be significant in Equations 3 and 4, but it does not get the expected sign. The interesting thing, however, is that other variables like SHFDI and RER that were significant in other equations are not in these two. There could be a special reason in the case of SHFDI since in the correlation matrix, OPEN and SHFDI are highly correlated making it difficult to distinguish and measure the separate influence of the two variables. In addition the Durbin-Watson for the two equations is very close to 0 which brings up the issue of multicollinearity.

The results in Equation 1 show that an increase in foreign direct investment will increase the wage gap. In this respect it can be said that what has been argued throughout the study, especially in relation to technological change holds in the case of Mexico. Particularly in terms of its close economic links with the US bringing skilled-biased technology to Mexico through foreign investment. Note however, that the SET hypothesis is not confirmed by the econometric results. There is indeed weak evidence that imports of capital goods have not contributed to enlarge the wage gap. The role of general trade liberalization through GATT is more complex. The results do not give support to the expectations of the theory. An explanation already advanced in this work is that Mexico was protecting the unskilled labor stronger than it did with the skilled labor before liberalization. At this point it can be strongly argued that the trade pattern between the United States and Mexico is very influential in the way that wages behave.

Despite the fact that the real exchange rate was little significant only in two of the equations, it brings important explanations with respect to the behavior of wages when combined with SHFDI and TARIFF. The sign of the coefficient suggests that the dominating effect of movements in this variable was the increasing imports of unskilled intensive goods from low-income countries, which hurt the unskilled labor.

In the case of economic openness, there is no congruency with what has been stated by the theory, since the regression shows that as Mexico has become more open, the wage gap has increased. However, there is no conclusive evidence that this variable influences wages, since it appears to be highly correlated with other variables in the equation.

VI. Concluding Remarks

This study examined the implications of trade liberalization and technological change for the wage gap between skilled and unskilled workers in Chile and Mexico.

There is evidence that relative wages have been increasing significantly after Mexico's accession to GATT. In order to investigate the link between trade liberalization and the wage gap, we considered two variables, namely the general reduction of tariffs through GATT and the degree of economic openness. The results for the two variables, particularly for the tariff one, are not in compliance with the theory as they indicate that trade liberalization has increased wage inequality. An explanation of this is that, as the tariffs went down this benefited skilled labor because Mexico protected its abundant factor (unskilled labor) more before liberalization. Another is that liberalization combined with the appreciation of the real exchange rate increased the penetration of Mexican market by labor-intensive goods from low-income countries. What is clear is that the strong economic links between Mexico and the United States have negatively affected wage inequality. At the same time that Mexico implemented trade liberalization policies, a large fraction of new manufacturing activities in Mexico have been the result of outsourcing by US multinationals. This has had a negative impact for the wages of the unskilled workers since the introduction of these new skill-biased technologies via FDI has increased the demand for skilled workers.

Note that technological change has to be considered together with trade liberalization because first, the transmission of new technologies from the US to Mexico has been facilitated by the latter; and second, the data shows that FDI has increased considerably after the trade reform. Hence, in order to assert that liberalization as such has not affected wage inequality negatively in Mexico, one would have to assume that the labor market effect of increasing exports of goods intensive in unskilled labor was larger than that from the acceleration of technological change. Based on the evidence shown by the data indicating that the wage gap has indeed expanded the conclusion is the opposite.

In sum, our results confirm that technological change has contributed to the expansion of wage inequality in Mexico, as predicted by the theories developed by the authors mentioned in this study. On the contrary, our results do not correspond to the predictions of mainstream trade theory. This does not mean that the theory does not hold in the present case. What it can be said is that in the case of a middle-income country like Mexico, comparative advantage and pre-reform protection structure may deviate from the standard assumptions made by the theory about developing

countries.

In the case of Chile, many authors have advanced the hypothesis that trade liberalization has been a factor behind observed increased wage inequality. It has been argued that liberalization increased the skill premium during the 1980s and 1990s, an outcome inconsistent with theory. In general, our results contradict these findings and give support to the theory. The results also contradict the conclusions made by authors who argued that observed increases in the relative wage of skilled workers in Chile was due to increased import of capital goods complementary to skilled labor.

The liberalization program introduced in 1973 by the military government led to large-scale privatization and tariff reductions. These policies were maintained with some modifications during the 1980s and 1990s, making Chile one of the most open economies in Latin America. Our empirical analysis indicates that trade variables were strongly associated to changes in the wage gap between skilled and unskilled workers in Chile. The variable reflecting changes in average tariff showed the expected positive sign confirming the prediction of the H-O-S model that decreased tariffs are likely to contract the wage gap. The coefficient of the variable reflecting the increased share of imports of capital goods in the GDP was also significant but it showed a negative sign converse to what was expected in accordance with the skill-enhancing trade hypothesis. Yet, this outcome is consistent with the S-S theorem where an increase of imports of skill-intensive goods such as capital goods causes a loss in the demand of skilled workers, and ultimately a contraction in the wage gap between skilled and unskilled workers. Another explanation is that, in the case of Chile, capital good imports are not the bearer of skill-biased technology as they originate to some extent from other middle-income countries in the region with similar factor endowments.

Notes

1 The assumption of constant returns to scale is consistent with the assumption of perfect competition and further with the notion that country size is irrelevant for international trade patterns.

2 The choice of a model with these two factors is essential when discussing distribution issues and wage gaps. But the fact is that they relate directly to the basic model since the production of capital-intensive goods is normally associated to the intensive use of skilled labor, while the production of labor-intensive goods to unskilled workers. See for example, Robbins (1996); Hanson & Harrison (1995); Robertson (2000).

3 During the military government rule labor rights were strongly limited. The objective was to achieve a flexible labor market. From 1973 through 1978 labor unions rights were limited, strikes were banned, dismissal of redundant workers was facilitated, wage bargaining was prohibited beyond the firm level and wages were kept low, allowing firms to keep down labor cost in order to be competitive on an international market. (Lear & Collins: 1995).

4 Industrial establishments that own the factors of production while someone else owns the material that is processed into a final good. They enjoy tax breaks in Mexico and the United States.

5 A multiplicative (logarithmic) version of the above equations was investigated but the related tests gave no significant results.

6 MERCOSUR is an imperfect customs union existing since 1995 with Argentina, Brazil, Paraguay and Uruguay as member states. In 1996 MERCOSUR signed a free trade agreement with Chile.

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