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to the Symposium

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Convergence: Mexico 1985–2002

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Tracking NAFTA's Shadow 10 Years on: Introduction to the Symposium

Daniel Lederman and Luis Servén

The North American Free Trade Agreement (NAFTA) is arguably the first “case study” of what might be expected from the increasing number of preferential trade agreements involving both developed and developing economies. Ten years after the treaty's inception, it is time to assess how its outcomes compare with initial expectations. The articles in this symposium issue provide insights into the effects of NAFTA on economic geography, trade, wages and migration, and foreign investment from Mexico's perspective. The contributions paint a complex post-NAFTA reality characterized by persistent intrabloc trade barriers, interregional inequality within Mexico, labor market outcomes that seem closely tied to migration patterns and international trade and investment, and foreign investment flows that appear weakly related to trade agreements. NAFTA seems to be the first trade agreement in history for which the traditional static trade creation or diversion effects are likely negligible—and hard to identify in any case.

Trade negotiations among Mexico, Canada, and the United States began informally in 1990 and more formally in 1991. The North American Free Trade Agreement (NAFTA) was implemented in January 1994. From the outset of negotiations, this preferential trade agreement among developed economies and a developing economy became controversial. On the one hand, it raised concerns about the impact of preferential trade on the multilateral trading system, especially after numerous other countries in Latin America and elsewhere jumped on the preferential trade agreement bandwagon. On the other hand, the advent of NAFTA raised public awareness of the developmental effects of trade liberalization, including its potential effects on economic growth, labor markets, and the environment.

Ten years later, it is useful to ask how closely NAFTA's outcomes have tracked initial expectations. The articles in this symposium issue explore specific aspects

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and effects of this preferential trade agreement from Mexico's perspective. The contributions paint a complex post-NAFTA reality, characterized by persistent intrabloc trade barriers, interregional inequality within Mexico, labor market outcomes that seem closely tied to migration patterns and international trade and investment, and foreign investment flows that seem only indirectly related to free trade agreements. NAFTA may be the first trade arrangement in history for which the traditional static trade creation or diversion effects are likely negligible—and hard to identify in any case. And NAFTA is arguably the first “case study” of what might be expected from the recent upsurge in preferential trade agreements involving both developed and developing economies.

Before entering into the specific details of the articles, it may be instructive to recall some relevant details about NAFTA. First, since Mexico had unilaterally reduced import tariffs beginning in 1985, it is difficult to separate the effects of NAFTA on the volume and composition of Mexico's trade from the effects of the unilateral reforms, especially since even the announcement of NAFTA talks could have had an impact on economic outcomes. Also, the U.S.–Canada Free Trade Agreement had been implemented in 1988, and consequently NAFTA's effects on global trade patterns are also difficult to differentiate from trends that predated 1994.

During the 1990s, Mexico became one of Latin America's heaviest trading economies, with the highest volume of trade as a share of gross domestic product (GDP). Mexico caught up with Chile on this indicator of economic integration and is fast approaching the very high trade shares—more than 100 percent of GDP—typical of smaller economies such as Costa Rica. Importantly, this increase in Mexico's trade was associated with fast growth in intra-NAFTA trade.

Second, while NAFTA entailed substantial trade reforms by Mexico, it required much less liberalization from the United States and Canada, which had already significantly lowered trade barriers. Most import tariffs and other restrictions to trade among the United States, Canada, and Mexico were eliminated over the first 10 years of implementation. The average Mexican tariff fell from about 12 percent in 1993 to 1.3 percent by 2001. U.S. tariffs on Mexican imports fell from 2 to 0.2 percent. However, duty-free access to NAFTA markets depends on the fulfillment of product- and sector-specific rules of origin, which determine the criteria for products to be considered as originating in a member country. Market access for some Mexican exports is inhibited by these rules.

Third, like most preferential trade agreements, NAFTA did not achieve truly free trade, and many distortions still remain. Some tariff rate quotas for sensitive agricultural products will finally be eliminated by 2008, but these quotas have not been binding, and thus most agricultural imports from the United States and Canada have entered Mexico duty-free. However, Mexico's import-competing agriculture benefited from subsidies ranging from decoupled income transfers to producers to a variety of subsidies affecting domestic producer prices. The decoupled income supports known as PROCAMPO are scheduled to

be eliminated by 2008, but like the other subsidies they are not currently subject to international disciplines. Also, all member countries have continued to use antidumping and countervailing duties according to their own national trade laws. In addition, NAFTA allows the use of temporary safeguard duties when a country faces sudden import surges that disrupt domestic production. At the same time, going beyond what other shallower preferential trade agreements have achieved, NAFTA established various dispute settlement mechanisms dealing with foreign investment and trade. It also established a review mechanism for the use of antidumping and countervailing duties.

Lastly, besides trade-related measures, NAFTA includes a variety of provisions affecting investment flows, financial and other services, government procurement, and protection of intellectual property rights. However, the agreement did not establish a fully liberalized financial system. For example, it provides for only limited foreign participation in the banking system. In contrast, it did establish an open capital account for cross-border financial services.¹ But Mexico had already unilaterally opened its capital account before NAFTA was implemented in 1994, and thus it is not obvious that the agreement had much additional impact through liberalization of the capital account.

In sum, NAFTA entailed substantial although incomplete trade reforms. At the same time, the agreement went well beyond traditional trade issues. On top of this complexity, Mexico experienced economic shocks after implementing NAFTA, which complicate the analysis of the impact of the agreement.

I. WHAT WAS EXPECTED FROM NAFTA?

When NAFTA came into force, there were hopes that the treaty would speed up growth and income convergence in Mexico toward its partners and that wage convergence and new employment opportunities in Mexico would discourage migration to the United States. At the same time, it was feared that the treaty might have a negative impact on Mexico's environmental regulations and environmental outcomes.

The impact on growth and income convergence—the dynamic effects—would have as key intervening mechanisms trade and foreign investment. These would accelerate technological catch-up through the adoption of foreign technologies embodied in imports (Keller 2001) or brought by foreign investors, as the competitive pressures created by trade openness forced firms to reduce production costs and perhaps created incentives for research and development under strengthened intellectual property rights (Lopez-Cordoba 2003). There would also be effects through factor movements from less to more productive

1. Annexes VII(B) and 1413.6 of NAFTA limited foreign penetration in Mexico's banking system to a maximum of 25 percent of the aggregate capital of all commercial banks. NAFTA's restrictions on foreign insurance companies were even more severe. Mexico removed the limitations on foreign entry into the domestic commercial banking system unilaterally during the financial crisis of 1995.

sectors and firms (Lederman, Maloney, and Servén 2005, chapters 2 and 5). At the same time, it was expected that firms would congregate close to the U.S. border, displacing Mexico's economic center further to the north and creating a gradient of progressively poorer regions at greater distance from the border.

Wages, jobs, and migration were at the center of the political debate over the merits of NAFTA from the very beginning. A reduction in the wage differential between Mexico and the United States was one of the primary hopes attached to NAFTA. Proponents of the treaty argued that rising trade and foreign direct investment (FDI) would increase demand for labor in Mexico and thus Mexican wages relative to U.S. wages, reducing incentives for Mexican workers to migrate to the United States (Hanson and Spilimbergo 1999). Indeed, former Mexican President Carlos Salinas de Gortari expressed the hope that NAFTA would lead to the export of goods rather than people.

The impact on FDI is an aspect of the dynamic effects of preferential trade agreements that has attracted considerable attention because of the presumed contribution of FDI to technological advances and productivity growth. Empirically, however, evidence suggests that entry into a preferential trade agreement does not itself ensure a takeoff of FDI inflows. Spain and Portugal experienced transitory FDI booms at the time of European Union (EU) accession, but Greece did not (Kehoe and Kehoe 1995). Furthermore, qualified observers expressed the fear that Mexico's FDI gains would come at the expense of Central America.

Lastly, a key concern among NAFTA skeptics—one that attracted much attention in the political and policy debate—was that the prospect of increased trade and FDI would induce Mexico to weaken its environmental regulations to attract businesses, the so-called race to the bottom that could transform Mexico into a pollution haven for foreign investors.

Since it is difficult to empirically assess the growth and structural effects of NAFTA on the Mexican economy and their subsequent impact on pollution, the evolution of Mexico's environmental regime may be the best measure of NAFTA's environmental consequences. A quick look at the literature reveals that Mexico's environmental regulations and enforcement capabilities in fact became stronger in the years when NAFTA was being negotiated and implemented.² In addition, the trade agreement was accompanied by an environmental side agreement, which may have institutionalized a source of constant pressure on the Mexican authorities. Furthermore, the most recent evidence concerning the

2. For example, Gilbreath (2003) shows that since 1988 Mexico has experienced a renaissance of environmental legislation that raised standards and the enforcement powers of the federal government. These developments, however, would need to be balanced against the controversial NAFTA provisions that protect foreign corporations from sudden and discriminatory changes in regulations. It is plausible that these provisions could be used by private companies to demand remedies when a local, state, or federal government changes regulations after foreign corporations have begun operating under previous regulations. Gilbreath argues that the rapid pace of the reforms during 1991–96 can only be explained by the political pressures exerted by the NAFTA debate in the United States and Mexico.

effect of international trade on pollution suggests that there is no adverse causal effect (Frankel and Rose 2005). Thus it is hard to conclude that the advent of NAFTA brought about an environmental race to the bottom. Rather, it seems to have produced a race to the top in environmental institutions. For these reasons, this symposium does not include a specific assessment of the environmental consequences of NAFTA.

II. ASSESSING THE EFFECTS OF NAFTA: CONTRIBUTIONS IN THIS SYMPOSIUM

The contributions focus on four topics: economic geography, trade, wages and migration, and foreign investment flows.

Economic Geography

However mild or strong the aggregate growth effects of NAFTA might have been, the economic gap between the poorest regions or states within Mexico and the rest of the Mexican economy did increase after the trade reforms—including the unilateral reforms initiated in the mid-1980s. It is not clear, however, whether this was the result of trade liberalization or the result of the continuing effects of the unfavorable initial conditions in Mexico's southern states.

The conventional wisdom in the literature seems to be that NAFTA and trade reforms disproportionately benefited the northern states of Mexico through economies of scale driven by transport costs. Hanson (1997) was one of the first to study how the economic geography of Mexico changed because of the unilateral trade reforms. His conclusion was that wages had in fact grown faster in cities along the Mexico–U.S. border than in the rest of the country.

A more recent contribution by Nicita (2004) explores another channel through which trade reforms might have affected Mexico's economic geography. He first analyzes the pass-through of tariff reductions for a set of agricultural commodity and manufactures aggregates across the Mexican territory, allowing for a less-than-full transmission of trade reforms for states further from the border. Second, Nicita estimates household income and consumption elasticities about the same set of aggregate prices, enabling him to calculate the welfare effects of tariff reductions across households. He finds that poverty fell in Mexico because of trade reforms but that some regions fared better than others.

The new evidence provided by Aroca, Bosch, and Maloney in this symposium confirms views advanced in earlier literature but provides a more nuanced depiction of trends in per capita incomes across regions within Mexico. First, while it is true that northern cities and states are richer than southern states, it is not clear that these differences imply a linear gradient regarding the U.S. border. There does not seem to be a convergence club of the north of Mexico, because the levels and trends in GDP per capita of the northern states are not significantly different from those of the central states, including the Federal District of

Mexico City, which remains the richest agglomeration in the country. Second, the three poor southern states—Chiapas, Guerrero, and Oaxaca—seem to constitute a club of poor states whose economic distance from the rest of the country increased after 1985. Thus, spatial analysis methods provide a clearer picture of the geography of integration by allowing for the emergence of pockets of poverty or convergence clubs.

Trade Effects

While trade creation and trade diversion effects did not occupy center stage during the initial NAFTA debate, they are always a cause for concern when trade preferences are extended on a discriminatory basis. In the early years, a host of *ex ante* estimates were carried out using computable general equilibrium models. The consensus today is that these attempts to study the trade effects of NAFTA—and other trade arrangements—failed to predict both the aggregate welfare effects and the sectoral composition of the ensuing growth (Kehoe 2003). More recent *ex post* estimates using gravity models of trade do not yet offer a clear-cut assessment of the trade effects of NAFTA. Post-NAFTA trends in trade patterns do not seem very different from earlier ones, which may simply reflect the difficulty in disentangling the impact of NAFTA from the delayed effects of Mexico's unilateral reforms of the late 1980s (Carrère forthcoming). It is also possible that limitations of the agreement itself dampened its potential impact on trade.

One such limitation, common to preferential trade agreements in general—unlike customs unions—is the use of rules of origin. These rules establish the criteria affecting the transformation and regional input use that must take place within a country's territory for a product to be considered produced by that member country. These rules are thought necessary to prevent trade deflection: the relabeling and reexport of imports from the rest of the world to take advantage of preferential access. But rules of origin are often the main objective of the negotiations, whose outcome is typically influenced by special interest groups (Estevadeordal 2000; Estevadeordal and Suominen 2005). Furthermore, if the rules are very onerous, exporters may decide to export under most-favored-nation tariffs, rendering the preferences irrelevant.

Another potential shortcoming of NAFTA and trade agreements in general is their use of administered protection in the form of antidumping and countervailing duties. If preferential trade agreements do not curb the use of these duties, the extent of true trade liberalization will fall short of the preferential tariff reductions, and thus trade creation will be lessened—although trade diversion may be lessened as well.

Two contributions in this symposium assess these potential limitations of NAFTA. First, Cadot and his coauthors examine the effects of rules of origin in the textiles and apparel industry, where trade diversion could have been strongest. At least since the contribution by Krueger (1993), a concern has been expressed in the literature about the potentially pernicious effects of rules of origin. Cadot

and his coauthors look at the behavior of export prices for Mexican apparel exporters. Their estimates of the pass-through from tariff preferences in the U.S. market to export prices for Mexican producers suggest that about one-third of the increase in export prices was offset by the cost of complying with NAFTA rules of origin.

Second, Blonigen explores the determinants of antidumping and countervailing duty investigations by the United States. His estimations of count data models suggest that the conditional frequency of such cases did not change after 1994. Thus, NAFTA failed to curtail the threat of such actions and their trade-reducing effects, which in a context of imperfect competition can be even larger than the effects of more transparent trade barriers such as import tariffs. Given the rules of origin and the threat of antidumping and countervailing duties, it is not surprising that estimates of trade creation and diversion fail to find much of an effect.

Effects on Labor Markets and Migration

Contrary to the hopes of NAFTA proponents, there is little evidence of a narrowing of the U.S.–Mexico wage differential under NAFTA. But this is one of the areas in which inferences about the treaty's effects are greatly complicated by the Tequila crisis. Mexico's wages relative to U.S. wages rose rapidly during the overvaluation of the peso in the run-up to the crisis and then fell sharply with the collapse of the peso and the recession of 1995. Trade liberalization cannot be held responsible for the sudden widening of the wage differential or for its relatively rapid narrowing following the crisis.

Robertson assesses the effects of NAFTA on labor market integration by looking for changes along three dimensions: (a) the responsiveness of Mexican wages to U.S. wage shocks, (b) the speed at which relative wages converge to their long-term differential, and (c) the rate of convergence of absolute wages. Robertson uses panel data on synthetic worker cohorts and makes a variety of adjustments to deal with the effects of the Tequila crisis. On the whole, he finds only limited evidence of increased integration under NAFTA by any of the above criteria. The strongest hint at convergence comes from the seemingly closer co-movement of the wages of skilled workers on both sides of the border, something not found for the wages of unskilled workers. This trend likely reflects the ongoing rise in the skill differential in all NAFTA partners, rather than the effects of the agreement. At best, the treaty seems to have made only a modest difference, and by some measures, labor markets appear less integrated under NAFTA than before.

Robertson seeks to explain this puzzle through migration, which, like trade and FDI, is another important force integrating labor markets. Assessments of trends in migration from Mexico to the United States are greatly complicated by the lack of reliable data, owing to the illicit nature of much of the migration. Robertson works around this problem by using data on U.S. border enforcement, which became stricter following NAFTA. An empirical analysis of the forces

driving wage differentials suggests that trade and FDI increases in the post-NAFTA period contributed to a narrowing of U.S.–Mexico wage differentials, *ceteris paribus*, but that much of the effect was offset by the simultaneous tightening of U.S. border enforcement that exerted a negative effect on Mexican wages by restricting illegal migration.

To assess the effect of NAFTA on migration itself, despite the data problem, Aroca and Maloney take an indirect route. They use information on the effects of NAFTA-related variables on migration within Mexico to infer the treaty's consequences for migration into the United States. To justify this approach, they offer evidence that domestic and international migrants share broadly similar characteristics and face mobility costs that are not too different.

The article's empirical analysis, based on data on migrants' origin and destination by state, allows disentangling substitution and income—or liquidity—effects of changes in relative earnings across locations. In contrast to much of the literature, this approach yields significant migration-detering effects of labor market performance variables at the source location. More important, the article finds that both FDI and trade flows are substitutes for labor flows: their pull effects on migration are generally larger than their push effects. One caveat, however, is the lack of good instruments to deal with the potential endogeneity of trade and FDI location decisions; for this reason, the results have to be viewed with some caution. Aroca and Maloney use their estimates to draw some tentative inferences on the impact of FDI on Mexican migration to the United States.

Foreign Direct Investment Effects

Conceptually, a preferential trade agreement affects both the profitability and the risk of investing in member countries. Preferential trade agreements can boost profitability by raising the return on capital in member countries, thus encouraging investment. Such trade agreements also alter the relative profitability of investing in different member countries in a way that depends primarily on whether investment flows are horizontally or vertically motivated—whether they substitute for trade flows or complement them (Blonigen 2005). If FDI is a substitute for trade flows, it may decline with the dismantling of trade barriers; if it is a complement to trade flows, it is likely to rise. Mexico, like most developing economies, receives primarily vertical FDI (Shatz and Venables 2001), and so NAFTA membership is expected to enhance Mexico's appeal to investors seeking a platform for exports to partner countries.

Preferential trade agreements also affect the perceived riskiness of investment through a credibility effect, which many analysts consider to be even more important than the profitability effect. It arises from the way preferential trade agreements lock in trade policies—and other reforms included in the agreement, such as protections provided to foreign investors—and from the agreement's guarantee of access to partner countries' markets. Some have argued that this credibility

dividend should be expected to play a much bigger role in developed–developing economy preferential trade agreements than in trade agreements among only developed economies or only developing economies (Blomstrom and Kokko 1997).

While NAFTA coincided with a surge in FDI into Mexico, the surge took place in the midst of a worldwide FDI boom. The article by Cuevas, Messmacher, and Werner attempts to disentangle the roles of NAFTA and other factors in Mexico's FDI performance. They use a panel empirical framework in which the effects of NAFTA membership on FDI inflows are captured by the host country's extended market, as measured by the aggregate GDP of all partner countries. This is combined with a variety of other variables representing local and global determinants of FDI.

They find robust support for the notion that joining a preferential trade agreement leads to higher investment inflows, to an extent that depends on the size of the host country's trade agreement partners. The authors estimate that NAFTA membership accounts for an increase in FDI in Mexico ranging from 25–30 percent—when Mexico's exports are held constant—to 60 percent—when the response of exports to preferential trade agreement membership is factored in.

One important question is whether the effect of preferential trade agreements on FDI inflows is just temporary, reflecting a portfolio stock adjustment—as, for example, Fernández de Córdoba and Kehoe (2000) found for Spain's integration into the EU. Cuevas, Messmacher, and Werner likewise find that their empirical equations tend to overpredict FDI inflows to Mexico at the end of the 1990s. This result is consistent with a one-time adjustment effect, but other explanations are also possible. An upward reassessment of the anticipated returns in Eastern European countries—and a downward reassessment of their perceived risk—with their expected EU accession may have reduced Mexico's relative appeal as an investment destination, for example.

Lastly, Cuevas, Messmacher, and Werner explore investment diversion—the notion that preferential trade agreements may make investment more attractive in member countries at the expense of outsiders—by adding an explanatory variable that captures any special attraction as an FDI destination that may come from membership in a preferential trade agreement. This approach fails to yield a statistically significant effect, however. But the result applies to all preferential trade agreements in the sample, leaving unexplored the extent to which NAFTA fits that general pattern. Lederman, Maloney, and Servén (2005, chapter 7) offer some NAFTA-specific evidence. Examining country-specific deviations from past FDI performance in the post-NAFTA years, they find that Mexico outperformed other Latin American countries in 1994–95 (or 1994–96) but not in later years. They also show that Mexico's high FDI performance does not seem to have been matched by underperformance by other countries in the region, suggesting that investment diversion effects, if present at all, are unlikely to have been very strong.

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Spatial Dimensions of Trade Liberalization and Economic Convergence: Mexico 1985–2002

Patricio Aroca, Mariano Bosch, and William F. Maloney

This article employs established techniques from the spatial economics literature to identify regional patterns of income and growth in Mexico and to examine how they have changed over the period spanned by trade liberalization and how they may be linked to the income divergence observed following liberalization. The article first shows that divergence has emerged in the form of several income clusters that only partially correspond to traditional geographic regions. Next, when regions are defined by spatial correlation in incomes, a “south” clearly exists, but the “north” seems to be restricted to the states directly on the U.S. border and there is no “center” region. Overall, the principal dynamic of both the increased spatial dependency and the increased divergence lies not on the border but in the sustained underperformance of the southern states, starting before the North American Free-Trade Agreement, and to a lesser extent in the superior performance of an emerging convergence club in the north-center of the country.

Over the decades since Mexico’s dramatic unilateral trade liberalization in 1985 and its membership in the North American Free-Trade Agreement (NAFTA), per capita incomes have increasingly diverged across Mexican states. Measures of sigma convergence show a decrease in dispersion from 1970 to 1985 and then a sharp reversion to levels of inequality thereafter. A growing number of studies using traditional beta convergence analysis (Barro and Sala-i-Martin 1995) also find divergence or, at least, a slowdown of convergence (Juan Ramon and Rivera-Batiz 1996; Esquivel 1999; Messmacher 2000; Cermeño 2001; Esquivel and Messmacher 2002; Chiquiar 2005).

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Concern is growing that this divergence is occurring in geographic patterns that will compound traditional inequalities: the northern states will reap most of the benefits of free trade and rapidly converge toward U.S. income levels, while the southern states will continue to lag, polarizing the country. However, the links from trade liberalization to the spatial location of economic activity and to economic convergence are not well understood, either theoretically or in the actual case of Mexico. This article employs established techniques from the spatial economics literature to identify regional patterns of income and growth and to show how they have changed over the period spanned by trade liberalization and how they may be linked to the observed divergence in income.

I. BACKGROUND

In 1985, Mexico began a process of unilateral liberalization that transformed it from an inward-looking economy based on import substitution to an open, liberalized economy. Trade-related reforms included a dramatic reduction of import licensing coverage from 90 percent of domestic production to 23 percent by 1988, a phased reduction of average levels of tariffs from 24 to 11 percent, and admittance to the General Agreement on Tariffs and Trade (GATT) in 1986. The pursuit of NAFTA, signed in 1994, would lead to a further reduction of average tariffs to 1.3 percent by 2001, the progressive liberalization of sensitive sectors, increased access to the U.S. market, and a greater attractiveness to foreign direct investment (Lustig, Bosworth, and Lawrence 1992; Lederman, Maloney, and Serven 2005).

Early analyses of the impacts of reform and of the predicted impact of NAFTA looked at output and exports of specific industries but were silent about how their location might be affected.¹ The emergence of the new economic geography (Krugman 1991) during the 1990s offered new tools for examining that question. It built on the interplay of agglomeration externalities of industry arising from the availability of specialized labor and intermediate inputs and technology spillovers on the one hand and transportation costs between markets on the other. Hanson (1997) suggested that Mexico's traditional inward-looking policies led industry to locate near concentrations of industry and population in central Mexico City and to serve the peripheral regions—the south and the north—from this base. However, the progressive liberalization of trade with the United States arguably made locating nearer the U.S. market more profitable, shifting the center of gravity of the Mexican economy to the north, potentially in a dramatic fashion. The benefits would likely dissipate with distance from the border, and, as some have argued, would increase the dispersion of welfare between north and south (Nicita 2004).

However, these outcomes are not a foregone conclusion. To begin with, theory remains ambiguous. For example, Behrens and Gaigne (2003) suggest that a

1. See, for example, Maloney and Azevedo (1995) and Lustig, Bosworth, and Lawrence (1992). Lustig, Bosworth, and Lawrence specifically acknowledge the lack of reference to spatial considerations (p. 65).

finding of increased polarization with trade liberalization depends critically on how transport costs are modeled.² Second, historically, Krugman (1991) and others (see Head and Mayer 2004 for a review) have noted the remarkable persistence of patterns of industry distribution over very long periods of time, despite large changes in economic environment. Such persistence may reflect the power of accumulated agglomeration externalities, often initially sparked by trivial historical accident or the importance of natural advantages that anchor industries to their initial locales. Davis and others (1997) argue that Heckscher-Ohlin-Vanek performs surprisingly well in explaining the location of production in Japan and that Krugman-style geography models add little. Ellison and Glaeser (1999) find that only 21 percent of the U.S. industries exhibit degrees of geographic concentration significantly higher than those predicted by natural advantages, such as weather and natural resources. Redding and Vera Martin (2003) show that both theoretically and in 45 regions in Europe factor endowments are important determinants of the location of production.³

In neither the new economic geography nor the Heckscher-Ohlin-Vanek view is it clear whether the sudden increase in demand from abroad, and an increase in the supply of cheaper and better-quality inputs, will lead to the displacement of existing nonborder growth poles or to their reinvigoration. Both scenarios are consistent with localized and isolated hot spots or with large multistate agglomerations distributed with no particular relation to the border.

In Mexico these types of considerations suggest that the emerging geographic patterns of economic performance may be subtle and hard to predict. Thus, for example, the increased costs of exporting from established central industrial locations such as Aguascalientes, Guadalajara, and Queretaro might be offset by their well-trained workforces and lower levels of congestion. Domestic and foreign firms interested in serving the Mexican market may be attracted by the increased access to cheaper and higher quality inputs from abroad and the lowered risk implied by NAFTA.⁴ Further, the location of some potential growth industries is clearly driven by immobile endowments that are not necessarily concentrated on the border. Esquivel (2000) finds that two-thirds of the differences in Mexican state incomes are a result of differences in natural characteristics (climate and vegetation).⁵ The elimination under NAFTA of import restrictions to the United States on mangos (produced in Guerrero and Michoacan), pineapples (Veracruz, Oaxaca, and Tabasco), and grapes in 1994 and the phasing out of

2. Hanson (1997) argues that the emergence of a second pole would lead to compression of the wage distribution rather than divergence.

3. Redding and Vera Martin (2003) show this should be the case in theory regardless of the degree of factor mobility. Working in a similar tradition, Bernstein and Weinstein (2002) reintroduce the importance of transport costs as a means of anchoring the indeterminacy intrinsic to HOV when the number of goods exceeds the number of factors.

4. See Lustig, Bosworth, and Lawrence (1992) for a discussion of NAFTA as a signal to foreign investors that Mexico was locking in the new liberalized rules of the game.

5. See Gallup, Gaviria, and Lora (2003) for an English summary of Esquivel's findings.

restrictions on tomatoes (Jalisco) and avocados (Michoacan) by 2008 should have a stimulative effect on nonborder areas with natural endowments.⁶ Both agricultural production and exports have made large gains in the post-NAFTA period.⁷

Further, nonborder regions may offer other low-cost means of transport to the United States than by road. Mexico's second and third largest airports are in Jalisco (center-south) and Yucatán (south). Air transport capacity, along with the high level of human capital and good governance, was important to Intel's locating a plant in south-of-Mexico Costa Rica.⁸ Yucatán benefits from the shallow-water port of Progreso, which offers easy access to U.S. ports in the Gulf of Mexico and to ports in Central and South America and the Caribbean. In 2003, Yucatán had the second highest concentration of *maquila* employment of a nonborder state—exceeded only by Jalisco. The port of Veracruz, the entry point to Mexico during its first period of globalization in the sixteenth century, remains Mexico's most important, with extensive road and rail networks that connect the central and southern states to Gulf of Mexico ports. Given this ready access to water transport, all other endowments being equal, a southern pole or a southeastern corridor enjoying the same benefits of proximity would seem as plausible as would the region's being left behind.

In fact, there is little evidence to date that the 1985 trade liberalization or NAFTA has led to a correlation of growth with proximity to the border. Hanson (1997) found no steepening of the north–south wage gradient after 1985. Using state per capita income data, Rodriguez-Pose and Sanchez-Reaza (2005) find no relationship in any time period—a result confirmed by the background regressions for this article.⁹ Esquivel (2000) finds no relationship between distance and level of income or growth. Chiquiar (2005) finds a relationship between changes in growth and distance, but that result appears to be limited to the span between 1970 and 1985 and 1985 and 1999 and does not survive when the period is broken into post-GAIT (1985–1993) and post-NAFTA (1993–2002).¹⁰

In sum, the geographic patterns of growth with liberalization are likely to be more complex than initially expected.

6. No attempt is made to be comprehensive here. The examples here are meant merely to show that these central and southern states cultivate these crops, some almost exclusively, and hence were likely to benefit from NAFTA.

7. See Lederman, Maloney, and Serven (2005) for a discussion of the resilience of Mexican agriculture.

8. Rodriguez-Clare (2001) notes that Costa Rica's better infrastructure in air transport gave it the edge over Chile.

9. Distance is never even remotely significant in a simple convergence regression for 1970–2002, 1970–85, and 1985–2002. When regional dummy variables are added, the results show that the Chiapas-Oaxaca-Guerrero region did unusually poorly relative to other regions in both 1970–85 and 1985–2002. The results are available from the authors on request.

10. Nicita's (2004) ex post simulations find gains in household welfare from trade liberalization to be distributed broadly along a gradient from the north. However, the core estimations driving the simulations, the pass-through of tariffs to prices, imposes a linear distance from the border interactive term that implies that the predicted values used in the simulations will show the same gradient pattern. To be convincing, the actual decline in prices in each state during liberalization should be used.

II. EXPLORING SPACE

Sigma and beta convergence approaches offer point estimates of the central tendency of the data toward convergence or divergence. However, as Quah (1993) notes, they obscure vast amounts of information on the dynamics of relative income movements across states and shed no light on the spatial dimensions of growth. As an example, simple plots of the distribution of income levels and growth rates (available on request) confirm Juan Ramon and Rivera-Batiz's (1996) findings of a concentration of both measures during 1970–80, consistent with parametric convergence test findings. However, from 1985 onwards, a prominent right tail appears in both income levels and growth rates, suggesting that a group of states has detached itself from the others.

Such snapshots of the distribution can be informative, but they hide important information—in particular, how to get from one snapshot to another. For example, are the outliers in the extreme right tails in plots of the growth distribution the same states that persistently show higher growth or is the distribution broadly symmetric over the longer term, with random states sometimes experiencing extraordinary growth? The first case would be consistent with the emergence of a spatial growth pole, while the second case would not.

A substantial literature has followed Quah's lead in constructing Markov transition matrices that tabulate the probabilities of states moving among a finite number of intervals of the national income distribution and hence characterize the dynamic patterns of relative income movements (Fingleton 1999; Lopez-Bazo and others 1999; Puga 1999; Rey 2001).¹¹ To avoid problems associated with creating arbitrary discrete divisions in the distribution of income (Bulli 2001), Quah (1997) proposes approximating a continuous distribution with the use of kernel density estimates. An advantage of both the transition matrices and the kernels is that they can be conditioned on state characteristics, including geographic location, to permit drawing inferences about the spatial dimensions of Mexico's growth process. Of interest is whether there is any evidence of "spatial correlation" or "spatial dependence," where either income levels or growth rates are correlated within geographic areas, and whether groups of states have emerged as either positive or negative growth poles.

Two sets of parametric tools are used to complement the visual analysis and facilitate statistical inference. First, as an approximate test of whether two kernels differ between time periods, the presence of a structural break is tested for in their discrete time analogues, with transition matrices capturing the movement of states among five income quintiles. Each i, j entry in the matrix represents the probability of a state transitioning from income class i to income

11. Employing these techniques for Mexico, García-Verdú (2005) again finds no evidence of convergence in the post-1985 period.

class j over a five-year period.¹² Following Bickenbach and Bode (2001), a Q -statistic is constructed to test for a structural break between the subperiods, both at the individual interval level and for the matrices as a whole:

$$(1) \quad Q_i = \sum_{j \in B_i} n_i \frac{(\hat{p}_{ij(1970-85)} - \hat{p}_{ij(1985-2002)})^2}{\hat{p}_{ij(1985-2002)}} \sim \chi^2(B_i - 1)$$

$$B_i = \{j : \hat{p}_{ij(1985-2002)} > 0\}$$

where \hat{p}_{ij} is the probability of a state moving from income interval i to income interval j . For the whole matrix the test is simply

$$(2) \quad Q = \sum_i Q_i.$$

Second, two parametric measures of spatial dependence are introduced: the global Moran and the local Moran. These are common in the spatial statistics literature but have only recently been applied to the study of economic growth (Rey 2001). The global Moran, Moran's I -statistic (Anselin 1988, 1995), is calculated for each period t as:

$$(3) \quad I_t = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{ij} z_i z_j}{S \sum_{i=1}^n z_i^2}, \forall t = 1, 2, \dots, T$$

where n is the number of states; the w_{ij} terms are the elements of a binary contiguity matrix¹³ $W(n \times n)$, taking the value 1 if states i and j share a common border and 0 if they do not; S is the sum of all the elements of W ; and z_i and z_j are normalized vectors of the log of per capita GDP of states i and j , respectively.¹⁴ Essentially, Moran's I aggregates the correlations between individual states and their spatial lags. Broadly speaking, in the same way that in time series econometrics a Durbin Watson test captures the comovement of contemporaneous residuals with those of neighboring (lagged) time periods, the Moran captures comovement with neighboring states (spatial lags). Statistical significance can be tested by comparing Moran's I -statistic with its theoretical mean and using a normal approximation.

12. The asymptotically unbiased and normally distributed maximum likelihood estimator of p_{ij} is determined by $\hat{p}_{ij} = n_{ij} / \sum_j n_{ij}$, where n_{ij} is the number of transitions from income class i to income class j over a period of time.

13. Distance-based matrices were also employed and gave similar results, available on request, to those presented here.

14. $z_i = \ln(\text{GDP}_{it} / \text{GDP}_t)$ denotes the logarithm of gross domestic product per capita of region i in period t (GDP_{it}), normalized by the sample mean of the same variable, GDP_t (De la Fuente 1997).

The global Moran may, however, conceal patterns of comovement in particular growth poles or convergence clubs, and it can be decomposed into the “local” Moran:

$$(4) \quad I_i = \frac{z_i \sum_j w_{ij} z_j}{\sum_j z_j^2 / n}$$

which indicates spatial clustering around a particular state i , either of positive or of negative correlation, when the statistic is significantly different from zero.¹⁵ In principle, the Moran will also identify the existence of comovements in states driven by the presence or intensification of a gradient, for instance, from the U.S. border.

III. DATA

The Mexican National Institute of Statistics, Geography, and Informatics (INEGI) tabulates official GDP data for Mexico’s 32 states. The data are available for 1970, 1975, 1980, 1985, 1988, and then annually for 1993–2002. As in Esquivel (1999), several corrections are made to this data. First, most oil is pumped in the states of Tabasco and Campeche, but the attribution of oil revenues has changed without obvious cause over time. Though the revenues are allocated to all states according to a federal sharing formula, in some years they were attributed entirely to Tabasco and in others to Campeche. To correct for this, oil production as captured in the mineral production category of the state accounts was excluded, but the resulting growth series was still too erratic and exaggerated to be credible.¹⁶ This behavior is attributed to unresolved petroleum accounting issues since growth series for the remaining 30 non-oil-producing states behave more reasonably. Though dropping these states clearly implies losing some of the spatial story, this seems preferable to contaminating the analysis with clearly unreliable series.

Second, population figures for Chiapas and Oaxaca were corrected for 1975, 1980, 1985, and 1988, because the 1980 census appears to have understated the states’ population-induced distortions in GDP per capita.¹⁷ Population figures for

15. Since the distribution of the statistic is usually unknown, Anselin (1995) suggests a Monte Carlo style method to generate it, consisting of the conditional randomization of the vector z_i . That is, Moran statistics are calculated between state i and a large number of hypothetical “neighborhoods” constructed as random permutations of states drawn from the entire sample. Then, the true neighborhood Moran is compared against this distribution.

16. Chiapas also produces modest amounts of oil, and this production was also subtracted from the state product series in 1975 and 1980.

17. According to official figures, mining production as a share of Chiapas’s GDP went from 7.5 percent in 1970 to 18 percent in 1975, to 45 percent in 1980, and back to 7 percent in 1985. Clearly, the 1975 and 1980 data reflect arbitrary assignments of oil production to Chiapas. These were corrected to bring the ratio of mining production to GDP to 7.5 percent for the outlier years.

those years were extrapolated using annual population growth rates between 1970 and 1990.

Finally, Mexico State was merged with the Federal District of Mexico City. The two have long been part of a common industrial aggregate, and there are strong labor market links between them.¹⁸ The analysis is run both with and without this aggregation, and while the fundamental story does not change, the more moderate growth behavior of the Federal District with the aggregated data appears more plausible, and hence those results are reported.

In sum, the analysis covers 29 states measured at five-year intervals with three observations before the unilateral trade liberalization of 1985 and three after (table 1, figure 1, and figure S.1 in the supplemental appendix, available at <http://wber.oxfordjournals.org>).¹⁹ The data indicate that regional differences in income in Mexico were vast in 2002: the GDP per capita of the poorest state, Oaxaca in the south, was only 23 percent of that of the richest state, Nuevo León in the north.

IV. IDENTIFYING REGIONS—COVARIANCE OF INCOME LEVELS

The analysis looks first at whether there has been any major reordering of income levels over time and whether there is any correlation across groups of neighboring states that would constitute a region or that would suggest emerging gradients. To see this, the stochastic kernel and its contour are plotted for levels of per capita income for 1970–85 and 1985–2002 (figures 2 and 3). Both plots show state income relative to average national income (“country relative”) in time t on the Y-axis and in time $t + 5$ on the X-axis. The same scale is used in both the pre- and post-liberalization periods to facilitate drawing inferences about changes in the variance of the kernels. The crosshairs depict the country average in period t and in $t + 5$. A couple of points merit highlighting.

First, if there were no change at all in the relative position of states, figures 2 and 3 would consist of a bisecting plane along the 45-degree line shown. The fact that states do shift their relative position gives the kernel its volume. Slicing the volume parallel to the X-axis reveals the distribution of states at each initial income level five years later. Again, the advantage over the simple distribution plots is the ability to see changes of position that might be hidden by identical snapshot distributions. Slicing parallel to the XY plane generates contour plots that show the relative probabilities of finding combinations of initial and final incomes. Second, significant income convergence would result in a rotation of

18. This may potentially lead to an overstatement of the capital city’s per capita income. This has led to reported population in the Mexico DF, remaining stable over the last twenty years, while the population in the state of Mexico doubled. Our thanks to Miguel Messmacher for this insight.

19. To keep to a five-year interval while also avoiding the 1995 crisis, which would have distorted the results, data for 1970, 1975, 1980, 1985, 1988, 1993, 1998, and 2002 were used in estimating the stochastic kernels and the transition matrices.

TABLE 1. Mexican 2002 GDP per Capita by State (1993 pesos)

Region and State (Abbreviation)	Population (in Thousands)	GDP (Millions of Pesos)	GDP per Capita	Standard Deviation/Mean
North			19,730	0.20
Baja California Norte (BC)	2,706	47,091	17,405	
Coahuila de Zaragoza (CO)	2,444	49,651	20,314	
Chihuahua (CU)	3,252	64,461	19,823	
Nuevo León (NL)	4,046	105,270	26,019	
Sonora (SO)	2,370	39,729	16,763	
Tamaulipas (TA)	2,990	45,124	15,094	
Central-north			11,333	0.28
Baja California Sur (BCs)	464	8,330	17,968	
Durango (DU)	1,536	18,953	12,341	
San Luis Potosí (SL)	2,373	25,656	10,811	
Sinaloa (SI)	2,697	30,628	11,356	
Zacatecas (ZA)	1,410	12,534	8,887	
Central			16,507	0.33
Aguascalientes (AG)	995	18,386	18,470	
Colima (CL)	569	8,119	14,263	
Guanajuato (GU)	4,942	55,583	11,246	
Hidalgo (HI)	2,330	20,364	8,741	
Jalisco (JA)	6,639	95,731	14,420	
Mexico and Federal District (MX)	22,796	482,133	21,150	
Michoacán (MI)	4,181	33,871	8,101	
Morelos (MO)	1,659	20,537	12,382	
Nayarit (NA)	977	8,333	8,527	
Querétaro (QU)	1,515	26,224	17,313	
South			7,761	0.18
Chiapas (CH)	4,232	26,307	6,216	
Guerrero (GE)	3,221	23,979	7,445	
Oaxaca (OA)	3,642	21,812	5,989	
Puebla (PU)	5,362	51,219	9,552	
Tlaxcala (TL)	1,022	8,011	7,841	
Veracruz (VC)	7,225	60,395	8,359	
Yucatán Peninsula			15,117	0.42
Quintana Roo (QI)	976	20,874	21,383	
Yucatán (YU)	1,737	20,142	11,596	
Not in sample				
Campeche (CA)	737	16,789	22,785	
Distrito Federal (DF)	8,813	327,009	37,107	
México (MX)	13,984	155,124	11,093	
Tabasco (TB)	1,996	17,050	8,542	
Total	103,040	1,483,284	14,395	0.40

Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

FIGURE 1. Map of Mexican States



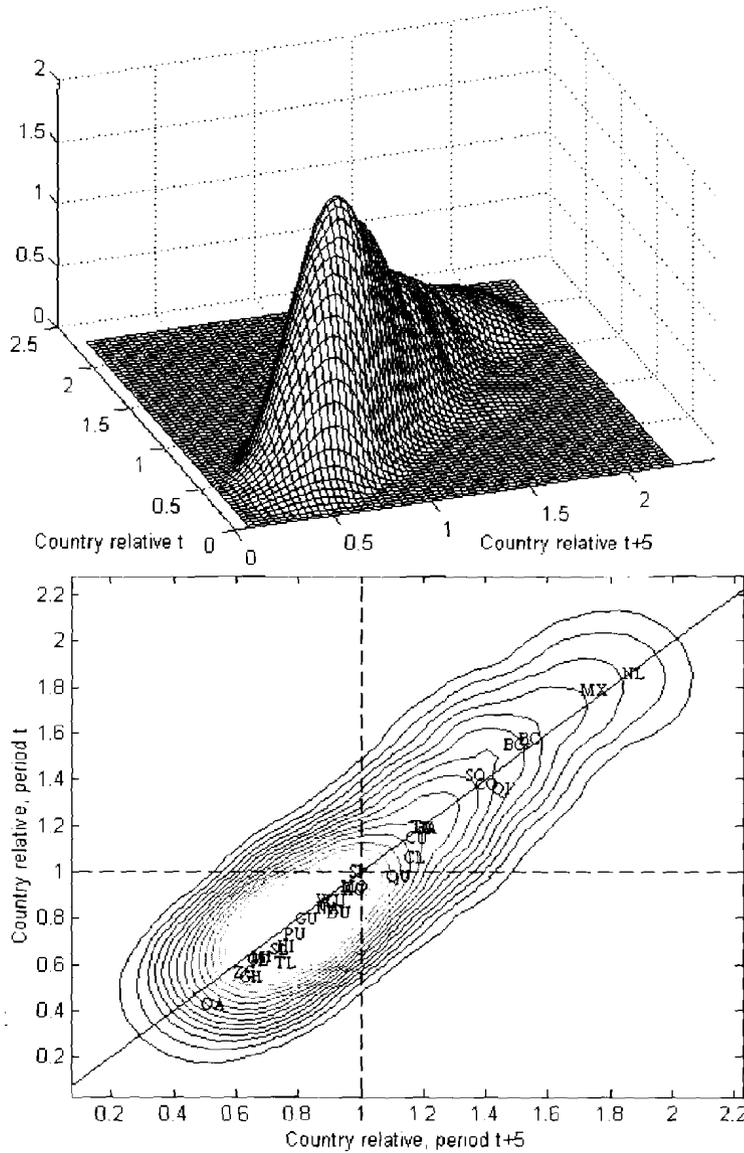
Source: Author's elaboration using ArcView from ESRI.

the kernel toward the Y-axis. States with lower incomes in t would have higher relative incomes in $t + 5$ and vice versa. Divergence would lead to the reverse.

For broad illustrative purposes, a state label is placed at the position corresponding to the average value for each state. This reference is only approximate since the kernel is estimated at three time points for each state, but given the revealed persistence in relative income levels, these reference points are informative.

Indeed, the high persistence in the distribution is the most salient feature of both figures. The probability mass is concentrated mainly in the diagonal of the plot, showing that states did not significantly change their relative position. Though the persistence is clear, striking differences emerge between the pre- and post-liberalization kernels. The single-peaked kernel in figure 2 has become a double- or even triple-peaked kernel, suggesting the formation of convergence clubs after 1985. Several forces drive this evolution. First, the bottom end of the distribution has become more compressed at around 0.70 of national average income, suggesting convergence toward the mean for the very poorest states. Second, above-average states converged towards 1.3 of the national average, depopulating the center of the distribution. Finally, income in the states of Mexico, Nuevo León, and Quintana Roo grew enough for the states to have formed the last peak of the distribution, with incomes above 1.7 of the national average. Another evolution, important to the finding of reduced beta convergence, is that poor states moved from below the 45-degree line in the

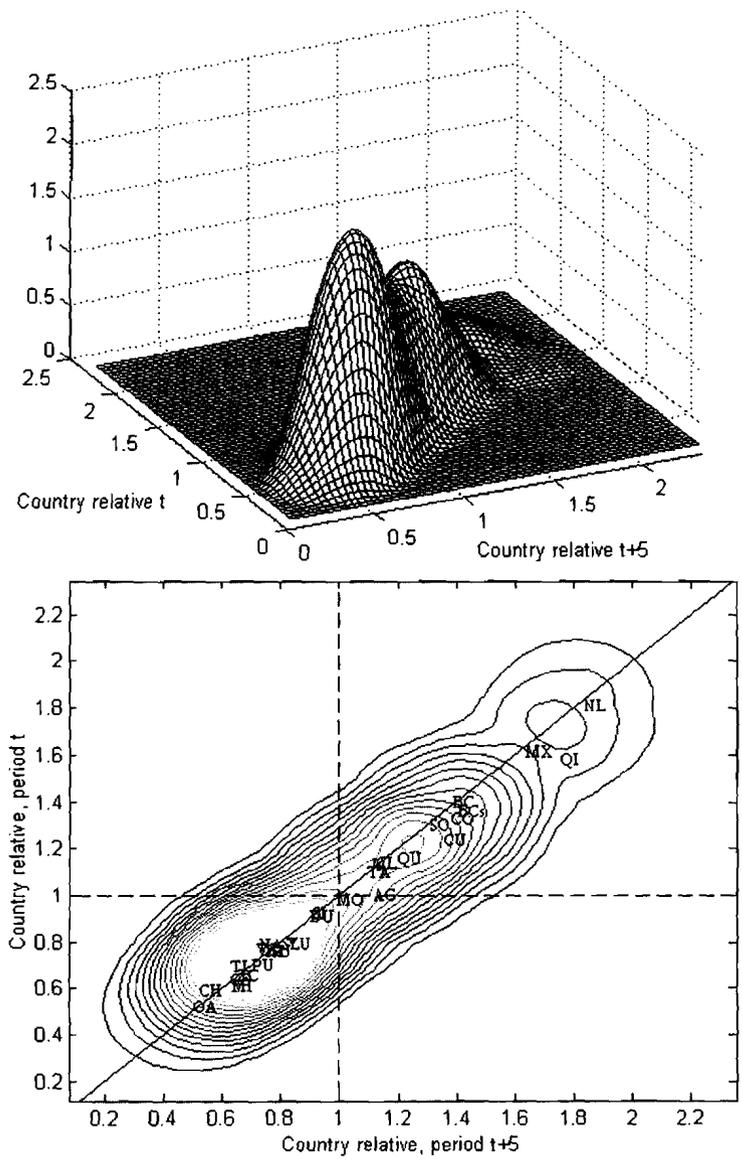
FIGURE 2. Unconditioned Kernel Density Plots, Levels, 1970–85 (State Income Relative to National Average Income)



Note: See table 1 for state abbreviations.

Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

FIGURE 3. Unconditioned Kernel Density Plots, Levels, 1985–2002 (State Income Relative to National Average Income)



Note: See table 1 for state abbreviations.
Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

pre-liberalization period to on or above it in the post-liberalization period. This suggests reduced upward mobility of the poorest states in the post-liberalization period.

The discrete transition matrices confirm the continuous kernel story. The persistence of income rankings is suggested by the high probabilities of remaining in the same interval tabulated along the main diagonal of the matrix (table 2). The Q -statistics suggest that the pre- and post-liberalization matrices are statistically different from each other at the 1 percent level, and a large part of the reason appears to be the changes in the dynamics of the poorer states suggested above. For instance, the probability of a state in interval 1 being in that same

TABLE 2. Transition Matrices, 1970–2002

1970–2002						
Number		1	2	3	4	5
35	1	0.86	0.14	0.00	0.00	0.00
35	2	0.17	0.69	0.14	0.00	0.00
35	3	0.00	0.14	0.77	0.09	0.00
35	4	0.00	0.00	0.03	0.80	0.17
34	5	0.00	0.00	0.00	0.18	0.82
1970–85						
Number		1	2	3	4	5
20	1	0.80	0.20	0.00	0.00	0.00
14	2	0.07	0.64	0.29	0.00	0.00
21	3	0.00	0.14	0.76	0.10	0.00
13	4	0.00	0.00	0.00	0.92	0.08
19	5	0.00	0.00	0.00	0.21	0.79
1985–2002						
Number		1	2	3	4	5
15	1	0.93	0.07	0.00	0.00	0.00
21	2	0.28	0.66	0.05	0.00	0.00
14	3	0.00	0.14	0.79	0.07	0.00
22	4	0.00	0.00	0.09	0.63	0.27
15	5	0.00	0.00	0.00	0.07	0.93
			Degrees of freedom	Q-statistic	p-value	
Ho: $\hat{p}_{ij}(1985-2002) = \hat{p}_{ij}(1970-85) i = 1$		1		5.71	0.02	
Ho: $\hat{p}_{ij}(1985-2002) = \hat{p}_{ij}(1970-85) i = 2$		2		18.92	0.00	
Ho: $\hat{p}_{ij}(1985-2002) = \hat{p}_{ij}(1970-85) i = 3$		2		0.18	0.91	
Ho: $\hat{p}_{ij}(1985-2002) = \hat{p}_{ij}(1970-85) i = 4$		2		4.68	0.09	
Ho: $\hat{p}_{ij}(1985-2002) = \hat{p}_{ij}(1970-85) i = 5$		1		6.31	0.01	
Ho: $\hat{p}_{ij}(1985-2002) = \hat{p}_{ij}(1970-85) \forall i$		8		35.83	0.00	

Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

interval five years later was 80 percent before 1985 and 93 percent after 1985. States in quintile one and two were able to move upward in the distribution with probability 7 and 5 percent in the post-liberalization period compared with 20 and 29 percent in the pre-liberalization period, suggesting that the increased sigma dispersion was caused partially by stagnation in the poorer states.

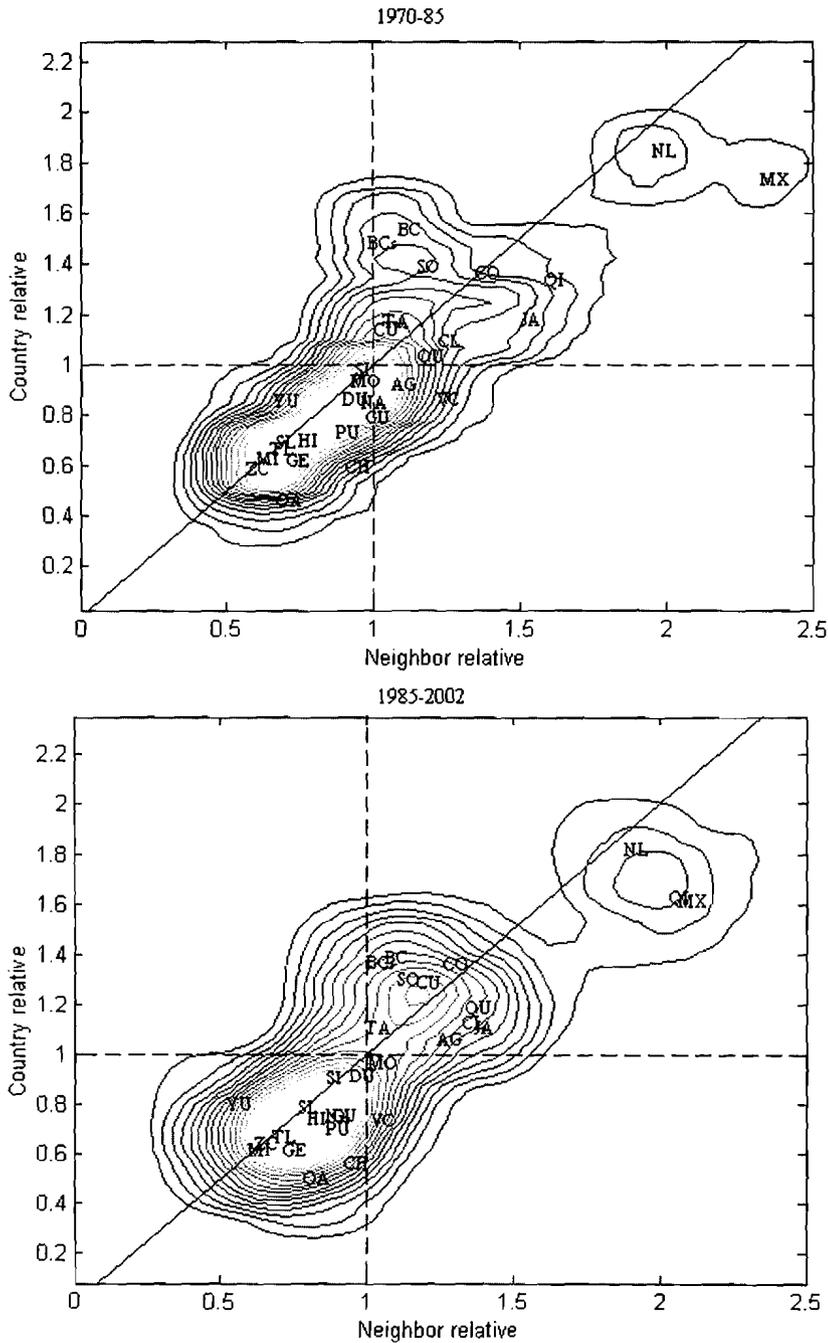
The Spatial Dimension

The next question is whether these convergence clubs translate into geographic "regions" as well. Quah (1997) identified a similar "twin peaks" phenomenon in the kernel derived from an international cross-section of per capita incomes and found it to be geographically driven—regional clusters of poor countries were getting poorer, while rich country agglomerations were getting richer. To see whether similar geographic patterns are emerging in Mexico, the kernels were regenerated, replacing $t+5$ with the income of the state relative to the average income of its contiguous neighbors ("neighbor relative") in time t (figure 4). If the local and economy-wide distributions of income are similar—if there are no clusters of states with similar incomes—probabilities would be concentrated along the main diagonal. If, however, poor states are found with poor states and rich with rich, there should be a rotation toward a vertical line at unity—a country-relative poor state will have the same income as that of its neighborhood.

Several points merit notice in the spatially conditioned kernel density plots. First, geography is not destiny in Mexico to the degree that it appears to be globally. Had the income clusters identified previously been totally determined by geography, the three observed peaks would have been vertically aligned at unity on the Y-axis. However, the post-liberalization spatially conditioned kernel density plot of figure 4 is fairly similar to the multiple-peaked unconditional kernel of figure 3, and there is a large group of states (including Michoacan, Nuevo León, Tlaxacala, and Zacatecas) whose mass lies largely on the 45-degree line. In the post-liberalization period, the intermediate peak consists mainly of the northern states of Baja California Norte, Baja California Sur, Coahila, and some successful central states such as Aguascalientes, Jalisco, and Queretaro (recently arrived) which show a negative spatial correlation with neighbors. Mexico and Quintana Roo, driven by Cancun-related tourism, similarly constitute unusually high-income areas, with Quintana Roo joining Nuevo León and Mexico as especially rich states in the third cluster identified in figure 3. Even after liberalization, the richest states could not be more independent spatially, since they are in three different regions of the country. There is no sign of Quah's (1997) dramatic convergence clubs of rich and poor states.

There is evidence, however, of spatial dependence that would suggest regional effects. Before 1985, there was some rotation and compression of the upper mass that suggests that, particularly among the northern states of Baja California Norte, Baja California Sur, Chihuahua, and Tamaulipas, there is a nascent convergence club in incomes. However, as the border convergence club

FIGURE 4. Kernel Density Plots, Levels, Conditional on Spatial Lag, Neighbors, 1970-85 and 1985-2002



Note: See table 1 for state abbreviations.
 Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

TABLE 3. Classification of Mexican States by Geographic Bands and Distance from the U.S. Border

Geographic Band	Distance From U.S. Border (Kilometers)
<i>Border</i>	0–350
Baja California Norte, Chihuahua, Coahuila de Zaragoza, Nuevo León, Sonora, Tamaulipas	Baja California Norte, Chihuahua, Coahuila, Nuevo León, Sonora, Tamaulipas
<i>North</i>	351–870
Baja California Sur, Durango, San Luis Potosí, Sinaloa, Zacatecas	Aguascalientes, Durango, Guanajuato, Querétaro, San Luis Potosí, Zacatecas
<i>Center</i>	871–1,130
Aguascalientes, Colima, Guanajuato, Hidalgo, Jalisco, Mexico/Federal District, Michoacán, Morelos, Nayarit, Querétaro	Hidalgo, Jalisco, Mexico/Federal District, Michoacán, Morelos, Sinaloa
<i>South</i>	1,131–1,416
Chiapas, Guerrero, Oaxaca, Puebla, Tlaxcala, Veracruz	Colima, Guerrero, Nayarit, Puebla, Tlaxcala, Veracruz
<i>Yucatán Peninsula</i>	>1416
Quintana Roo, Yucatán	Baja California Sur, Chiapas, Oaxaca, Quintana Roo, Yucatán

Source: Authors' compilation.

strengthened, the second line of states did not follow, and hence there is no strong rotation of the northern part of the country broadly imagined toward the Y-axis. Durango, San Luis Potosi, Sinaloa, and Zacatecas, all contiguous to the border states, are relatively poor and lie largely on the 45-degree line. There is also a group of poor southern states—Chiapas, Guerrero, Oaxaca, Puebla, and Veracruz—that is found to be better-off relative to their neighbors than relative to the country. For example, Chiapas's income is around 50 percent of the national average, but it is as rich as its neighbors (a neighbor's relative income of roughly unity). These results suggest that there may be aggregations, which might be called "border" and "southern" regions, which can be tested for statistically.

Also of interest is how proximity to the United States may affect states in a common way, even if they are not contiguous. Thus, two additional definitions of neighborhood are introduced to the kernel analysis. The first is based on traditional geographic bands and is similar to the categories used by Hanson (2004).²⁰ The second definition establishes five categories based on distance by land to the United States, the specification most likely to turn up evidence of a gradient, as discussed by Hanson (1997). The states associated with each neighborhood for the two classifications are shown in table 3.

20. The categorization here differs from that of Hanson by the inclusion of Aguascalientes with the central states and Puebla, Tlaxcala, and Veracruz with the south. However, when the calculations are run using Hanson's classification, the results are almost identical.

The contour plots pre- and post-liberalization, spatially conditioned by distance from the United States using the bands-defined neighborhood, reveal a strengthened border cluster (figure S.2). This arises because the new neighborhood of the border states does not include the relatively poorer second-line states the way the contiguity matrix does. This is especially clear in the post-liberalization plot, which shows Baja California Norte, Chihuahua, Coahuila de Zaragoza, and Sonora all piled on the vertical axis. Nuevo León remains by itself.

Second, there also seems to be a prominent clustering of the southern states of Chiapas, Guerrero, Oaxaca, Tlaxcala, and Veracruz, which becomes clearer in the second period as Chiapas, Guerrero, Oaxaca, and Veracruz all move closer to the vertical line at 1 on the X-axis. This causes an extension of the kernel toward the vertical that suggests convergence in income. The kernel using distance from the United States (data not shown) is similar to that using the bands, but the results are less clearly delineated. This arises mainly because the south is split into two, leaving the poor states of Chiapas and Oaxaca associated with the far richer states of Baja California Sur, Quintana Roo, and Yucatán.

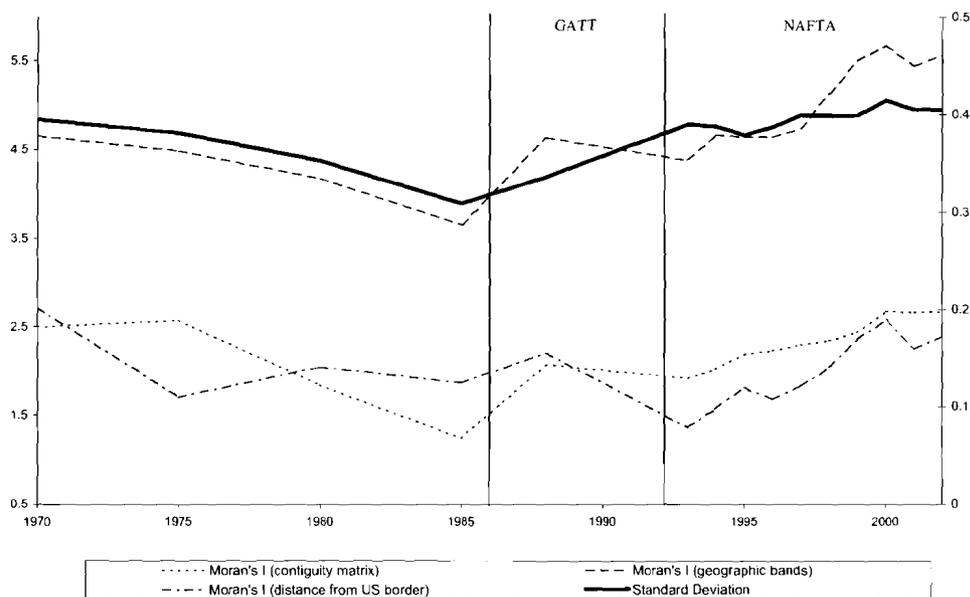
In sum, the convergence clubs suggested in figures 2 and 3 partially map onto border and southern regions of Mexico. However, there are no other obvious patterns of spatial association or clustering in the rest of the country. For all three definitions of neighborhood, northern and central states align mostly along the 45-degree line, showing little spatial dependence.

Parametric Measures of Spatial Dependence

Moran statistics are used to establish whether the patterns suggested by the spatially conditioned kernels are statistically significant. Moran's *I* normal standardized values for 1970–2002 are plotted for the three definitions of neighborhood along with the standard deviation of GDP per capita for the same period as a measure of sigma convergence. It is immediately clear that for Mexico as a whole spatial dependence in income levels has increased along with the sigma divergence after a period when both had fallen (figure 5). The contiguity-based neighborhoods most closely track the standard deviation (with a correlation coefficient of 0.85), but the other neighborhoods also follow a similar pattern, albeit less clearly. The subtle indications of spatial dependence suggested in the kernels emerge as statistically significant in the Moran test, most notably, and consistent with the kernels above, in the band measure that most clearly captures the border and southern concentrations of wealth and poverty.

The local Moran statistics largely confirm the observations from the kernels.²¹ The local Moran statistics are presented in several formats. First, maps show the geographic distribution of significant local Moran statistics based on

21. Local Moran coefficients have also been calculated for the bands and distance matrices at five-year intervals, showing high correlations with the ones obtained using the contiguity criteria. Although results are not reported for the sake of brevity, we note any difference arising from the three different neighborhood definitions.

FIGURE 5. Global Moran I (Levels) and Standard Deviation, 1970–2002

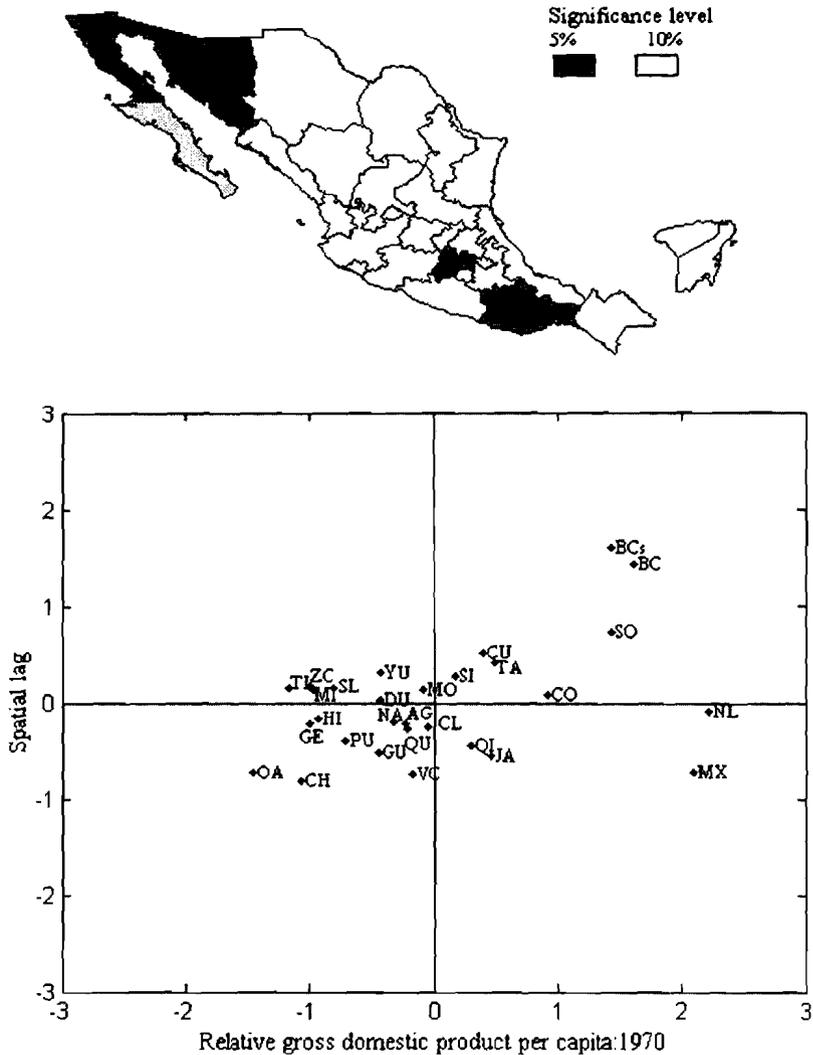
Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

contiguity for the 10 and 5 percent levels for 1970 and 2002, the endpoints of the sample (figures 6 and 7). Second, the Moran scatterplots accompanying the maps graph the level of income of the state against that of its spatial lag for the same period to illuminate the relations captured by the statistics. A significant positive slope suggests that rich states are found in convergence clusters with other rich states (quadrant 1) and poor states with other poor states (quadrant 3). Quadrants 2 and 4 represent cases where rich states are found among poor states, or poor states among rich states. More details are provided in table 4, which shows significance levels and signs of the Moran statistics at five-year intervals across the sample for all three definitions of neighborhood. Three main findings emerge.

First, in the early period, the analysis confirms a cluster of poor states around Chiapas, Guerrero, Oaxaca, and Puebla, corresponding to the traditional southern states. This cluster appears strongly in the maps and in quadrant 3 of the scatter plots, and table 4 suggests that this relationship has been getting stronger across time for all definitions of neighborhood.

Second, for geographic bands and distance, the border states considered as a block clearly stand as a pole of high-income levels that has become stronger with time. However, the lack of any significance when the connectivity measure is used confirms that the income levels of the second-line states are not correlated with those of the border states, and hence it may not be useful to talk about the "north" more generally. Baja California Norte, Baja California Sur, and

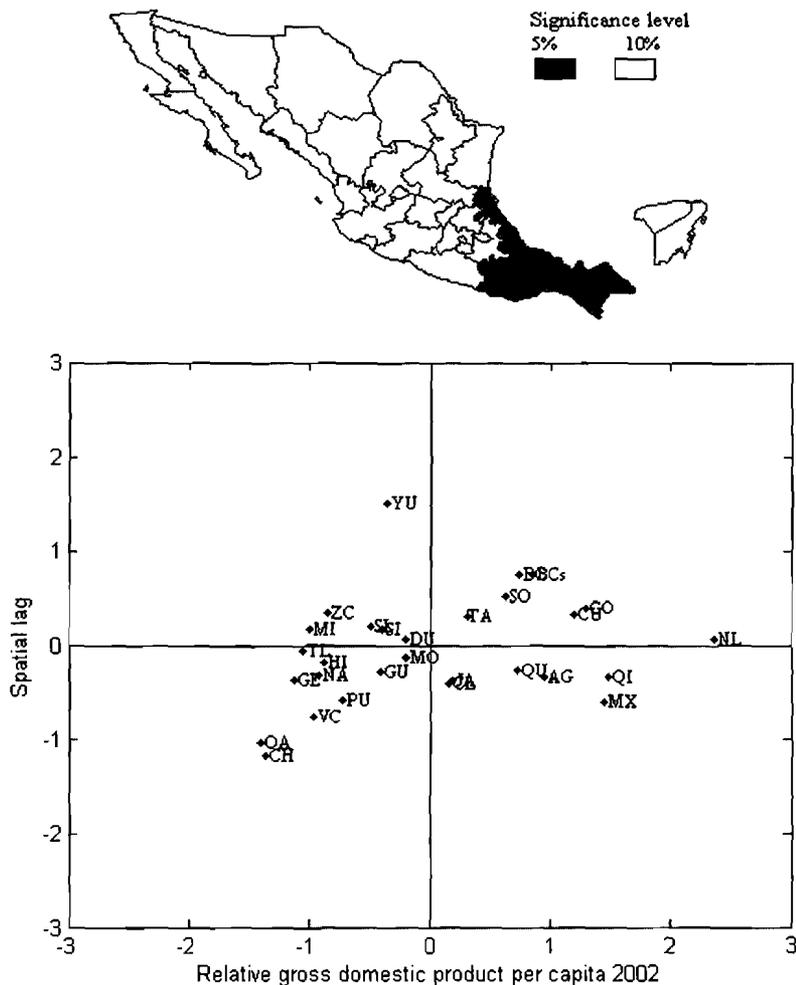
FIGURE 6. Significance of Local Moran for 1970 GDP per Capita—Map and Moran Scatterplot



Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

Sonora appear in quadrant 1 of the scatter plots as well-off states in better-off neighborhoods and so might be seen as a well-off convergence cluster located in the north of the country along the U.S. border. However, these correlations seem to slowly disappear by the beginning of the 1990s and the “north,” as a spatial unity encompassing more than just the border states, disappears. The higher income of the frontline states has not spilled over much to the second line.

FIGURE 7. Significance of Local Moran for 2002 GDP per Capita—Map and Moran Scatterplot



Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

In the center, there is little evidence of convergence clusters, consistent with the findings of the kernel plots. Most of the central states are located in quadrants 2 and 4, almost suggesting a downward sloping line (if the outliers are ignored) and a tendency for rich states to be found among poor and poor among rich. The greater variance in income per capita in this region (table 1) underlies the finding of a lack of spatial dependence: poor states such as Hidalgo, Michoacan, Nayarit, and Zacatecas and rich states such as Aguascalientes, Mexico/Federal District, and Queretao share the same neighborhood. Consequently, no significant Moran statistics are found in this area for any period,

TABLE 4. Local Moran, Levels

State	1970			1975			1980			1985			1993			2002		
	C	B	D	C	B	D	C	B	D	C	B	D	C	B	D	C	B	D
<i>Border</i>																		
Baja California Norte	++	++	++	++	++	++	++	++	++	+	++	++		++	++		++	++
Chihuahua		+	+		+	+						+		++	++		++	++
Coahuila de Zaragoza		++	++		++	++		++	++		++	++		++	++		++	++
Nuevo León		++	++		++	++		++	++		++	++		++	++		++	++
Sonora	++	++	++		++	++		++	++		++	++		++	++		++	++
Tamaulipas		++	++		++	++		++	++		++	++		++	++		++	++
<i>North</i>																		
Baja California Sur	++		-					+										
Durango			+			++					+							
San Luis Potosi																		
Sinaloa																		
Zacatecas																		
<i>Center</i>																		
Aguascalientes																		
Colima																		--
Guanajuato																		
Hidalgo																		
Jalisco																		--
Mexico/Federal District	--																	
Michoacan de Ocampo																		--
Morelos																		
Nayarit																		
Queretaro de Arteaga																		++

(Continued)

TABLE 4. Continued

State	1970				1975				1980				1985				1993				2002			
	C	B	D		C	B	D		C	B	D		C	B	D		C	B	D		C	B	D	
<i>South</i>																								
Chiapas		++			+	++			++				+	++			++				++			++
Guerrero		++			++	++			++				+	++			++				++			++
Oaxaca	++	++			++	++		++	++				++	++			++				++			++
Puebla	++	++			++	++			++				+	++			++				++			++
Tlaxcala	++	++			++	++			++				+	++			++				++			++
Veracruz-Llave																								
Yucatán Peninsula																								
Yucatán																								
Quintana Roo																								

Note: C, contiguity matrix; B, geographic band; D, distance from U.S. border.

Source: Authors' analysis based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

with the exception of the negative values associated with Jalisco and Mexico/Federal District, indicating that these two are well-off states surrounded by poor neighbors. At this point, these results suggest that the Mexico/Federal District agglomeration has not pulled its neighbors along with it in any consistent fashion.

In sum, both the kernel plots and the parametric measures suggest that, as a region with some degree of commonality of levels of income, the south exists, the north seems to be restricted to states directly on the U.S. border, and there is little evidence of a center. The absence of a clearly defined center group of states is perhaps unexpected if their performance were heavily influenced by the existence of north–south and Mexico City gradients. Their interaction might give rise to more complex income relations than, for instance, are seen on the border, but it is not obvious why an almost random distribution of rich and poor states should appear.²²

V. IS THERE ANY LINK BETWEEN GEOGRAPHIC EVOLUTION AND DIVERGENCE?

The next question is whether thinking of these groups as regions helps to explain the pattern of economic divergence or whether the comovement of the global Moran and the standard deviation are unrelated. Clearly, the post-liberalization divergence is driven by many forces, and disentangling them is complex. For instance, both Aguascalientes and Quintana Roo pulled away strongly from their local neighborhood, which would lead to greater divergence, while Mexico appeared to become less of an outlier in its neighborhood, which would lead to greater convergence.

Applying techniques developed for subgroup decomposition of inequality developed by Shorrocks and Wan (2005) provides a more systematic, although still imperfect way of seeing how much of the increased dispersion has a geographic component. This can be done using the mean logarithm deviation index given by:

$$(5) \quad E_0(y) = \frac{1}{n} \sum_i \ln \frac{\mu}{y_i}$$

where n is the number of states, y_i the income per capita of state i , and μ is the mean income of the country. This involves simply partitioning the sample into a set of geographic regions and calculating the two components of aggregate

22. These findings are somewhat at odds with Hanson's previous work arguing for the existence of gradients descending from Mexico City and the border, and we can think of perhaps two reasons why. First, he worked with wages which may be more equilibrated by migration flows than aggregate per capita income may be over the medium term. That said, again it is worth reemphasizing that he also found no increasing north–south gradient after trade liberalization. Second, it may be that his imposition of a linear relationship with distance from the border or Mexico City obscures the heterogeneity in the state data that is more easily detected by the kinds of techniques employed here.

inequality: a within-group component, which is a weighted average of regional inequality, and a between-group component, which captures the inequality due to variations in average incomes across regions. The states are grouped according to the geographic bands division.

Several points merit attention when the evolution of overall inequality and of between-group and within-group components is plotted together with the ratio of between-group to total inequality (figure S.3). First, the mean logarithmic deviation basically retrieves the same pattern of evolution of inequality as the standard deviation in figure 5. Second, most of the increase in inequality (94 percent) between 1985 and 2002 occurs during 1985–93, prior to NAFTA. Both the between-group and the within-group component grew in this period, suggesting that although 60 percent of the increase in dispersion was interregional, much of the increase occurred within regions. Third, the 1994–2002 period was relatively stable in terms of inequality. However, differences across regions increased at a time when within-group inequality was decreasing. Overall, between-group inequality can explain 72 percent of the increase in total inequality from 1985 to 2002, with much of this inequality explained by regional level movements between border, south, and rest (table 5). If the sample is divided into three regions (border, south, and rest), between-group inequality explains 66 percent. Again, this suggests a dominant role for the poor performance of the south in explaining the divergence across the period.

VI. GROWTH

Additional information on what may be driving dispersion can be gleaned from the evolution of the spatial distribution of growth rates. An analogous, if somewhat simplified, set of exercises can identify regional patterns of comovement in growth (see appendix at the end of this article for definitions).

When the kernels are rerun with all possible definitions of neighborhood, they fail to reveal any significant visual regularities. Unconditional kernels show that the mass of probabilities seems to occupy the four quadrants more or less equally (figure 8): a state that grows fast today is as likely to grow slowly tomorrow as to continue to grow fast. This is not so surprising when it is remembered that in the pre-liberalization period many of the northern states had alternating high- and low-growth rates as a result of the 1982 debt crisis, which hit the most dynamic states the hardest. Something similar seems to have occurred at the end of the 1990s. The distribution shows greater variance in the post-liberalization period but still does not show strong persistence in growth rates. Conditioning on the different neighborhoods suggests little in the way of growth convergence clusters (figure 9). In every case, the central mass is fairly tightly aligned along the 45-degree reference, which suggests that states growing fast relative to the country also tend to grow fast relative to their neighbors.

TABLE 5. Between- and Within-Group Inequality

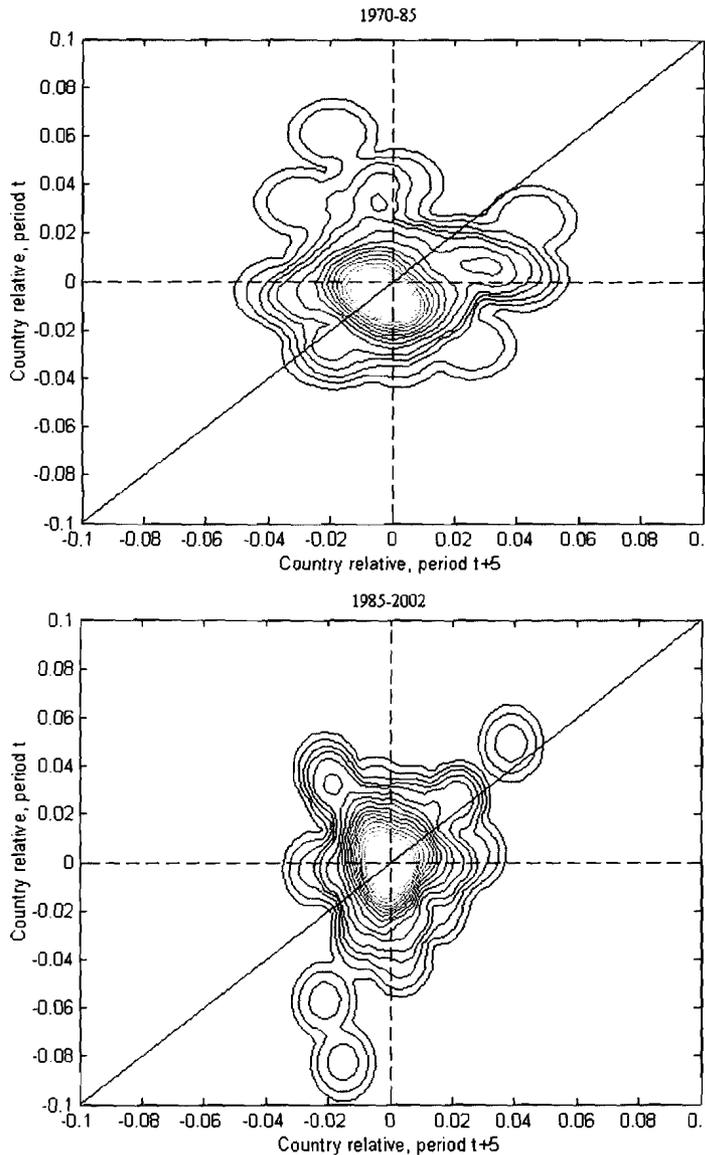
Year	Total Inequality	Between Group	Within Group	Ratio of Between-Group to Total Inequality (Percent)	Contribution to Change in Inequality (Percent)	
					Between Group	Within Group
1970	0.078	0.038	0.040	49		
1985	0.045	0.021	0.024	47		
1993	0.073	0.038	0.035	52		
2002	0.075	0.043	0.032	57		
All regions						
1970–85					50	50
1985–2002					72	28
Border-south-rest classification						
1970–85					50	50
1985–2002					66	34

The overall Moran's *I*-statistic using connectivity and the geographic bands suggests a degree of spatial dependence in the pre-liberalization period, but over time this dependence has decayed: there has been a despatialization of growth rates in Mexico (figure 10). For the distance from the U.S. neighborhood measure, however, no spatial dependence is apparent until the 1994–2002 period, coinciding with NAFTA.

The local Morans at first seem to suggest that spatial growth patterns are dominated by the north–south dichotomy (table 6). During 1970–85, all measures suggest positive comovements among border states in the third quadrant of low-growth states among low-growth states, but no other clusters (figure S.4). This border cluster disappears in the post-liberalization period, but Chiapas, Guerrero, Oaxaca, Tlaxcala, and Veracruz replicate its behavior in the post-liberalization period: low-growth states among low-growth states (figure S.5). Additionally, the connectivity-based Moran suggests that the Mexico/Federal District aggregation significantly underperforms in the early period, a time when its neighborhood was doing much better. These findings are consistent with the income convergence observed before liberalization and the divergence observed after. What is striking, however, is that for none of the definitions of neighborhood do the local Morans suggest a northern pole of growth in the post-liberalization period as a whole (see table 6, column 2). Instead, the local Morans suggest that there is mild evidence of a central cluster of high growth in the states of Aguascalientes and Guanajuato.

Dividing the post-liberalization period into post-GATT and post-NAFTA subperiods yields consistent but stronger results (figures 11 and 12). Since the only evidence of spatial dependence in the post-liberalization period comes in the exercise using neighborhood defined as the distance from the United States, the

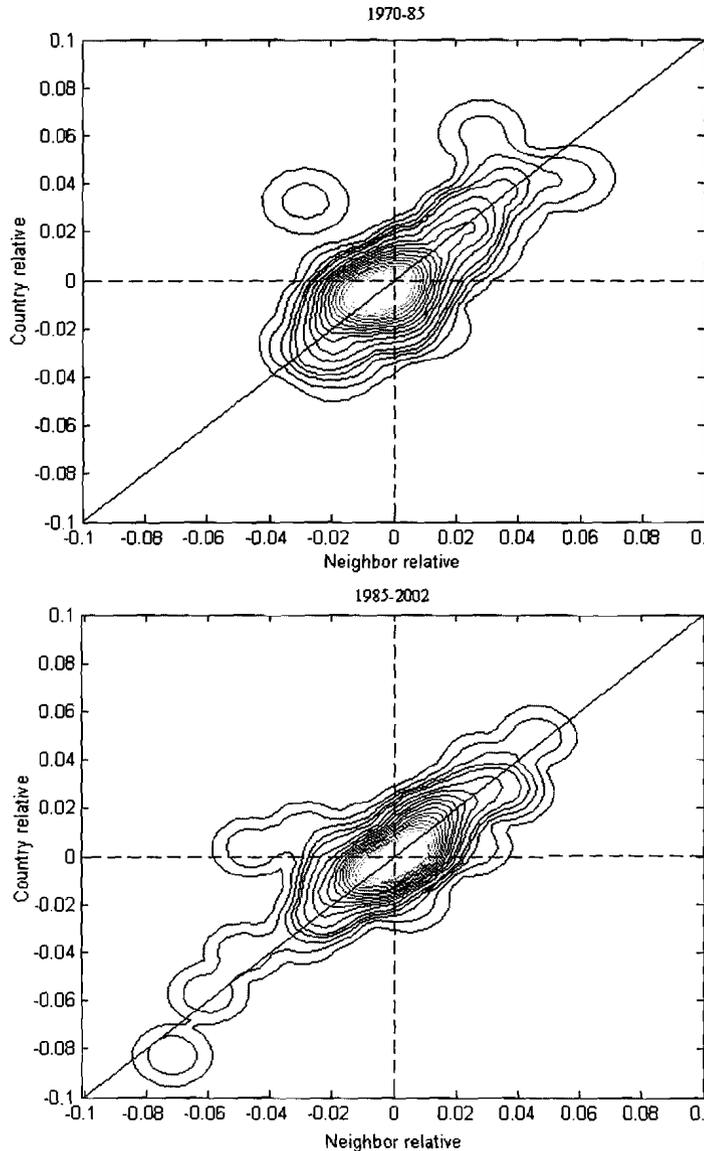
FIGURE 8. Unconditioned Kernel Density Plots, Growth, 1970–85 and 1985–2002



Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

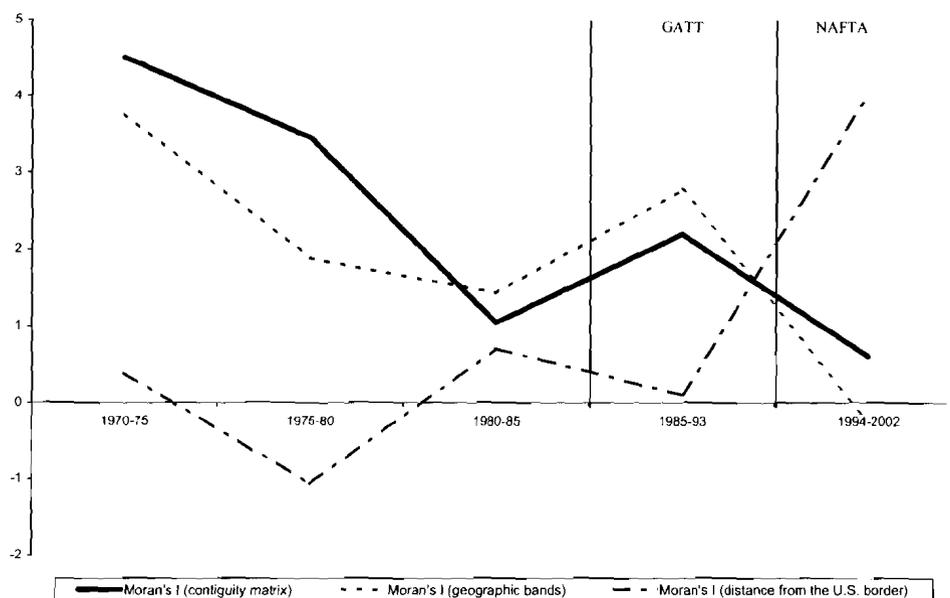
Moran scatterplots are calculated using this measure of neighborhood. During 1985–93, the only major development is the extremely poor performance of southern states, especially Chiapas, Tlaxacla, and Veracruz. Although some southern states such as Puebla were growing faster than average, other poor

FIGURE 9. Kernel Density Plots, Growth, Conditional on Spatial Lag, Neighbors, 1970–85 and 1985–2002



Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

central and northern states like Hidalgo, Nayarit, and Zacatecas performed below average, while rich states such as Aguascalientes, Chihuahua, and Quintana Roo grew steadily. These tendencies are consistent with increased income dispersion over this period, but they make clear geographic generalization

FIGURE 10. Global Moran I , Growth Rates

Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

difficult. Neither the north as a whole nor the border area constitutes a pole of comoving states driving divergence.

The 1994–2002 period is also characterized by increasing but less dramatic divergence. However, again the border states do not seem to constitute a growth pole. Chihuahua, Coahuila de Zaragoza, and Nuevo León perform above average, and Coahuila and Nuevo León commove significantly. But Baja California Norte grows at below-average rates and Sonora and Tamaulipas at average rates. Clearly, this above-average performance by rich states while poor states grow at below-average rates will contribute to divergence. But, it is not the case that the border states as a group grew in a common way or dramatically outperformed the rest of the country.

A clear growth pole does emerge among the second-line and central states of Aguascalientes, Guanajuato, Queretaro, and Zacatecas (see table 6, figure 12). Since these states are roughly equidistant from the border, this, not the comovement of the border states, is what drives the significant distance-based Moran I in this period. Since most of these states are relatively rich, their success suggests a potentially important dynamic outside of the border-south dynamic discussed above. The south as a whole still underperforms, especially Guerrero, although the southern block seems less coordinated than when the entire post-liberalization period is considered.

In sum, it seems difficult to argue that a special reaction to NAFTA of the states closest to the border was the driving force behind divergence. The consistently poor performance of the south, which does form a regional cluster, emerges as a central element in the story.

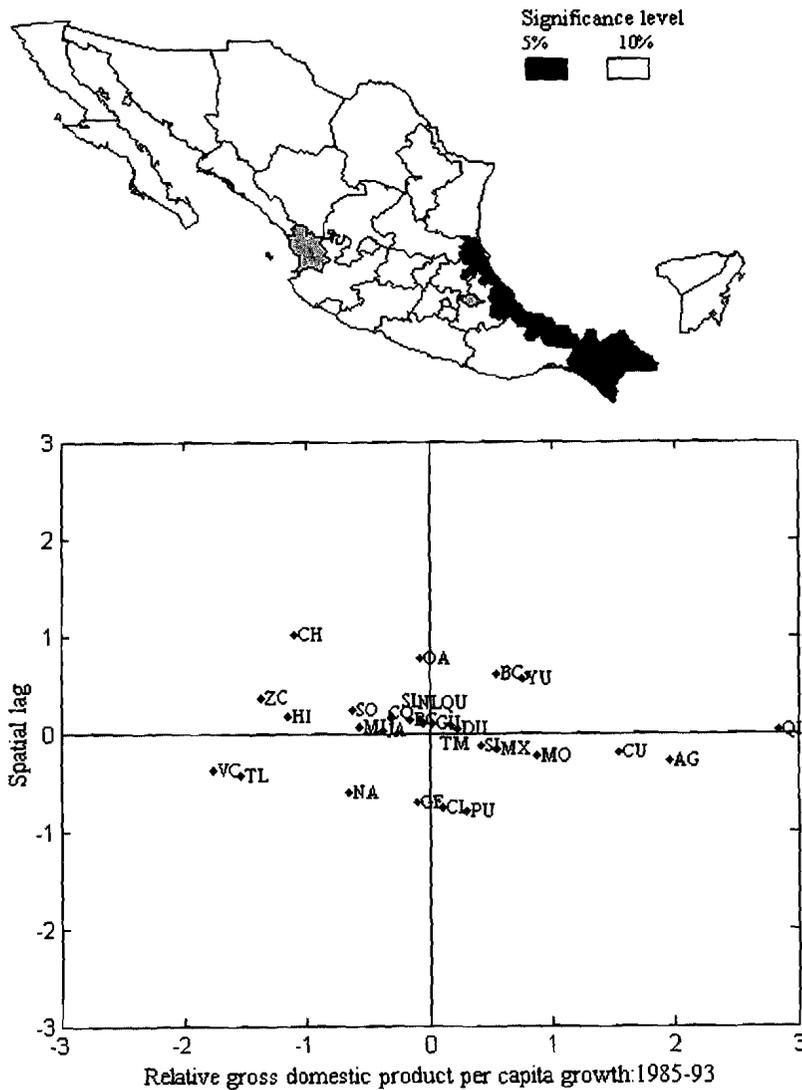
TABLE 6. Local Moran, Growth Rates

State	1970-85			1985-2002			1985-93			1994-2002			
	C	B	D	C	B	D	C	B	D	C	B	D	
<i>Border</i>													
Baja California Norte	++		++										
Chihuahua													
Coahuila de Zaragoza			+	+							+		
Nuevo León		++	++								+	+	+
Sonora	++	++	++										
Tamaulipas		++	++										
<i>North</i>													
Baja California Sur	+		-										
Durango												++	
San Luis Potosi												+	
Sinaloa													
Zacatecas											++	++	
<i>Center</i>													
Aguascalientes							+					++	
Colima													
Guanajuato							+				++	++	
Hidalgo													
Jalisco													
Mexico/Federal District	- -												
Michoacan de Ocampo													
Morelos												- +	
Nayarit						- ++			+				
Queretaro de Arteaga												++	
<i>South</i>													
Chiapas				++	++			++	- -				
Guerrero					++	+					++	+	+
Oaxaca		++		+	++								
Puebla									+				
Tlaxcala		+			++	++		++	+				
Veracruz-Llave	-	- -		++	++	++	++	++	++				
Yucatán Peninsula													
Yucatán								+					
Quintana Roo													

Note: C, contiguity matrix; B, geographic band; D, distance from U.S. border.

Source: Authors' analysis based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

FIGURE 11. Significance of Local Moran for Growth of GDP per Capita, 1985-93: Map and Moran Scatterplot



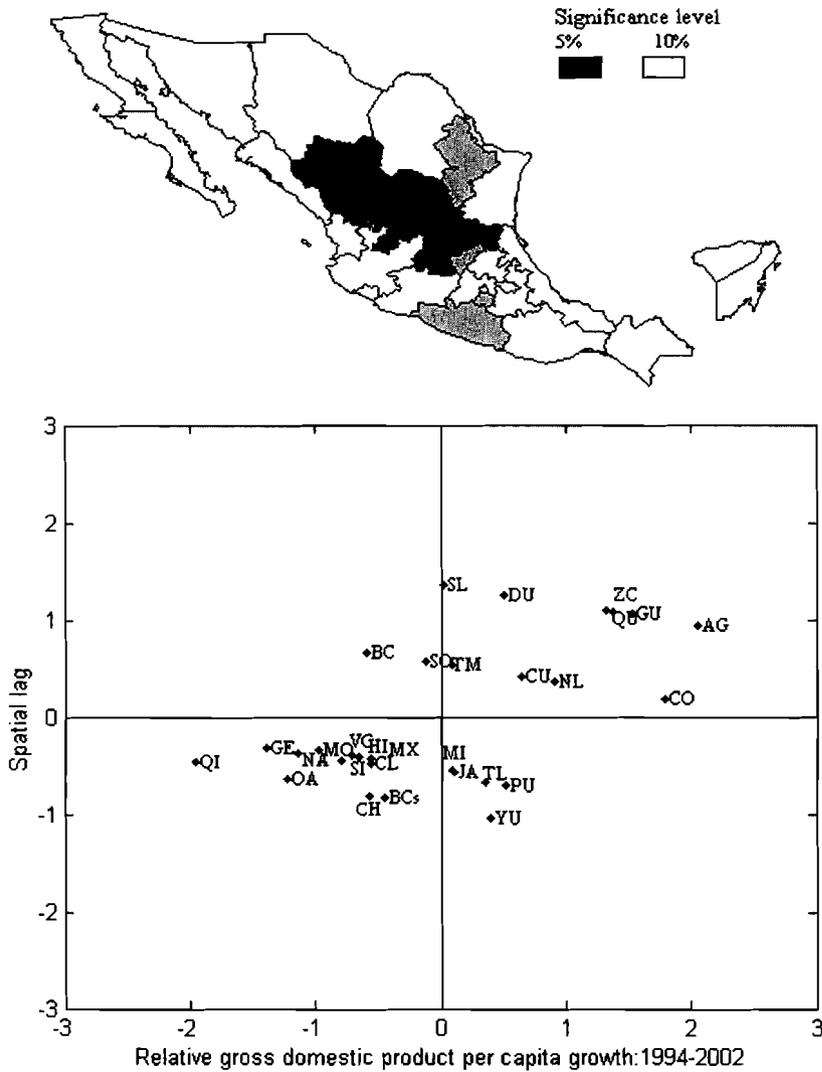
Note: See table 1 for state abbreviations.

Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

VII. CONCLUSIONS

This article employs established techniques from the spatial statistics literature to investigate how spatial patterns of economic activity evolved during the period of

FIGURE 12. Significance of Local Moran for Growth of GDP per Capita, 1994–2002: Map and Moran Scatterplot



Note: See table 1 for state abbreviations.

Source: Authors' calculations based on census data from the Mexican National Institute of Statistics, Geography, and Informatics.

trade liberalization and how these patterns may be related to the finding of increased divergence among state incomes. Three main findings emerge.

First, the post-liberalization period was characterized by a tremendous increase in dispersion, which materialized in the constitution of several income clusters. However, these income clusters only partially map to geographic regions.

Second, when regions are defined by spatial correlation in incomes, a “south” clearly exists, but the “north” seems to be restricted to the states directly on the U.S. border. Income levels fall off sharply immediately below the border and are distributed with no geographic pattern throughout the remaining, mostly central areas of the country. These findings appear inconsistent with the idea of an income gradient radiating from Mexico City and, to a lesser extent, a powerful gradient radiating down from the U.S. border.

Third, overall the central dynamic of both the increased spatial dependency and the increased divergence lies not on the border, but more in developments in the south and to some degree in an emerging growth cluster in the north-center. The majority of the increased divergence of state incomes in the post-liberalization period is due to the increasing gap between the south and the rest of the country, and only modest explanatory power is gained by breaking out the border region. Further, post-liberalization growth rates are not especially tied to closeness to the U.S. border and, consistent with the nonspatial parametric literature, do not offer strong support for an increasing gradient from north to south. The substantial divergence occurring in the 1985–93 period seems unrelated to the consolidation of a faster growing northern block, not even one of just the border states—only the south shows covarying growth rates across this period. In sum, two more likely explanations for the divergence occurring after trade liberalization than the strengthening of the border states are the sustained underperformance of the southern states, beginning before NAFTA, the treaty most affecting local agricultural industries, and to a lesser extent the superior performance of an emerging convergence club in the north-center of the country.

APPENDIX. CONDITIONING OF KERNELS

Definitions

y_{it} is the income per capita of state i in year t , \bar{y}_t is the national average income per capita in year t , and y_{wt} is the average income per capita of the spatial lag in year t .

Figure 8

Kernels generated using three growth spans of five years each before and after 1985:

$$\left(\frac{y_{it+s}}{\bar{y}_{t+s}} \middle/ \frac{y_{it}}{\bar{y}_t} \right) - 1 \text{ conditioned to } \left(\frac{y_{it}}{\bar{y}_t} \middle/ \frac{y_{it-s}}{\bar{y}_{t-s}} \right) - 1$$

Figure 9

$$\left(\frac{y_{it}}{\bar{y}_t} \middle/ \frac{y_{it-s}}{\bar{y}_{t-s}} \right) - 1 \text{ conditioned to } \left(\frac{y_{it}}{y_{wt}} \middle/ \frac{y_{it-s}}{y_{wt-s}} \right) - 1$$

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Market Access and Welfare under Free Trade Agreements: Textiles under NAFTA

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The effective market access granted to textiles and apparel under the North American Free Trade Agreement (NAFTA) is estimated, taking into account the presence of rules of origin. First, estimates are provided of the effect of tariff preferences combined with rules of origin on the border prices of Mexican final goods exported to the United States and of U.S. intermediate goods exported to Mexico, based on eight-digit Harmonized System tariff-line data. A third of the estimated rise in the border price of Mexican apparel products is found to compensate for the cost of complying with NAFTA's rules of origin, and NAFTA is found to have raised the price of U.S. intermediate goods exported to Mexico by around 12 percent, with downstream rules of origin accounting for a third of that increase. Second, simulations are used to estimate welfare gains for Mexican exporters from preferential market access under NAFTA. The presence of rules of origin is found to approximately halve these gains.

Improved market access may not have been the main reason that Mexico entered the North American Free Trade Agreement (NAFTA), but it was certainly among the anticipated benefits at the negotiations. By 2002, NAFTA preferences in goods markets should have given Mexican exporters a 4 percent

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average price margin over competitors in U.S. markets. On the basis of the tariff data, the average tariff preference for textiles and apparel was close to 8 percent.

Were it not for rules of origin that must be satisfied to sell in the United States at the tariff-inclusive price, market access would be expected to result in substantial rents for Mexican exporters to the United States. However, NAFTA negotiations reveal the importance of rules of origin in preferential trading arrangements. Krueger (1993) notes that the November 1992 draft chapter on rules of origin was 193 pages long and that the United States supported more stringent rules of origin, while Canada and Mexico preferred a low regional value-added content rule. She also notes that the interesting case to analyze was that in which the “US had a significant cost advantage relative to Mexico, but a cost disadvantage vis-à-vis the rest of the world” (p. 11). This is almost the exact case for trade in textiles (i.e., intermediate goods) between Mexico and the United States.

Krishna (2005) summarizes several contributions since Krueger’s study, and more empirical research is starting to appear (see Cadot and others 2005b). As a result of this work, rules of origin are being increasingly recognized as the primary causes of the disappointing trade expansion effects of preferential trading arrangements. Rules of origin constrain the sourcing policies of final good producers, generating higher input and administrative compliance costs. Recent studies that rely on utilization rates of preferences to assess the effects of rules of origin on the benefits of trade preferences (Estevadeordal 2000; Anson and others 2005; Cadot and others 2005; Carrère and de Melo 2005) have found evidence of non-negligible compliance costs.

Trade flows, however, offer no information on the distribution of the rents generated by trade preferences, which is necessary to determine the likely welfare effects of preferential market access combined with rules of origin. To make further progress and assess the welfare effects of market access under free trade agreements, the effects of preferences on prices rather than on quantities or utilization rates must be estimated. This implies estimating the pass-through effects of tariff preferences on consumer prices (i.e., the extent to which tariff preferences translate into a corresponding increase in foreign producer prices)—an exercise similar to estimating exchange rate pass-through—which is carried out in section I. These estimates are then used in a simulation model to quantify the likely welfare effects for Mexican producers of preferential access in textiles and apparel under rules of origin in the United States.

Two recent studies estimate the effects of trade preferences on member-country prices in agreements between developed and developing countries using the textiles and apparel sector, where preferences are typically substantial. Olarreaga and Özden (2005) looked at the effect the Africa Growth and Opportunity Act had on the unit values of U.S. apparel imports from Africa, and Özden and Sharma (2004) explore rent capture by apparel producers from the Caribbean Basin Initiative. Their research shows that preferences translate

into higher border prices for preferred exporters and that pass-through of the tariff reductions is also substantial (between a third and a half).

However, the premise that higher border prices imply higher rents for producers is not necessarily true. First, as Olarreaga and Özden (2005) note, part of the increase in the border price may be captured by intermediaries in the exporting country, which may in fact be large companies based in the importing country. Second, as Özden and Sharma (2004) note, part of the border price increase may simply cover the additional cost of complying with rules of origin (higher input prices and other administrative costs).¹

Cadot, Estevadeordal, and Suwa-Eisenmann (2005) suggest that rules of origin under NAFTA have the political function of creating a captive market for U.S. intermediate goods. In this case, the price of U.S. intermediate goods should be sensitive to rules of origin and tariff preferences downstream. This hypothesis is tested by regressing the border price of U.S. intermediate goods exported to Mexico (relative to the border price of those same goods when exported to nonpreferential destinations) on rules of origin and tariff preferences applied by the United States on downstream (re-exported) Mexican goods. Vertical links are captured using an input–output table.

This article contributes to the literature in three ways. First, it estimates pass-through effects in the presence of rules of origin from intermediate good producers to final good producers in partner countries (in this case, from textile producers in the United States to Mexican apparel producers). Second, it links pass-through estimates directly to rules of origin through the use of proxies. This is the first time that estimates of the pass-through effects of tariff preferences directly take into account the effects of rules of origin. Third, it sets up a partial equilibrium simulation model that gives the order of magnitude of these estimated effects on welfare.

When rules of origin are not controlled for, the elasticity of the border price of Mexican exports to U.S. tariff preference margins is close to 80 percent.² After rules of origin are controlled for, however, Mexican apparel producers retain only about half the preference margin. Rules of origin and tariff preferences downstream indeed affect U.S. intermediate good prices in a statistically significant way, contributing over half of the predicted price rise of U.S. exports

1. The approach in this research is extended in the following ways. As in Olarreaga and Özden (2005), border prices for preferential and most-favored-nation shipments are compared using unit values calculated from International Trade Commission trade data at the eight-digit level of the Harmonized System (HS). As in Özden and Sharma (2004), these border price differences are regressed on tariff preference margins and control variables. But instead of quantity variables, a vector of dummy variables for rules of origin are included using a database compiled by Estevadeordal (2000). In a second step, on the basis of those estimates, simulation techniques are used to calculate the likely market access improvement for Mexican exporters of apparel to the United States under NAFTA.

2. That is, a reduction of NAFTA tariffs below most-favored-nation tariffs by x percentage points translates into an increase in Mexican producer prices by $0.8x$ percentage points, and so a decrease in U.S. consumer prices by $0.2x$ percentage points or a 20 percent pass-through.

that is attributable to NAFTA (30 percent for rules of origin alone), and U.S. intermediate good producers are able to retain a sizable share of the rents generated by Mexican preferential tariffs. Inspired by these reduced-form econometric estimates, a partial equilibrium structural model is then simulated to calculate the orders of magnitude of the reduced welfare gain for Mexican exporters to the United States that is due to the presence of rules of origin.

I. MODELING PREFERENCE PASS-THROUGH UNDER RULES OF ORIGIN

Table 1 describes the data used in section II to estimate the pass-through effects under NAFTA. The 865 tariff lines (at the eight-digit level of the Harmonized System, HS) of the data set are spread across the 11 textiles and apparel chapters. Exports are concentrated in two sectors, knitted apparel (HS-61) and nonknitted apparel (HS-62), both final sectors according to the Broad Economic Categories classification used here. On average, utilization rates for exports of Mexican textiles and apparel that entered the U.S. market under NAFTA are fairly high, although they are lower for final goods (around 70 percent) than for intermediate goods. The preference margins were just about equal to the U.S. most favored nation tariff rates in 2002. Because the statistical work is carried out at the HS eight-digit level, tariffs and utilization rates are weighted by import shares (to prevent giving undue weight to tariff lines with marginal trade flows).

The cumulative density function confirms that utilization rates are higher for intermediate goods than for final goods, though the majority of Mexican exports to the United States are in the final goods category (figure 1). This heterogeneity in utilization rates at the HS eight-digit level reflects a combination of heterogeneity in firm cost characteristics and possibly of heterogeneity in product characteristics.³

As in most preferential trade agreements, preferential rules of origin in textiles and apparel under NAFTA include a change of tariff classification that can be applied at either the chapter level (HS two-digit level) or the heading level (HS four-digit level).⁴ This requires the Mexican final product shipped to

3. Carrère and de Melo (2005) develop a simple model in which heterogeneity in compliance costs across firms leads to utilization rates in the range ($0 < u_i < 1$) and exploit this heterogeneity to come up with an estimate of the breakdown of compliance costs associated with RoO into a (fixed) administrative component and a distortionary component.

4. In addition to the product-specific rules described in table 1, rules of origin also include regime-wide rules. In the case of NAFTA, these include a *de minimis* (or tolerance) criterion, which stipulates a 7 percent maximum share of nonoriginating materials that can be used without affecting the origin of the final product; bilateral cumulation, which stipulates that producers in Mexico can use inputs from the United States (and Canada) without affecting the final good's originating status provided that the inputs are themselves originating (i.e., provided that they themselves satisfy the area's rules of origin); roll-up, which states that nonoriginating materials (which have acquired origin by meeting specific processing requirements) maintain this origin when used as inputs in a subsequent transformation (i.e., the non-originating materials are no longer taken into account in calculating value added; and a self-certification method. In the case of NAFTA, duty-drawbacks are not allowed. For more details, see Cadot and others (forthcoming), table 2.

TABLE 1. Mexican Exports of Textiles and Apparel to the United States and Description of Rules of Order under North American Free Trade Agreement

	Rules of origin (percent of HS eight-digit tariff lines)										
	Number of HS eight-digit tariff lines	Share of total (percent)	Share of Mexican exports to United States (percent)	Mean utilization rate ^a (percent)	Mean tariff preference margin ^a (percent)	Change in tariff classification			Technical requirement and change in tariff classification		
						At heading level (HS four-digit)	At chapter level (HS two-digit)	At heading level (HS four-digit)	At chapter level (HS two-digit)	At heading level (HS four-digit)	At chapter level (HS two-digit)
Section 11: Textiles and textile articles	865	100	100	80.70 (77.93)	9.97 (6.63)	15.84	34.2	0.69	49.25	53.53	
Chapter											
50: Silk	1	0.12	0.01	—	—	100	0	0	0	0	0
51: Wool, fine, or coarse animal hair; horsehair yarn and woven fabric	24	2.77	0.33	98.85 (99.86)	12.82 (17.45)	91.67	8.33	0	0	0	4.17
52: Cotton	90	10.4	1.96	92.60 (97.95)	8.36 (8.15)	68.89	27.78	3.33	0	0	3.33
53: Other vegetable textile fibers; paper yarn and woven fabrics of paper yarn	13	1.5	0.02	83.65 (83.69)	1.67 (3.09)	53.85	46.15	0	0	0	0
54: Man-made filaments	67	7.75	2.61	94.3 (99.81)	11.86 (19.78)	0	98.51	0	1.49	1.49	5.97
55: Man-made staple fibers	68	7.86	1.79	90.34 (98.81)	11.31 (9.44)	57.35	38.24	1.47	2.94	2.94	5.88
56: Wadding, felt, and nonwovens; special yarns; twine, cordage, ropes, and cables and articles thereof	52	6.01	1.32	71.89 (81.63)	7.34 (6.97)	0	98.078	0	1.92	1.92	1.92
57: Carpets and other textile floor coverings	27	3.12	0.18	95.96 (97.58)	3.07 (3.71)	0	100	0	0	0	100
58: Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery	45	5.2	0.47	87.48 (97.09)	7.04 (8.49)	0	100	0	0	0	4.44

(Continued)

TABLE 1. Continued

	Number of HS eight- digit tariff lines	Share of total (percent)	Share of Mexican exports to United States (percent)	Mean utilization rate ^a (percent)	Mean tariff preference margin ^a (percent)	Rules of origin (percent of HS eight-digit tariff lines)				Final goods
						Change in tariff classification		Technical requirement and change in tariff classification		
						At heading level (HS four-digit)	At chapter level (HS two-digit)	At heading level (HS four-digit)	At chapter level (HS two-digit)	
59: Impregnated, coated, covered or laminated textile fabrics, textiles articles of a kind suitable for industrial use	42	4.86	0.79	87.68 (95.98)	4.53 (5.05)	7.14	90.48	0	2.38	0
60: Knitted or crocheted fabrics	4	0.46	0.01	99.77 (99.76)	18.02 (17.71)	0	100	0	0	0
61: Articles of apparel and clothing accessories, knitted or crocheted	145	16.76	33.85	69.41 (62.16)	13.13 (6.40)	1.38	2.069	0	96.55	100
62: Articles of apparel and clothing accessories, not knitted or crocheted	205	23.7	48.74	71.03 (82.91)	11.11 (6.03)	0	0.49	0	99.51	100
63: Other made-up textile articles; sets; worn clothing and worn textile articles; rags	82	9.48	7.91	88.10 (92.80)	7.85 (5.59)	1.22	2.44	2.44	93.9	86.59

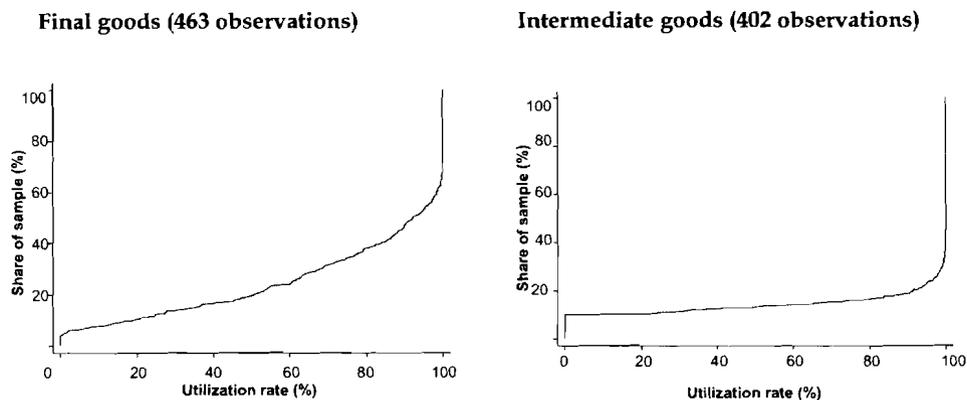
—, not available.

^aFigure in parentheses is the weighted average, which reflects the importance of each tariff line in total Mexican exports to the United States.

Note: Exceptions to change in tariff classification (generally prohibiting the use of nonoriginating materials from a certain subheading, heading, or chapter) also exist but are not mentioned since they concern 99 percent of the tariff lines in section 11. The sample period is 2002; sample data are from the textiles and apparel sector (HS eight-digit level, section 11).

Source: Authors' analysis based on data described in the text.

FIGURE 1. Cumulative Density Function of Utilization Rates by Mexican Exporters under NAFTA in Textiles and Apparel Sector 2002



Source: Authors' analysis based on data described in the text.

the United States to be classified in a chapter (or heading) of the HS different from its imported intermediate components. Clearly, a change of chapter is more restrictive than a change of heading. Most sectors subject to a change in heading or chapter are classified as intermediate. Except carpets (chapter 57), final goods not only include a change of tariff classification but also rely on a technical requirement imposed on the final good's production process to confer origin. Changes of tariff classification and technical requirements are not the only criteria applied. In the case of textiles and apparel, 99 percent of the tariff lines also include an exception (not included in table 1). Exceptions lead to considerable complication for customs officials in determining origin in preferential agreements.⁵

The textiles and apparel sector has several characteristics that merit attention here. First, there is product differentiation, which suggests that there might be price interaction between member and nonmember countries. If so, modeling this interaction might be useful (as in Chang and Winters 2002), rather than assuming perfect competition (as in Özden and Sharma 2004).

Second, virtually all nonpreferential trade in textiles and apparel products is governed by the Agreement on Textiles and Clothing, the successor to the Multi-Fibre Arrangement. Under the Agreement on Textiles and Clothing agreed on as part of the Uruguay Round, quotas on garments were to be progressively enlarged until final phaseout in January 2005. But importing

5. Since an exception applies to virtually all tariff lines in textiles and apparel, it cannot be included in the statistical analysis here, which relies on the use of dummy variables. Furthermore, exceptions can be positive (the criterion does not apply) or negative (a further criterion must apply). Exceptions usually require a further criterion, beyond a change of tariff classification, to be met. A particularly vivid example in the case of NAFTA is the case of men's overcoat made of wool (HS-62011). Establishing origin requires in most instances a change in chapter with the restriction that the visible lining must be produced from yarn and finished in either party (see the detailed description in Brenton and Ima-waga 2005).

countries backloaded the enlargement of binding quotas until the very end of the transition phase—the end of 2004 (Spinanger 1998). Thus, during the sample period (2000–02), most of the world’s nonpreferential trade in garments was still affected by binding quotas. Intra-NAFTA trade in textiles and apparel, by contrast, has been governed by annex 300B of NAFTA, which superseded the Multi-Fibre Arrangement and the Agreement on Textiles and Clothing and mandated an immediate elimination of quotas on “originating” Mexican goods (those that comply with the stipulated rules of origin) and a gradual elimination of quotas for “nonoriginating” Mexican goods (those that do not comply with the stipulated rules of origin).⁶ Under a regime of binding quantitative restrictions on nonpreferred exporters, price interaction did not exist between Mexican producers and non-NAFTA exporters because Mexicans were operating along a residual demand curve, whose elasticity was unaffected by the pricing decisions of quota-constrained competitors. These observations justify the monopolistic competition modeling framework below with product differentiation.

Modeling Pass-Through: A Monopolistic Competition Framework

The model outlined here features monopolistic competition with Dixit–Stiglitz preferences on the final good market but disregards price competition between suppliers. This allows an expression of the pass-through that depends on the presence of rules of origin to be derived.⁷

Suppose then that n different Mexican final goods, indexed by j , are sold on the U.S. market in competition with goods imported from the rest of the world. Let x_j be the quantity of Mexican goods sold and x_j^* the quantity of foreign goods sold (i.e., imports from the rest of the world). There is no U.S. production of final goods. And let X_0 be an aggregate of other goods consumed by U.S. households. Preferences are

$$(1) \quad U(\cdot) = X_0 + \sum_{j=1}^n \ln X_j$$

where

$$(2) \quad X_j = \left[x_j^{\rho_j} + (x_j^*)^{\rho_j} \right]^{1/\rho_j}.$$

6. The NAFTA Treaty, annex 300B, section 1, §2.

7. A similar framework with product differentiation (the so-called “Armington framework”) but without monopolistic competition across suppliers is also adopted in the simulation exercise of section III. This slightly different framework is largely equivalent since it also implies less than full rent capture by Mexican exporters even without rules of origin on intermediate goods and obviates the need to make assumptions about economies of scale that is typical in the monopolistic competition framework. To shorten the presentation of the simulation model in section III, all instances in this section where the simulation model departs from the structure presented here are noted.

The quasi-linearity of U ensures that the marginal utility of income is constant and equal to 1, while the log form of the second term ensures that an interior budget allocation holds between the n Mexican goods and other goods. This means that tariff changes have no income effects, an assumption maintained in the simulations of section III. Additivity of preferences implies strong separability, so two-stage budgeting holds, confining the price effects of tariff preferences to apparel products. The elasticity of substitution between Mexican and foreign brands of good j is

$$(3) \quad \sigma_j = \frac{1}{(1 - \rho_j)}$$

where p_j is the border price of Mexican goods and p_j^* the border price of foreign goods. When q_j is the internal price of Mexican goods, q_j^* the internal price for foreign goods, and t_j the ad valorem tariff,

$$(4) \quad q_j = (1 + t_j)p_j.$$

An equation that accounts for the difference between most-favored-nation and NAFTA tariffs will be introduced shortly.

Let

$$(5) \quad Q_j \equiv q_j^{1-\sigma_j} + (q_j^*)^{1-\sigma_j}.$$

The U.S. demand for the Mexican brand of good j is then

$$(6) \quad x_j = \left(\frac{q_j^{-\sigma_j}}{Q_j} \right) E_j$$

where

$$(7) \quad E_j = q_j x_j + q_j^* x_j^*$$

is the subexpenditure on good j . The own-price elasticity of U.S. demand for Mexican final good j is

$$(8) \quad \varepsilon_j = \sigma_j + \frac{(1 - \sigma_j) q_j^{1-\sigma_j}}{Q_j}.$$

The equations for the foreign good are similar.

Mexican final goods are produced by combining value-added with m different intermediate goods indexed by i under a Leontief technology with input-output coefficient a_{ij} . Each intermediate good can come from either the United States or the rest of the world, because the goods are perfect substitutes.⁸ Let \bar{z}_{ij} denote the

8. In the simulations below, intermediate goods by origin enter into production according to a constant elasticity of substitution aggregator function.

quantity of “composite” (U.S and foreign) intermediate good i used in the production of final good j ; that is, $\bar{z}_{ij} = z_{ij} + z_{ij}^*$. Then,

$$(9) \quad x_j = \min \left\{ F_j(K_j, L_j); \frac{\bar{z}_{1j}}{a_{1j}}; \dots; \frac{\bar{z}_{mj}}{a_{mj}} \right\}.$$

In the absence of rules of origin, perfect substitutability means that Mexican choice of intermediate goods (U.S. or foreign) would be bang-bang. If U.S. intermediate goods were all more expensive than foreign ones, for instance, they would not be used at all. However, with rules specifying a minimum content r_j (expressed here for simplicity as a proportion of total intermediate use), Mexican exporters have to use U.S. intermediate goods in proportion r_j and foreign intermediate goods in proportion $1 - r_j$.⁹

Let $C_j(x_j)$ be the cost function dual to F_j and $\phi_j(p_j) \equiv C_j[x_j(p_j)]/x_j(p_j)$ the corresponding unit-cost function, and suppose that $\phi_j' > 0$. If p_i is the price of U.S. intermediate good i and p_i^* the price of its foreign substitute, the marginal cost of Mexican final good j is

$$(10) \quad \begin{aligned} \Phi_j &= \phi_j + \sum_{i=1}^m a_{ij} [r_j p_i + (1 - r_j)(1 + t_i) p_i^*] \\ &= \phi_j + \sum_{i=1}^m a_{ij} \bar{p}_i \end{aligned}$$

where

$$(11) \quad \bar{p}_i = r_j p_i + (1 - r_j) q_i^*$$

and

$$(12) \quad q_i^* = (1 + t_i) p_i^*.$$

A similar expression holds for the functional forms adopted in section III, where binding rules of origin raise final good unit costs.

Optimal pricing by Mexican final good exporters implies

$$(13) \quad \left(1 - \frac{1}{\varepsilon_j}\right) q_j = (1 + t_j) \left(\phi_j + \sum_{i=1}^m a_{ij} \bar{p}_i\right).$$

9. As summarized in table 1, there is actually no regional value content in the textiles and apparel sector, the most common rules of origin requiring changes of tariff classification. Exceptions apply to 99 percent of textiles and apparel tariff lines, and technical requirements apply to 50 percent of them. Given the large increase in Mexican intermediate purchases from the United States since NAFTA, it can be safely assumed that these requirements were designed to raise the regional value content of Mexican production. Several papers collected in Cadot and others (forthcoming) document how NAFTA's exceptions, changes of tariff classification, and technical requirements have been calibrated to make U.S. sourcing the only option.

Because \bar{p}_i is an increasing function of r_j whenever $p_i > q_i^*$, the supply price of the Mexican final good in the United States is itself an increasing function of the local content requirement r_j .¹⁰

MEXICAN PASS-THROUGH. Mexican pass-through is addressed here first, then a slightly different version of the model is used to study U.S. pass-through. Assume first that the price of U.S. intermediate goods is fixed. Let p_j^N stand for NAFTA producer prices, p_j^M for most-favored-nation producer prices, t_j^N for NAFTA tariffs, and t_j^M for most-favored-nation tariffs. And let $\Delta p_j \equiv p_j^N - p_j^M$ and $\Delta t_j \equiv t_j^M - t_j^N$. Differentiating equation 13 and linearizing show that

$$(14) \quad \frac{\Delta p_j}{p_j^M} \simeq \psi_j \frac{\Delta t_j}{1 + t_j^M} + \Theta_j r_j$$

where $\Theta_j > 0$ and $\psi_j > 0$ are expressions given in full in supplemental appendix 1 (available at <http://wber.oxfordjournals.org>). The first term captures the impact of NAFTA tariff preferences on Mexican producer prices, so $1 - \psi_j$ measures the pass-through effect (i.e., the impact on U.S. consumer prices) resulting from preferential market access. The second term, which depends on input–output relationships, the price of U.S. intermediate goods, and the elasticity of demand for the final Mexican good in the United States, measures the impact on Mexican border prices of increases in the price of the intermediate good “exported” from the United States and induced by rules of origin.

In this model, both preferential rates and rules of origin are assumed to be exogenous. In general (and certainly in the case of NAFTA, as explained by Estevadeordal 2000), negotiations can be viewed as a game played by three parties in which negotiation is over two instruments: speed of preferential tariffs phaseout and rules of origin criteria. Thus, there is a potential for multicollinearity between r_j and $\Delta t_j / (1 + t_j^M)$ in equation 14. However, this article uses the most recent trade data (2000–02), covering a period when the phaseout was virtually complete, and nearly all tariff preferences were equal to most-favored-nation tariffs.¹¹ The U.S. most-favored-nation tariff can be considered free from endogeneity to NAFTA’s rules of origin.¹² But a more ambitious assessment of rules of origin would rely on a political economy approach, as in Cadot, Estevadeordal, and Suwa-Eisenmann (2005).

10. If $p_i \leq q_i^*$, the local content requirement is not binding.

11. For example, on the Mexican method sample below for 2000–02, the preference margin for Mexican imports was equal to the U.S. most-favored-nation tariff for 1,176 of 1,304 tariff lines—that is, 90 percent of the HS eight-digit tariff lines.

12. In the context of the debate on the relation between preferential trade arrangements and multilateral trade liberalization, Limão (forthcoming) finds evidence that the U.S. most-favored-nation tariffs could be endogenous because U.S. preferential trade arrangements led to less subsequent multilateral trade liberalization.

U.S. PASS-THROUGH. To consider the market for U.S. intermediate good i , the assumption that its price is fixed is relaxed. Let $z_i(p_i)$ be its U.S. supply; if it is exhausted by Mexican demand, the market-clearing condition is

$$(15) \quad \sum_{j=1}^n a_{ij}x_j(p_j) = z_i(p_i).$$

Differentiating equation 15 and letting ε_i^s be the supply elasticity of intermediate goods and ε_j^s the supply elasticity of final goods result in:

$$(16) \quad \frac{\Delta p_i}{p_i^M} \simeq \frac{z_i}{p_i^2 \varepsilon_i^s} \sum_{j=1}^n a_{ij}x_j \varepsilon_j^s \frac{\Delta p_j}{p_j^M},$$

which is similar in form to equation 14 but depends on downstream final good prices.¹³

II. PASS-THROUGH ESTIMATION AND RESULTS

In equation 14, rules of origin took the form of a regional value content. This is not the case in the textiles and apparel sector, though exceptions and technical requirements have similar effects. Dummy variables are used to capture the effects of the current rules, with each representing a specific legal form of rules of origin. CC_j is equal to 1 if a change of chapter on good j is required, and $TECH_j$ is equal to 1 if a technical requirement is imposed.¹⁴ The equation to be estimated for the Mexican pass-through is thus

$$(17) \quad \frac{\Delta p_j}{p_j^M} = \alpha_0 + \alpha_1 \frac{\Delta t_j}{1 + t_j^M} + \alpha_2 CC_j + \alpha_3 TECH_j + u_j.$$

All parameter estimates are expected to be positive, and $1 - \alpha_1$ measures the Mexican pass-through.

13. This may raise an endogeneity issue. As in equation 14, $\Delta p_i/p_i^M$ depends on a weighted sum of $\Delta p_i/p_i^M$ in which the weights are the input-output coefficients b_{ij} . In equation 14, $\Delta p_i/p_i^M$ can be similarly shown to depend on a weighted sum of $\Delta p_i/p_i^M$ through Θ_j (see supplemental appendix 1). Thus, the link between the regressor and the error term in equation 14 is through two nested weighted sums and is thus, although linear, very indirect.

14. As an alternative, Estevadeordal (2000) index could have been used as a proxy for the effect of rules of origin. Such an approach would not be appropriate for the textiles and apparel sector. First, besides the ubiquitous exceptions, only three types of rules of origin are used: change in tariff classification at the heading level, change in tariff classification at the chapter level, and a technical requirement. Thus, for textiles and apparel, Estevadeordal's index takes only three different values (out of seven). Given that, changes in headings and changes in chapters are perfectly collinear (i.e., a tariff line without a change in chapter systematically has a chapter heading and vice versa), using Estevadeordal's index does not add more variability to the rules of origin indicator than the dummies CC and $TECH$. Moreover, the specification used here does not impose an a priori ranking between the different combinations of rules of origin.

The equation to be estimated for the U.S. pass-through is

$$(18) \quad \frac{\Delta p_i}{p_i^M} = \beta_0 + \beta_1 \frac{\Delta t_i}{1 + t_i^M} + \beta_2 CC_i + \beta_3 TECH_i + \beta_4 \sum_j b_{ij} \frac{\Delta t_j}{(1 + t_j^M)} \\ + \beta_5 \sum_j b_{ij} CC_j + \beta_6 \sum_j b_{ij} TECH_j + \varepsilon_i$$

The U.S. pass-through of Mexican tariff preferences, measured by $1 - \beta_1$, is estimated after controlling for two types of effects relevant to the determination of U.S. intermediate good prices. The first type, measured by coefficients β_2 and β_3 , is the effect of rules of origin applying to U.S. intermediate goods themselves. To avoid unnecessarily complicating the calculations, this effect is not considered when intermediate goods are not assumed to be produced with imported intermediate goods, but it does occur in the simulation in section III where Mexican final goods use imported intermediate goods.

The second type is demand effects, which are measured by coefficients β_4 (effect of downstream U.S. preferences on Mexican goods using intermediate i filtered by input-output coefficients a_{ij}), β_5 , and β_6 (the same effect for downstream rules of origin). These effects are instruments for the prices of downstream final goods, which are endogenous, as argued above. Intuitively, a higher U.S. preference on downstream Mexican goods raises the induced demand for intermediate goods and thus their price. Likewise, stiffer rules of origin downstream pick up the “captive market” effect discussed in the introduction. Thus, all coefficients are expected to be positive, and the null hypothesis for β_5 and β_6 is that there is no captive market effect.

Equation 16 is estimated with panel data using the weighted least squares estimator, which performs better than ordinary least squares on the sample because it modulates the importance of each observation in the final solution (details are supplied in supplemental appendix 4). This method assigns each tariff line a weight that reflects its importance in total Mexican exports to the United States (NAFTA and most-favored-nation regimes combined). In the same way, equation 17 is estimated on cross-section data using the weighted least squares estimator with a weight that reflects the importance of each line in total U.S. exports to Mexico.¹⁵ (Input-output data are available for only 1 year.)

Data

Unit values and tariff preference margins are compiled at the HS eight-digit level from U.S. Department of Commerce, Department of Treasury, and International

15. It could be that unobserved commodity characteristics affect the difference between NAFTA and most-favored-nation export prices, even at the HS-8 level. In principle, this could be corrected by the use of difference-in-difference estimation (comparing before and after NAFTA). However, the difference between NAFTA and most-favored-nation export prices cannot be computed before NAFTA, so this method is unusable here.

Trade Commission data, as detailed in supplemental appendixes 2 and 3.¹⁶ For equation 17, the sample includes all HS eight-digit lines of section 11 (textiles and textile articles as defined in the HS trade classification; see supplemental appendix 2) for 2000–02. Only tariff lines with positive U.S. imports of Mexican products and strictly positive U.S. imports from Mexico under NAFTA are included—that is, only tariff lines with positive rates of utilization u_{it} of NAFTA's preferential regime, since when $u_{it} = 0$, there is no rent to share.¹⁷

Two methods are used to compute $\Delta p_i/p_i^M$, the dependent variable in the estimation of the Mexican pass-through in equation 17. The first method, called the Mexican method because it compares the unit value of the same Mexican good imported under NAFTA and most-favored-nation tariff rates, has the advantage of using two unit values that are strictly comparable in the calculation, but it reduces the size of the sample by excluding tariff lines with 100 percent utilization rates (nearly half the observations). The second method, called the rest of the world (ROW) method, includes all observations but measures the relative price $\Delta p_i/p_i^M$ as the percentage difference between the border price (unit value) of a good imported from Mexico under NAFTA and the border price of the same good imported from all U.S. import sources including Mexico under the most-favored-nation regime. In contrast to the Mexican method, the ROW method introduces some product heterogeneity.

The sample used for the estimation of equation 18 includes all intermediate goods used in manufacturing Mexican textiles and apparel products for export to the United States under the same conditions as before—that is, positive Mexican imports from the United States under NAFTA with utilization rates of 0–100 percent. Tariff preference is now computed on Mexico's imports of U.S. intermediate good i , while the rules of origin are the same as before (because the same rules apply to all of NAFTA's signatories). In addition to tariff preferences and rules of origin on imports of U.S. intermediate goods i , the regression includes tariff preferences and rules of origin on downstream

16. Unit values are calculated by dividing import values by volumes. This method yields notoriously noisy proxies for the true prices at which goods are sold, as customs records of physical volumes are typically less reliable than their records of values, and both are affected by composition problems. Composition problems are somewhat mitigated at deep levels of disaggregation, but then the quantities involved tend to be smaller, and aberrant numbers are encountered more frequently. The HS eight-digit level is arguably the best compromise in this regard. U.S. tariffs are calculated by taking the ratio of collected duties to custom value at the tariff-line level in order to take into account any special subregime or partial exemption.

17. There may be no rent to capture from those lines because of very stringent rules of origin. This would indicate a sample selection problem. However, the lines with $u_{it} = 0$ account for only 6.7 percent of the total HS-8 tariff lines, and there is no evidence that rules of origin are more restrictive for those lines (for instance, only 37 percent of lines with $u_{it} = 0$ have to satisfy a technical requirement compared with 68 percent for lines with $0 < u_{it} < 100$). Nevertheless, with a selection bias, the cost of rules of origin for Mexican exporters is underestimated (based on the assumption that if complying with rules of origin is costly enough, and if tariff preferences do not compensate for these larger costs, the utilization rate would be 0), which reinforces the argument defended in the article.

TABLE 2. Descriptive Statistics, Mexican Pass-Through (percent)

Good j	Mexican method		ROW method	
	All goods	Only final goods	All goods	Only final goods
Number of observations	1,304	913	2,497	1,324
u_{jt} ^a	73.24	69.58	75.68	71.78
$\frac{\Delta p_{jt}}{p_{jt}^M}$ ^a	4.58	4.87	3.99	4.55
$\frac{\Delta t_{jt}}{1+t_{jt}^M}$ ^a	6.07	5.87	6.22	5.79
CC_j ^b	91.87	92.36	82.66	92.56
$TECH_j$ ^b	65.57	80.36	48.34	88.60
Intermediate goods	29.98	—	46.98	—
Final goods	70.02	—	53.02	—

—, not applicable.

^aWeighted averages (reflecting the importance of each tariff line j in total Mexican exports to the United States).

^bShare of HS eight-digit level tariff lines.

Note: The sample period is 2000–02. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11).

Source: Authors' analysis based on data described in the text.

good j weighted by input–output coefficients b_{ij} .¹⁸ Table 2 reports descriptive statistics for the variables used in equation 16 and table 3 for the variables in equation 18.

A change of chapter because of rules of origin together with bilateral cumulation implies that when nonoriginating (rest of the world) inputs are used, the transformation in Mexico must be substantial enough for the final good to belong to a chapter that is not identical to that of its nonoriginating components. This amounts to an implicit regional value content for value-added and originating inputs, taken together, relative to the value of nonoriginating inputs. Such a requirement is more complicated than in the simple model of section I but has essentially the same effect—and is modeled as a regional value content in the simulation in section III. Cadot, Estevadeordal, and Suwa-Eisenmann (2005) document how technical requirements tend to be fine-tuned to suit special interests, with equivalent cost-raising effects.

Under the Mexican method, 91.9 percent of tariff lines at the HS eight-digit level had to satisfy a change of classification at the chapter levels, and 65.6

18. Because of lack of data, these “input–output” coefficients are computed from the U.S. input–output table for 2000 converted from U.S. input–output codes (approximately 300 lines) to the HS eight-digit level, the degree of disaggregation at which unit values are measured. “Blowing up” of aggregate coefficients into HS eight-digit level disaggregation was done by attributing to each HS eight-digit line a value of intermediate good sales equal to the inverse of the number of HS eight-digit lines falling in its U.S. input–output code category.

TABLE 3. Descriptive Statistics, U.S. Pass-Through (percent)

Good <i>i</i>	All goods	Only intermediate goods
Number of observations	837	473
$\frac{\Delta p_i^a}{p_i^M}$	12.16	13.33
$\frac{p_i^M \Delta t_i}{(1+t_i^M)^a}$	12.32	13.76
CC_i^b	82.32	68.92
$TECH_i^b$	42.29	7.61
$\sum_j a_{ij} \frac{\Delta t_j}{(1+t_j^M)^a}$	5.71	5.72
$\sum_j a_{ij} CC_j^a$	34.01	42.33
$\sum_j a_{ij} TECH_j^a$	68.80	67.24

^aWeighted averages (reflecting the share of each U.S. intermediate sales of line *i* to Mexican textiles and apparel sector).

^bPercentage of HS eight-digit tariff lines.

Note: The sample period is 2000. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11).

Source: Authors' analysis based on data described in the text.

percent had technical requirements on the product or process (see table 2). The share of tariff lines affected by technical requirements strongly increases if the sample is restricted to final goods.

Results

Table 4 reports the Mexican pass-through estimates using the Mexican method. (Results obtained using the ROW method, which were almost identical, are in table S5.1.) The first set of estimates includes only the tariff preference margin (and time effects) as explanatory variables. Coefficients for the rate of tariff preference are always significant at the 5 percent level and robust to the choice of method, suggesting that Mexican producers retain about 80 percent of the preference margin. The null hypothesis of no pass-through (no change in U.S. consumer price or border price increase equal to 100 percent of the tariff preference) cannot be rejected at the 5 percent level, indicating that Mexican producers retained a fairly large share of the rents created by trade preference. The extent of pass-through is consistent with a differentiated product model with a relatively high elasticity of substitution between suppliers to the United States. Furthermore, because the effects of tariff changes in a period with no rules of origin are not estimated here, it is unknown whether these effects reflect some of the cost-increasing effects for Mexican producers that result from applying rules of origin.

However, when dummy variables for the presence of rules of origin are included, the picture changes. Part of the border price increase now compensates Mexican producers for the cost of complying with NAFTA's rules of origin,

TABLE 4. Regression Results, Mexican Pass-Through, Mexican Method

$\frac{\Delta p_{jt}}{D_{jt}^M}$	All goods		Only final goods		All goods		Only final goods	
	Coefficient	<i>t</i> -statistics	Coefficient	<i>t</i> -statistics	Coefficient	<i>t</i> -statistics	Coefficient	<i>t</i> -statistics
$\frac{\Delta_{jt}}{1+t_{jt}^M}$	0.784**	3.29	0.799**	3.33	0.501**	2.98	0.474**	3.04
CC_{jt}	—	—	—	—	0.998*	1.97	1.054**	2.73
$TECH_{jt}$	—	—	—	—	1.674**	3.75	1.989**	4.51
Number of observations	1,304		913		1,304		913	
Adjusted R^2	0.51		0.51		0.55		0.56	

—, not applicable;

*, significant at the 10 percent level;

** , significant at the 5 percent level.

Note: Constant and time effects are included but not reported. The sample period is 2000–02. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11). The estimator used is weighted least squares.

Source: Authors' analysis based on data described in the text.

whose coefficients are large, positive, and significant.¹⁹ The coefficient on the tariff preference falls from 0.784 to 0.501, meaning that Mexican producers retain only about half the tariff preference margin. This suggests that previous estimates of the share of rents retained by producers were significantly overestimated.

The coefficients on rules of origin variables also suggest that these requirements have a significant effect on price and therefore—presumably—on production costs.²⁰ This is consistent with Carrère and de Melo's (2005) research on the relative costs of various types of rules of origin under NAFTA. As intuition suggests, the effect of rules of origin is also stronger and more precisely estimated when the sample is restricted to final goods (as defined in the Broad Economic Categories classification).

If such a significant share of the preferences granted to Mexican producers is lost, where do they go? On one hand, rules of origin may well be dissipative barriers (like discriminatory product standards), raising production costs without directly creating offsetting rents elsewhere. On the other hand, they may generate rents upstream in the value chain. To explore this hypothesis, the pass-through of Mexican preferences by U.S. exporters of intermediate goods is now analyzed.

Mexico's tariff preference has a highly significant and quantitatively large effect, with a pass-through of only 38 percent over the whole sample and no pass-through at all when the sample is restricted to intermediate goods (table 5). This suggests that U.S. intermediate good suppliers may have substantial market power relative to Mexican final good assemblers. Since the United States sells mostly intermediate textile products to Mexico, it would appear that U.S. producers retain 93 percent of the price increase available to U.S. suppliers from not having to pay the Mexican tariff.

The effect of rules of origin on the price of U.S. exports to Mexico is not significant, suggesting, as expected, that rules of origin affect final good

19. Because dummy variables serve as proxies for rules of origin and the dependent variable is measured in percentage points, the coefficients give the estimated price increase, measured in percentage points, attributable to the presence of rules of origin.

20. By 2000–02, quantitative restrictions on all Mexican textiles and apparel exports had been phased out. A few residual quotas remained on nonoriginating Mexican goods in peculiar cases (for example, upon use of NAFTA's safeguard clause; see U.S. Customs Service 1998). As for quantitative restrictions on most-favored-nation producers under the Agreement on Textiles and Clothing, they contributed to create a rent for Mexican producers that is not taken into account in the equation here. If those rents were positively correlated with the presence of rules of origin, the estimates here might attribute to the presence of rules of origin the effect of the rent from quantitative restrictions and then overestimate the rules of origin coefficient, though the coefficient on the price term would still be consistent (provided that the rents would be uncorrelated with the price term). The authors are grateful to a referee for pointing this out.

TABLE 5. Regression Results, U.S. Pass-Through

$\frac{\Delta p_i}{P_i^M}$	All goods		Only intermediate goods	
	Coefficient	<i>t</i> -statistics	Coefficient	<i>t</i> -statistics
$\frac{\Delta t_i}{1+t_i^M}$	0.620**	6.54	0.928**	6.76
CC_i	-1.516	-1.31	1.405	0.72
$TECH_i$	2.319	1.11	1.983	1.51
$\sum_j a_{ij} \frac{\Delta t_j}{1+t_j^M}$	0.689**	3.86	0.637**	2.07
$\sum_j a_{ij} CC_j$	0.037*	1.86	0.022	0.54
$\sum_j a_{ij} TECH_j$	0.053**	2.01	0.119**	2.39
<i>Cst</i>	-3.848*	-1.67	-9.898**	-2.28
Number of observations	837		473	
Adjusted R^2	0.54		0.51	

—, not applicable;

*, significant at the 10 percent level;

** , significant at the 5 percent level.

Note: Constant and time effects are included but not reported. The sample period is 2000–02. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11). The estimator used is weighted least squares.

Source: Authors' analysis based on data described in the text.

assemblers in Mexico more than intermediate good producers in the United States. By contrast, U.S. tariff preferences on downstream final goods have a large and significant effect on the price of U.S. intermediate goods used to fabricate them. The strength of the effect (with a pass-through of only 31–36 percent) is indeed a surprise, given how imperfectly the input–output links are measured. More important here, rules of origin downstream matter, although their effect is quantitatively small (unsurprising, given that the effect is filtered by input–output coefficients). For the entire sample, changes of chapter and technical requirements are significant, confirming anecdotal evidence that technical requirements are often manipulated by upstream interests to distort the input choices of downstream industries.

The estimates in table 5 lead to a decomposition of the sources of the price increase of U.S. intermediate (textile) exports of textiles and apparel to Mexico of 12.16 percent, computed from the raw data in table 3. The predicted rise in the price of U.S. exports to Mexico for all exports computed from the estimated coefficients in table 5 at the sample mean is 12.6 percent, which is close to the observed value of 12.2 percent (see table 3). Similar decomposition results hold when only exports of intermediate goods are considered. The predicted price rise attributable to the combination of tariff preferences and rules of origin can be decomposed as follows: 46 percent is due to the Mexican tariff preference $[\Delta t_i / (1 + t_i^M)]$, 24 percent to U.S. preferences downstream $\sum_j b_{ij} [\Delta t_j / (1 + t_j^M)]$, and 30 percent to rules of origin downstream

$(\sum_j b_{ij}CC_j + \sum_j b_{ij}TECH_j)$. The last two effects are felt upstream through input–output coefficients.²¹

In sum, on the basis of the results for Mexican exports of final goods to the United States and for U.S. exports of intermediate goods to Mexico, only half the price increase from selling in the United States without having to pay the U.S. tariff is retained by Mexican exporters, while U.S. exporters retain over 90 percent of the price increase from being able to sell in the Mexican market without having to pay the tariff. Rules of origin contribute significantly to the lower pass-through for Mexican exporters but not for U.S. exporters. Finally, U.S. exporters of intermediate goods appear to derive market power from the increase in demand for their products from downstream Mexican producers of final apparel goods. These results are captured in the stylized simulations reported below.

III. NAFTA WELFARE EFFECTS FOR MEXICAN PRODUCERS: SOME SIMULATIONS

Taken together, the econometric evidence seems to suggest that Mexican producers of final goods may have hardly increased their sales to the United States, while U.S. producers of intermediate goods substantially increased their sales to Mexico. If so, the welfare benefits from earning higher rents from sales in the U.S. market since the signing of NAFTA should be less than in the absence of rules of origin.

The data confirm these predictions. NAFTA resulted in a sharp increase of 24 percent in the ratio of intermediate good (textiles) purchases by Mexico from the United States relative to purchases from the rest of the world since NAFTA, while the corresponding ratio of sales of final goods to the United States relative to the rest of the world increased only 2 percent. Likewise, NAFTA has been accompanied by a pattern of vertical exchange of the offshore assembly type whereby the United States ships semifinished goods for assembly in Mexico and then reimports them as finished products.²² Taken together, these quantity

21. It may be tempting to interpret the negative value for the constant as evidence of strategic price cuts in response to a decrease in the prices charged by either U.S. producers or nonpreferred ones, as documented by Winters and Chang (2000) in the context of Spain's accession to the European Union and by Chang and Winters (2002) in the context of Mercosur. However, this interpretation of the constant would be dubious in our context: strategic price cuts ought to be systematically related to the depth of tariff preferences and thus should not be picked up by the constant.

22. Let R^Z denote the 2-year average value of the ratio of Mexican intermediate good purchases from the United States to those from the rest of the world, and let R^F denote the 2-year average value of the ratio of Mexican sales of final goods to the United States to those to the rest of the world. Likewise let V , the ratio of specialization in intermediate purchases in the United States over final sales to the United States be an indicator of the extent of vertical trade between Mexico and the United States. Let 1998–2000 averages be representative of NAFTA and 1992–94 be representative of pre-NAFTA averages. The figure cited in the text refers to the increase in these indicator values following the implementation of NAFTA. See Anson and others (2005) for a further description of these results.

developments suggest poor Mexican access to the U.S. market and a shift to a vertical pattern of Mexican–U.S. trade, as predicted by the ex ante analysis of Krueger (1993). Along with the econometric results, these quantity developments suggest the fruitfulness of carrying out illustrative simulations that help capture the likely welfare effects of the presence of rules of origin revealed in the pass-through estimates.

Model Sketch

To calculate orders of magnitude of the effects of NAFTA on Mexican exporters, simulations are carried out with a partial equilibrium structural model (see supplemental appendix 6) inspired from the model presented in section I and calibrated to take into account the results in tables 4 and 5. Suppose that Mexican apparel producers sell all their output abroad, either to the United States under NAFTA, X^{US} , or to the rest of the world, X^{ROW} . (No domestic sales simplifies the welfare analysis, but it results in an overestimate of the welfare gains from NAFTA preferences because higher prices for Mexican consumers are not taken into account.) They direct their sales to each market depending on relative profits per unit, according to a constant elasticity of transformation function with elasticity Ω .

Likewise, to simplify the evaluation, Mexican producers purchase all their intermediate goods abroad, either from the United States, Z^{US} , or from the rest of the world, Z^{ROW} . A Leontief technology links value-added and aggregate intermediate demand, a_z . Assume an upward-sloping supply curve for value added in the Mexican textiles and apparel industry (if value-added has an infinitely elastic supply, there would be no opportunity costs for capital and labor, and welfare effects of NAFTA would be 0). And let ε_X be this elasticity of supply and P_X^{US} the unit producer price of Mexican apparel exported to the U.S. market. The unrestricted unit cost under nonbinding rules of origin is C_z , and the restricted cost under binding rules of origin is C_z^R . To capture the market power to U.S. producers of the rules of origin negotiated under NAFTA (the captive market effect), it is assumed that under NAFTA, only Mexican producers purchase U.S. intermediate goods at increasing cost—that is, they face a finite supply elasticity of U.S. intermediate goods ($\varepsilon_Z^{US} < \infty$). Finally, let λ be the administrative cost component of complying with rules of origin, assumed to be fixed per unit of apparel sold to the United States. In line with the econometric evidence in table 5, U.S. producers of intermediate goods are not penalized by the presence of rules of origin negotiated under NAFTA.

Mexican apparel producers sell most of their apparel to the United States (80 percent in the illustrative simulations in table 6) and are assumed to be price-takers when they sell their apparel to the rest of the world. U.S. demand for apparel is represented by a Marshallian demand curve with elasticity ε , and, as in section I, income effects are omitted. U.S. consumers choose between apparel from Mexico and the rest of the world according to a constant elasticity of substitution function with elasticity σ_Q .

TABLE 6. Simulation Results

Percent	1	2	3	4	5	6	7
ε_Z^{US}	8	8	8	8	5	5	5
λ	0	0	2	2	2	2	2
$\Delta t_X \equiv (t_X^M - t_X^N)$	10	10	10	10	10	10	10
$\Delta t_Z \equiv (t_Z^M - t_Z^N)$	0	10	10	10	10	10	10
$(\frac{Z}{X})$	40	40	40	40	40	60	60
$\left[\frac{z^{US}}{Z^{US} + Z^{ROW}} \right]_0$	30	30	30	30	30	30	40
$\left(\frac{z^{US}}{Z^{US} + Z^{ROW}} \right)_1^{(R)}$	30	32	32	(38) ^a	(38) ^a	(38) ^a	(52) ^a
Results	Percent change from corresponding base values						
X^{US}	11.0	15.5	13.2	9.8	8.7	10.9	9.5
P_X^{US}	7.2	6.1	4.6	5.5	5.7	5.2	5.5
P_Z^{US}	0.0	0.0	0.0	0.0	6.7	7.1	7.7
$C_Z(C_Z^R)$	0.0	-9.1	-9.1	(-2.1)	(0.2)	(0.4)	(1.9)
W_P	20.1	30.4	20.6	18.2	15.6	20.6	17.4
G	9.6	-22.3	-23.6	-31.7	-32.4	-31.0	-46.5
W_T	19.5	27.2	22.9	15.0	12.6	13.9	9.1

$Z(X)$, intermediate good; λ , administrative costs (percent of unit cost); G , government tariff revenue; $W_P (= P_{VA}X)$, private welfare [see also equation 19 in the text; $W_T (= G + W_P)$ is total welfare].

^aCorresponds to a binding regional value content.

Note: All simulations, assume $\varepsilon = 1$, $\varepsilon_X = 1$, $\sigma = 1$, $\sigma_Q = 5$, $\Omega = 1$. $ES_0 = [X^{US}/(X^{US} + X^{ROW})] = 80$ percent. See equation 22 in the text for definition of variables.

Source: Authors' estimates.

For a small NAFTA preference margin ($\Delta t \equiv t^M - t^N < 0$), the percentage increase in producer surplus from preferential market access \hat{W}_p ²³ (here equal to the private welfare benefit under the assumption of no domestic demand) is

$$(19) \quad \hat{W}_p = \left(1 + \hat{P}_{VA}\right)^{1+\varepsilon_X} - 1 \approx (1 + \varepsilon_X)\hat{P}_{VA}.$$

Nothing prevents \hat{W}_p from being negative, in which case Mexican apparel producers would not export under NAFTA.

As in section I, the distortional cost of rules of origin is black boxed through a regional value content equivalent. If subscript 0 denotes profit maximizing per unit use of U.S. intermediate goods before NAFTA and subscript 1 denotes the corresponding use by the representative competitive Mexican firm when it faces binding rules of origin and preferential access, on the cost side

$$(20) \quad z^R \equiv \frac{Z_1^{US}}{Z_1^{ROW}} > z^0 \equiv \frac{Z_0^{US}}{Z_0^{ROW}}$$

23. Let hats ($\hat{\cdot}$) denote a percentage change in the variables.

which gives the restricted cost function for intermediate goods

$$(21) \quad C_Z^R = P_Z^R(z^R, P_z^{ROW}; \sigma)$$

where P_z^{ROW} is the price of intermediate goods purchased outside NAFTA and σ the elasticity of substitution in use between intermediate goods from the United States and the rest of the world. Thus, $C_Z^R > C_Z$ in the presence of binding rules of origin, and equation 18 captures the distortionary costs associated with rules of origin.

Equilibrium in the U.S. market for Mexican apparel requires U.S. demand for Mexican goods, Q_{US}^{Mex} , to equal Mexican supply to the United States, X^{US} , as reflected in equation 22. NAFTA has effects on the demand and supply sides. On the demand side, the preference margin, Δt , reduces the consumer price of Mexican apparel, P_Q^{Mex} , sold in the United States. On the supply side, rules of origin (r, λ) raise the unit cost of sales to the United States, $P_X^{US}(r, \lambda)$. Likewise, when U.S. producers of intermediate goods have market power, Mexican production costs are raised. Equilibrium under NAFTA in the Mexican apparel industry is achieved by adjusting the unit price of Mexican apparel exports to the United States until $P_Q^{Mex} = P_X^{US}$. The reduced-form expression corresponding to the underlying structural model (see supplemental appendix 6) for equilibrium in the Mexican apparel sector can then be written in terms of demand and supply elasticities, and share parameters describing the sector before NAFTA can be written as:

$$(22) \quad Q_{US}^{Mex} \left[P_Q^{Mex}(\Delta t); \varepsilon, \Omega, \sigma_Q \right] = X^{US} \left[P_X^{US}(r, \lambda); \varepsilon_X, a_Z, \varepsilon_Z^{US}, \sigma \right]$$

where ε is the U.S. apparel price elasticity of import demand and σ_Q the elasticity of substitution between apparel from Mexico and the rest of the world in U.S. apparel demand.

Welfare Estimates

Table 6 describes the results of illustrative simulations with calibration inspired from the pre-NAFTA shares given above and the pass-through estimates reported in section II. Because no econometric estimates of the various elasticities are available, they are all assumed to be equal to unity (i.e., $\varepsilon = \sigma = \Omega = \varepsilon_X = 1$), except for those influencing Mexican and U.S. pass-through, that is, σ_Q and ε_Z^{US} .²⁴ The simulations start in a pre-NAFTA situation where Mexican apparel producers benefit from a 10 percent tariff preference in the United States and U.S. producers of intermediate goods benefit from a 10 percent tariff preference when they sell in Mexico. These starting values are roughly in line with the

24. Assuming $\sigma_Q = 5$ gives a value of the pass-through of approximately 0.7, which is close to the econometric estimates in table 4. Likewise, $\varepsilon_Z^{US} = 5$ yields an estimated pass-through of close to 0.7, also in line with the results in table 5.

aggregate data in tables 2 and 3 if factoring in that Mexican producers of apparel probably had a margin of preference in excess of the most-favored-nation tariff (6 percent) because of binding quotas under the Agreement on Textiles and Clothing. Moreover, assuming symmetry in preferences helps to further isolate the determinants of NAFTA's welfare effects under asymmetric rules of origin. Except in column 7, the unrestricted share of intermediate textile imports from the United States is assumed to be 30 percent, and, in line with the data, Mexicans initially export 80 percent of their apparel products to the United States. All these assumptions are described in the top part of table 6, where the corresponding row indicates the assumed values for the parameters leading to the results in the corresponding column. To ease interpretation, simulations are additive for the first five columns (the last two columns report on sensitivity analysis on the results given in column 5) so that the results of any given column are directly comparable to the results in the preceding column.

Simulations are intended to give orders of magnitude of sequentially adding the NAFTA effects detected above. Start then with the results in column 1. Giving a 10 percent preference to Mexican exporters of apparel to the United States allows them to retain 7.2 percent of the price preference, and exports to the United States increase 11 percent. Private welfare goes up by 20.1 percent, and government revenue increases by 9.6 percent. In column 2, the 10 percent tariff on the purchase of intermediate goods from the United States is eliminated. Because rules of origin have not yet been introduced, Mexican producers benefit from paying a lower price for their purchases of intermediate goods from the United States. Since they minimize costs, they also increase their share of U.S. intermediate good purchases to 32 percent, and unit costs fall 9.1 percent. Lower intermediate costs are reflected in a slightly lower increase in the unit sale price to the United States (and also to the rest of the world), and total welfare goes up even more despite the tariff revenue loss, thanks to the gains from removing a distortion.

The effects of rules of origin are added successively in columns 3, 4, and 5. In column 3, a 2 percent per unit cost is added to account for the administrative costs associated with compliance with rules of origin. This estimate is borrowed from the nonparametric estimates reported in Carrère and de Melo (2005). Not surprisingly, benefits from NAFTA for Mexican exporters decrease markedly. In column 4, the regional value content scheme is introduced. It forces Mexican producers to increase their purchase of U.S. intermediate goods 25 percent (the observed increase mentioned above). This regional value content serves as a proxy for the costs associated with exceptions and the various technical requirements that have to be met to obtain originating status. For the chosen parameter configuration and assumed preferential access, unit costs still fall, but export sales increase by only 9.8 percent, and welfare gains are almost halved from what they would be in the absence of rules of origin. Finally, in column 5, the market power and pass-through effects for U.S. producers of intermediate goods are added. Mexican firms can no longer assume a fixed price ($\varepsilon_Z^{US} = \infty$) to

purchase U.S. intermediate goods; instead, they face an upward-sloping U.S. supply of intermediate goods, with unit costs up by 6.7 percent. Welfare gains are further reduced to less than half their estimated value in the absence of rules of origin. Arguably, this is a conservative estimate, since the data indicate that despite NAFTA, the ratio of Mexican exports of textiles and apparel to the United States barely increased 2 percent.

The last two columns give results of NAFTA, factoring in all the rules of origin effects, but starting from different parameter values. In column 6, the share of intermediate goods in apparel is increased from 40 to 60 percent. Two opposite effects—a gain from tariff reduction and a loss from paying a higher price for U.S. intermediate goods—almost cancel each other out, so that the overall effect is small. In column 7, the 25 percent increase in the share of purchases of U.S. intermediate goods is assumed to start at 40 percent (instead of 30 percent). The regional value content is more constraining, and gains from NAFTA implementation are down to a third of their estimated values in the absence of rules of origin.

IV. CONCLUDING REMARKS

This article studied Mexican access to the U.S. market under NAFTA in the textiles and apparel sector and shows that only about half the tariff preference (of about 8 percent) was retained by Mexican producers. The induced upstream effect on the price of U.S. intermediate (textile) goods used in the production of Mexican final (apparel) goods is found to be significant and rather large. The price of U.S. intermediate goods sold to Mexico is, on average, 12–13 percent higher than the price of the same goods for export to other (nonpreferential) destinations. The elimination of the tariff on imports of U.S. intermediate goods by Mexican producers thus did not result in lower intermediate goods costs. Technical requirements (a particular form of rules of origin that is prevalent in the textiles and apparel sector) alone account for a full third, or about 4 percentage points, of that price increase—a strong signal in otherwise noisy data.

On the basis of these estimates, simulations were conducted in a stripped-down model of the Mexican textiles and apparel sector, in which Mexican apparel producers can sell to the rest of the world with no conditions or to the United States under NAFTA with the condition that they increase their purchases of U.S. textile intermediate goods. The results confirm that preferential margins of the magnitude granted under NAFTA severely reduced the gains from NAFTA for Mexican exporters. Arguably, plausible parameter estimates suggest that welfare gains were easily reduced by half because of the rules associated with proving the goods' origin.

Beyond the specifics of the textiles and apparel sector under NAFTA, these results inform the debate on the usefulness of trade preferences as a development tool. Because preference margins are limited to the level of most-favored-nation

tariffs, which for industrial countries are fairly low (with apparel among the few exceptions), preferences absorbed in half by a combination of higher costs and pass-through to buyers are likely to be of limited value to developing country partners. Taken together, the results support the suspicion that rules of origin are less a development policy tool to prevent screwdriver assembly (a potentially worthy objective) and more a circuitous way of raising the profits of upstream producers by creating a captive market for them in partner countries. This is likely to be especially important in preferential trade arrangements between developed and developing countries where vertical trade (capital-intensive component manufacturing in developed countries, labor-intensive assembly in developing countries) is prevalent. The flurry of regional trade agreements may then well be a costly diversion that distracts from necessary reforms to improve the functioning of the world trading system.

SUPPLEMENTARY DATA

Supplementary data can be found at www.wber.oxfordjournals.org.

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The Effects of NAFTA on Antidumping and Countervailing Duty Activity

Bruce A. Blonigen

Treatment of unfair trade laws has become an important topic in negotiations on preferential trading areas. Recent preferential trading areas involving the United States, one of the most significant users of these laws, have established special binational dispute settlement panels to arbitrate disagreements. Using a panel database of U.S. antidumping and countervailing duty activity from 1980 through 2000, the article examines whether the use of dispute settlement panels has reduced such activity between the United States and its North American Free Trade Agreement partners. The analysis finds little evidence for any effect, calling into question the effectiveness of dispute settlement panels in reducing unfair trade law activity.

With the success of multilateral trade negotiation rounds under the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) in reducing traditional forms of trade protection, such as tariffs and quotas, attention has turned to the use of antidumping and countervailing duty laws by WTO member countries. In some countries, these laws have been on the books since well before the GATT/WTO existed. However, as GATT/WTO membership has grown over the past two decades, such activity has exploded.¹

This trend is worrisome for its implications for the ultimate effectiveness of recent and future GATT/WTO rounds. It may be that countries with antidumping and countervailing duty laws are willing to negotiate greater reductions in other forms of trade protection, since such laws allow the most import-sensitive sectors a channel of relief when negotiated reductions in trade barriers take place. But it is also the case that increased antidumping and countervailing duty activity may seriously undermine free trade agreements that do not fully address

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1. See Prusa (2001) for analysis of the recent spread of antidumping and countervailing duty laws and their use across WTO member countries. Blonigen and Prusa (2003) provide an extensive survey of the literature on the economics of antidumping activity.

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the use of such laws.² In recent WTO meetings, it has become apparent that traditional users of antidumping and countervailing duty laws, particularly the United States, have been extremely reluctant to allow such laws even to be put on the agenda of future WTO negotiations. As the Doha Round has stagnated, countries have focused efforts on negotiating preferential trading areas.

The United States is a substantial user of antidumping and countervailing duty laws and also has made renewed efforts in the past decade to negotiate preferential trading areas. In both the Canadian–U.S. Free Trade Agreement (CUSFTA) and the North American Free Trade Agreement (NAFTA), the United States strongly resisted calls by Canada and Mexico for suspension of antidumping and countervailing duty activity.³ Instead, a compromise was reached, and codified in Chapter 19 of CUSFTA and NAFTA, to establish binational panels to review antidumping and countervailing duty actions between member countries when requested by an involved party (Gantz 1998).⁴ Did this compromise solution have any impact on antidumping and countervailing duty activity? The answer is important not only for future preferential trading areas negotiated by the United States, such as the Free Trade Area of the Americas,⁵ but also for any bilateral or multilateral trade negotiations involving countries with such laws.

On the one hand, the NAFTA binational dispute panels might not be expected to have much effect, since they are limited to determining whether a country appropriately followed its own national laws in making a particular antidumping or countervailing duty determination. Thus, the review panels can neither question nor change such laws, which was a crucial issue for the United States. On the other hand, the process provides an alternative to having national courts handle appeals of antidumping and countervailing duty decisions, thus offering the possibility of greater impartiality.⁶ And, in fact, virtually all appeals of U.S. antidumping and countervailing duty decisions by Canada and Mexico since NAFTA have come through the dispute settlement mechanism rather than national courts of appeals, and the dispute panels have often remanded decisions to U.S. agencies, resulting in changes to the original rulings (Macrory 2002). In addition, Jones (2000) finds that both U.S. antidumping filings against Canada

2. While antidumping and countervailing duty activity often involves narrowly specified import products, the high duties often imposed and other features of the administration of these programs can result in substantial welfare impacts. Gallaway, Blonigen, and Flynn (1999), using 1993 data, estimate that U.S. antidumping and countervailing duty programs cost the United States \$4 billion annually.

3. In January 1994, CUSFTA was incorporated into NAFTA, which was expanded to include Mexico.

4. The Chapter 19 review process was separate from a more general dispute settlement mechanism for all NAFTA-related issues stipulated in Chapter 20.

5. The U.S. use of antidumping and countervailing duty laws has been a particular concern to Argentina and Brazil in the negotiations for a Free Trade Area of the Americas (FTAA). For example, a January 31, 2001, front-page article in Brazil's *Gazeta Mercantil* reported that antidumping issues had led to an FTAA negotiation impasse between Brazil and the United States.

6. The national courts of appeals for unfair trade cases are the Court of International Trade of the United States, the Federal Court of Canada, and the Federal Fiscal Tribunal of Mexico.

and Canada's antidumping filings against the United States dropped significantly after CUSFTA, which he attributes to the dispute settlement process.⁷

This article provides a more detailed empirical examination of U.S. antidumping and countervailing duty actions from 1980 through 2000 to determine the effects, if any, of the dispute settlement panels established under CUSFTA and NAFTA on U.S. antidumping and countervailing duty activity with respect to Canada and Mexico.⁸ This article improves on Jones's (2000) statistical approach in a number of ways. First, Jones limits his sample to observations on U.S. and Canadian antidumping and countervailing duty activity. This holds each regression to just 18 observations and does not adequately control for trends in U.S. antidumping and countervailing duty activity that may affect all countries equally. In contrast, this article samples and estimates U.S. antidumping and countervailing duty activity across all U.S. import sources, a better strategy for distinguishing the effects of Chapter 19 on U.S. antidumping and countervailing duty activity against its NAFTA partners from other general trends in such U.S. activity. Second, Jones estimates the effects of the Chapter 19 dispute settlement process through a simple dummy variable indicating the years since CUSFTA was established. Such a variable could be picking up the effects of myriad other changes that may have coincidentally occurred after the establishment of the dispute settlement process. This article uses detailed measures of actual Chapter 19 dispute settlement activity to more accurately test the effect on antidumping and countervailing duty activity. Finally, Jones examines only the impact on the frequency of U.S. antidumping and countervailing duty cases against Canada, not on the outcomes. The analysis here examines the impact not only on U.S. filings but also on the likelihood of successful filings.

In contrast to the previous literature, this analysis finds little evidence that Chapter 19 has significantly affected U.S. antidumping and countervailing duty activity against its NAFTA partners. In particular, for Mexico there is no evidence that Chapter 19 activity significantly lowered U.S. filings or the number of affirmative decisions. This result is robust to measuring Chapter 19 activity as recent filings or as recent filings that led to remands for U.S. government agencies to redetermine their original decisions. The results are also statistically insignificant when Chapter 19 activity is specified as cumulative filings or remands rather than as those from the previous year. There is likewise no evidence that Chapter 19 dispute settlement filings or remands affected the

7. A few law journal articles and U.S. General Accounting Office (now the Government Accountability Office) reports have observed a number of developments in the operation of the binational review panels stipulated under Chapter 19. U.S. GAO (1997); Vega-Canovas (1997); Gantz (1998); and Pippin (1999) assess how well the binational panel system reviews have worked in fulfilling their stipulated goals.

8. The primary focus on U.S. antidumping and countervailing duty activity is due to data accessibility issues, as well as the fact that the United States is the largest market in NAFTA and the largest user of antidumping and countervailing duty laws.

number of U.S. cases against Canada. This contrasts with the findings of Jones (2000). However, there is evidence that cumulative Chapter 19 filings and remands did lower the number of affirmative U.S. antidumping and countervailing duty decisions for Canada. Surprisingly, import penetration is not found to be a statistically significant variable for determining U.S. antidumping and countervailing duty activity, so the increased trade volumes resulting from CUSFTA and NAFTA also are unlikely to have affected U.S. activity.

I. ANTIDUMPING AND COUNTERVAILING DUTY INVESTIGATIONS AND CHAPTER 19 DISPUTE SETTLEMENT PROCEDURES

There are many common features in the application of antidumping and countervailing duty protection across countries, primarily because successive rounds of GATT/WTO multilateral trade negotiations have codified standard practices.⁹

Antidumping and countervailing duty cases begin with a petition from a domestic industry (or related party such as a labor union or trade association) for protection against imports that are allegedly being dumped—sold at unfairly low prices. Before remedies can be put into place, the appropriate authorities must rule on whether the alleged unfair trade practice is occurring and if so on whether it has caused or threatened to cause “material injury” to the domestic industry. For antidumping cases, the authorities first determine whether dumping is actually occurring by comparing transactions in the import market against some measure of “fair” or “normal” value. For countervailing duty cases, the authorities must determine whether the foreign government is providing an export subsidy to its firms and then calculate the magnitude of such subsidy. Then, for both antidumping and countervailing duty cases, the authorities must examine economic data such as import penetration, domestic industry performance, and macroeconomic effects and decide whether the imports are a significant cause of injury or potential cause of injury.

If material injury is found, the authorities impose duties to remedy the “unfair” imports. U.S. statutes allow for appeals of antidumping and countervailing duty decisions through a number of channels. Parties can appeal decisions to a higher national court within the country applying the unfair trade remedy. As WTO members, involved parties and governments can also take decisions to the WTO dispute settlement process.

CUSFTA and NAFTA added another avenue for appeal, Chapter 19, which permits bypassing national courts and appealing decisions directly to a five-member binational review panel. Two panel members must come from each

9. The NAFTA negotiations also pushed Mexico to reform its antidumping and countervailing duty laws in a number of substantial ways. Most of the reforms were to add the much-needed due process features to Mexican procedures, including the abolition of provisional duties before preliminary decisions, full participation by involved parties in the administrative process, timely written notifications of decisions, and the right to immediate appeals. See Giesze (1994) and Pippin (1999) for further details.

country represented in the dispute, drawn from a list of 25 people designated by each country. The fifth member is chosen from the list of one of the represented countries. In practice, countries seem to take turns choosing this fifth member.

The panel is charged with establishing whether the national authority made errors in “fact or law” in its determination, as set out in the complaint. Thus, the application of the national antidumping or countervailing duty law is under review, not the laws themselves. The panel either affirms the original decision or remands the decision to the national authority for reconsideration. Panels cannot reverse or dismiss a decision. Application of unfair trade remedies is not affected unless a dispute settlement panel remands a decision to the national authority and the authority changes its original ruling.

The consensus seems to be that the panels were working well under CUSFTA (before NAFTA), with judgments that were considered fair, noncontroversial, and impartial for both countries (see, for example, U.S. GAO 1997, p. 14). Many of the early decisions under CUSFTA were being administered within the stipulated 315 days, a substantial improvement over the standard timeline of national appeals courts. However, implementation under NAFTA has gone less smoothly. In particular, cases concerning Mexico have not been timely, causing concern on the part of Mexican officials. Part of the problem has been language difficulties and finding qualified Mexican experts to sit on the panels. In addition, satisfaction with panel decisions involving both Canada and Mexico has been much lower with the higher profile cases, such as the pork, swine, and softwood lumber cases. The lumber case was ultimately resolved by high-level negotiations between the United States and Canada, not through the Chapter 19 settlement process.

II. HYPOTHESES

CUSFTA and NAFTA led to two developments that could substantially affect U.S. antidumping and countervailing duty activity—increased imports and a new dispute resolution mechanism. To the extent that import penetration increases antidumping and countervailing duty activity, the increase in imports from Canada and Mexico could lead to an increase in U.S. antidumping and countervailing duty filings against NAFTA partner countries. Thus, import penetration (the value of a country’s imports as a share of U.S. GDP) would be expected to be positively correlated with U.S. antidumping and countervailing duty activity.

The new dispute settlement mechanism under CUSFTA and NAFTA brought greater external scrutiny of U.S. administration of its antidumping and countervailing duty laws, which might reduce the incidence of such activity with respect to Canada and Mexico. There were 48 filings by Canada and 20 filings by Mexico against the United States through 2000 (table 1). For both countries in roughly a third of the cases, the original decision by the U.S. agencies was affirmed, in a third the cases were remanded to the U.S. authorities for reconsideration, and in a third the cases were terminated (withdrawn) before the panel made any decision. As discussed by Jones (2000), in a handful of cases the

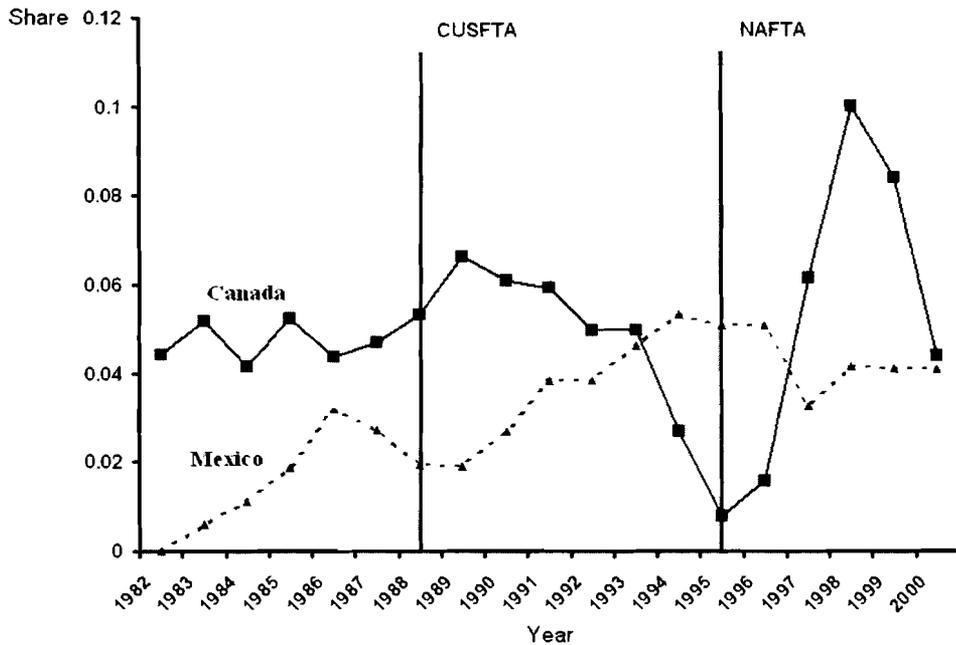
TABLE 1. CUSFTA and NAFTA Chapter 19 Dispute Settlement Petitions and Determinations Regarding U.S. Antidumping and Countervailing Duty Actions, 1989–2000

Year	Canadian Filings Against the United States				Mexican Filings Against the United States			
	Filings	Affirmed	Remanded	Terminated	Filings	Affirmed	Remanded	Terminated
1989	11	6	4	1	Not applicable	Not applicable	Not applicable	Not applicable
1990	3	0	1	2	Not applicable	Not applicable	Not applicable	Not applicable
1991	5	0	2	3	Not applicable	Not applicable	Not applicable	Not applicable
1992	6	1	5	0	Not applicable	Not applicable	Not applicable	Not applicable
1993	5	2	1	2	Not applicable	Not applicable	Not applicable	Not applicable
1994	1	0	1	0	1	1	0	0
1995	1	1	0	0	4	2	2	0
1996	0	0	0	0	1	0	0	1
1997	3	0	1	2	5	1	1	2
1998	2	1	1	0	3	0	0	0
1999	5	0	0	5	2	0	0	0
2000	6	0	0	3	4	0	0	0

Note: The nine Mexican filings for 1998–2000 and three Canadian filings in 2000 are still active investigations.

Source: NAFTA Secretariat http://www.nafta-sec-alena.org/DefaultSite/index_e.aspx.

FIGURE 1. Three-Year Moving Average of Canadian and Mexican Share of Total U.S. Anti-dumping and Countervailing Duty Activity, 1980–2000



Source: Author's analysis using data on U.S. antidumping and countervailing duty cases reported in the Federal Register. Some of the data are available from the author's U.S. antidumping web page: <http://darkwing.uoregon.edu/~bruceb/adpage.html>.

remands led to some changes from the original decision.¹⁰ While there was significant activity involving both countries, Mexican cases have generally taken longer, with cases filed in 1998 (or later) still to be determined as of this writing. This may lead to some differences in the effect of Chapter 19 activity on U.S. antidumping and countervailing duty cases.

There is little evidence based on the number of cases of a significant change in the average share of U.S. antidumping and countervailing duty activity for Canada after CUSFTA or for Mexico after NAFTA (figure 1). While this simple analysis suggests little effect of Chapter 19 activity on U.S. antidumping and countervailing duty actions against its NAFTA partners, other factors that may not be particular to the NAFTA partners may have been affecting U.S. antidumping and countervailing duty activity during these time periods. Econometric analysis is needed to control for these other factors.

10. These are documented in Jones (2000, table 2). The largest change was a remand that led to elimination of the countervailing duty on Canadian softwood lumber, which then led to negotiations between the United States and Canada. U.S. cases against red raspberries, pork, steel rail, live swine, and magnesium also had remands that resulted in somewhat lower duties.

III. ECONOMETRIC ANALYSIS

An empirical model was developed to estimate the impact of NAFTA on anti-dumping and countervailing duty activity. The dependent variable is the number of U.S. antidumping and countervailing duty petitions against a particular import source for a given year.¹¹ Following standard practice, petitions across import sources and time are assumed to follow a discrete distribution—the negative binomial distribution. It can be assumed that the parameter governing the frequency of antidumping and countervailing duty actions for these distributions is a linear function of explanatory variables. The effect of these explanatory variables on the observed frequency of antidumping and countervailing duty actions can then be estimated through maximum likelihood techniques.¹²

The list of included explanatory variables begins with import penetration. As discussed in the *Hypotheses* section, increased import penetration is expected to have a positive impact on U.S. antidumping and countervailing duty activity against the source country. Thus, the coefficient on import penetration can provide an estimate of the effect of increased import penetration by NAFTA partners on U.S. antidumping and countervailing duty activity toward these partners.

A number of annual Chapter 19 filings by Canada and Mexico are used to test the effect of Chapter 19 activity on U.S. antidumping and countervailing duty activity against its NAFTA partners. Since Canadian filings are expected to affect U.S. activity only against Canada and analogously for Mexico, each filing measure is interacted with a dummy variable indicating the import source. The expectation is that a greater number of Chapter 19 filings will reduce current filings and affirmative decisions of U.S. antidumping and countervailing duty cases against Canada and Mexico. Because U.S. filings and decisions may be affected only when Chapter 19 filings led to reconsiderations of previous cases, an alternative estimate considers measures of annual Chapter 19 remands as an explanatory variable as well. The analysis assumes that there were no other changes (legal or otherwise) that altered incentives for parties to pursue other channels of appeal.

In determining appropriate explanatory variables, the analysis here follows a number of previous statistical analyses of the factors that determine the

11. An alternative measure of activity is the volume of imports subject to investigations from a particular import source in a given year, since a count measure makes the implicit assumption that all cases are equally important in terms of import volume. However, import volumes for products subject to antidumping and countervailing duty investigations are often not publicly reported because of confidentiality concerns when the case involves a small number of firms.

12. Examples of such papers using maximum likelihood estimation of Poisson or negative binomial distributions to model the frequency of U.S. antidumping activity include Feinberg (1989); Feinberg and Hirsch (1989); Jones (2000); and Knetter and Prusa (2003). A more extensive literature has examined the factors that determine the outcomes of these filed petitions, including Finger, Hall, and Nelson (1982); Moore (1992); DeVault (1993); Baldwin and Steagall (1994); Blonigen and Feenstra (1997); and Hansen and Prusa (1997).

frequency of U.S. antidumping and countervailing duty action generally. Following Knetter and Prusa (2003), real U.S. GDP growth and the real exchange rate (foreign currency per U.S. dollar, specific to each country or region) are included, with lower real GDP growth and appreciation of the U.S. currency relative to the import sources expected to make antidumping and countervailing duty filings more likely. Following Jones (2000), corporate profitability and unemployment variables are included, with lower corporate profitability and higher unemployment expected to increase U.S. filings. Change in import penetration is included to control for any effect of import penetration not explained by exchange rate movements, such as trade protection changes instituted by CUSFTA and NAFTA. Higher import penetration is expected to be associated with greater filing activity. Following Knetter and Prusa (2003), the explanatory variables are lagged by one year, since U.S. authorities use economic data from recent previous years to determine dumping and injury. Regional fixed effects are also included to control for unobserved region-specific features that may increase or decrease the incidence of U.S. antidumping and countervailing duty activity against a particular region, everything else being equal.

Data

To serve as controls, data on U.S. antidumping and countervailing duty activity with respect to other import sources are also included. Thus, the dataset consists of a balanced panel covering 1980 through 2000 and includes seven import sources: Canada, Mexico, Japan, the European Union, Latin America excluding Mexico, Asia excluding Japan, and the rest of the world. The first four countries and regions are the major U.S. trading partners, and the final three are commonly used regional groupings. Starting the sample in 1980 is standard in the literature, as this is the year when the United States made a major change in its antidumping and countervailing duty laws and activity. With seven regions and 21 years, the sample numbers 147 observations.¹³

Data on U.S. antidumping and countervailing duty filing activities and decisions for 1980–2000 for the dependent variable come from the U.S. Antidumping Database constructed by the author and available from the National Bureau of Economic Research web site (<http://www.nber.org/antidump>). Data on Chapter 19 dispute settlement proceedings and decisions are available from the NAFTA Secretariat (http://www.nafta-sec-alena.org/DefaultSite/index_e.aspx). Data on annual U.S. corporate profits, U.S. unemployment rate, and U.S. GDP growth rate are from *Economic Report of the President* (Council of Economic Advisers 2002, tables B-94, B-42, and B-1). Data on import flows come from the *Direction of Trade Statistics Yearbook* (IMF various years).

13. In contrast, Jones (2000) runs separate equations for the United States and Canada covering 1980–97, which means that each regression is based on only 18 observations and does not benchmark relative to a control group.

Real exchange rate data for Mexico, Canada, and Japan come from the Economic Research Service of U.S. Department of Agriculture (USDA ERS) and are available from its web site (<http://www.ers.usda.gov/data/sdp/>). The real exchange rate for the rest of the world comes from the broad index of the real U.S. dollar exchange rate of the *Economic Report of the President* (Council of Economic Advisers 2002, table B-110). And the real exchange rate for the European Union, Latin American, and Asian regions are calculated as trade-weighted averages of the real exchange rates for important countries from those regions, using the USDA ERS dataset. Each real exchange rate index was normalized by dividing each annual observation by the index's sample mean.

Table 2 provides descriptive statistics for the explanatory variables and dependent variables used in the statistical analysis, as well as the expected sign on the coefficient for each explanatory variable.

Econometric Analysis: Initial Specifications

The results of the negative binomial maximum likelihood estimates of the explanatory factors for U.S. antidumping and countervailing duty filings and affirmative decisions are reported for the total annual number of U.S. filings and for affirmative decisions only (table 3). Many of the general results also hold for alternative estimates, as discussed below.

The overall fit of the equation is generally good, with a Wald statistical test easily rejecting the hypothesis of jointly insignificant explanatory variables at the 99 percent confidence level. While the fit of the equation is statistically significant, the control variables are generally not, though four of the five have the expected sign. The general pattern for the alternative estimations is for import penetration, the exchange rate, and corporate profitability to have the expected sign, with coefficients for corporate profitability and the exchange rate often statistically significant at standard confidence levels. The result that exchange rate appreciation is correlated with higher U.S. antidumping and countervailing duty activity accords with the findings of Knetter and Prusa (2003). Jones (2000) finds that lower U.S. corporate profitability led to a greater incidence of U.S. antidumping and countervailing duty activity.

Several of the regional fixed effects are statistically significant and yield an interesting pattern. In particular, both Canada and Mexico have statistically significant negative coefficients, with the estimates suggesting that both countries experience about six fewer U.S. duty cases each year than the omitted regional fixed effect, rest of the world, everything else being equal.¹⁴

With respect to the focus variables, there is little evidence that NAFTA Chapter 19 filings affect annual U.S. antidumping and countervailing duty filings. The coefficient on NAFTA dispute settlement filings by Canada is, as expected,

14. Marginal effects are not the coefficient estimates in this nonlinear specification. Rather, they were numerically calculated using the econometric package STATA.

TABLE 2. Descriptive Statistics for Variables Used in Econometric Analysis and Expected Coefficient Signs for Explanatory Variables

Variable	Expected Sign	Mean	Standard Deviation	Minimum	Maximum
<i>Dependent variable</i>					
Filings of antidumping and countervailing duty cases		9.31	13.14	0.00	116.00
Filings of antidumping cases only		6.49	7.23	0.00	46.00
Affirmative antidumping and countervailing duty cases		3.54	4.08	0.00	21.00
Affirmative antidumping and cases only		2.84	3.47	0.00	20.00
<i>Explanatory variable</i>					
Canadian NAFTA dispute settlement filings \times dummy variable for Canada	–	0.30	1.41	0.00	13.00
Mexican NAFTA dispute settlement filings \times dummy variable for Mexico	–	0.11	0.61	0.00	5.00
Canadian NAFTA dispute settlement remands \times dummy variable for Canada	–	0.09	0.52	0.00	5.00
Mexican NAFTA dispute settlement remands \times dummy variable for Mexico	–	0.02	0.18	0.00	2.00
Import penetration	+	0.01	0.01	0.00	0.03
Real exchange rate	+	1.01	0.15	0.68	1.46
Real GDP growth	–	3.03	1.95	–2.00	7.30
Unemployment rate	+	6.48	1.42	4.20	9.70
Corporate profitability	–	4.56	1.37	0.80	6.20

Note: See discussion under *Data* for more detail on sources and variable construction.

Source: Author's analysis based on data described in the text.

TABLE 3. Negative Binomial Maximum Likelihood Estimates of the Determinants of the Number of U.S. Antidumping and Countervailing Duty Activities: Effects of NAFTA Dispute Settlement Filings

Regressor	Total Filings		Affirmative Decisions Only	
	Antidumping and Countervailing Duty	Antidumping Only	Antidumping and Countervailing Duty	Antidumping Only
<i>Focus variables</i>				
Canadian NAFTA dispute settlement filings \times dummy variable for Canada	-0.073 (-1.29)	-0.081 (-0.97)	-0.163 (-1.23)	-0.154 (-1.18)
Mexican NAFTA dispute settlement filings \times dummy variable for Mexico	0.140 (1.26)	0.195* (1.73)	0.018 (0.10)	0.087 (0.54)
<i>Control variables</i>				
Import penetration	4.165 (0.24)	0.160 (0.01)	19.809 (0.77)	-2.925 (-0.12)
Exchange rate	0.198 (0.42)	0.860** (2.14)	0.341 (0.71)	0.789 (1.64)
Real GDP growth	0.045 (1.26)	0.038 (1.08)	0.026 (0.61)	0.004 (0.08)
Unemployment rate	0.073 (1.26)	-0.024 (-0.45)	-0.031 (-0.44)	-0.130* (-1.69)
Corporate profitability	-0.114 (-1.60)	-0.198*** (-3.21)	-0.158** (-2.19)	-0.179*** (-2.82)
<i>Regional fixed effects</i>				
Canada	-1.175*** (-5.17)	-1.311*** (-5.14)	-1.269*** (-3.20)	-1.325*** (-3.47)
Mexico	-1.939*** (-5.53)	-1.921*** (-5.81)	-1.946*** (-4.46)	-2.018*** (-4.77)
European Union	0.639* (1.90)	0.435 (1.50)	0.109 (0.34)	0.239 (0.76)
Japan	-0.700*** (-3.57)	-0.373* (-1.82)	-0.255 (-0.99)	0.160 (0.62)
Asia, excluding Japan	0.286 (1.29)	0.455* (1.83)	0.561* (1.65)	0.914*** (2.59)
Latin America, excluding Mexico	-0.345 (-1.37)	-0.524** (-2.12)	-0.167 (-0.62)	-0.469 (-1.62)
Number of observations	147	147	147	147
Pseudo-R ²	0.11	0.12	0.12	0.15

*Significant at the 10 percent level (two-tailed test).

**Significant at the 5 percent level (two-tailed test).

***Significant at the 1 percent level (two-tailed test).

Note: Numbers in parentheses are *t*-statistics. Regressor set also includes a constant term (not reported). The omitted regional fixed effect is rest of the world to avoid perfect multicollinearity with the constant.

Source: Author's analysis based on data described in the text.

negative (suggesting that greater Canadian dispute filings decrease U.S. antidumping and countervailing duty filings against Canada), but is not statistically significant at standard confidence levels. The coefficient on NAFTA dispute settlement filings by Mexico is positive, opposite to the hypothesized sign, and statistically insignificant as well. Although import penetration increased after NAFTA for both Canada and Mexico, the coefficient on import penetration is statistically insignificant, meaning that import penetration had no discernible impact on U.S. antidumping and countervailing duty filings related to NAFTA.

Because antidumping activity might respond differently to NAFTA effects than countervailing duty activity, the regression was also estimated with the number of U.S. antidumping filings only as the dependent variable (table 3, column 2). This alternate specification has little impact on any of the coefficients, although the fit of the equation is somewhat better and more variables display statistical significance.

While NAFTA dispute settlement filings might not deter domestic firms in the United States from filing antidumping and countervailing duty cases, the filings might make U.S. government authorities less likely to rule affirmatively in antidumping and countervailing duty cases. After all, it is their decisions, and hence their credibility, that is under review by the dispute settlement panels. When the regressions are estimated with the annual number of affirmative U.S. decisions against a region as the dependent variable, coefficients are generally of the same signs as for total U.S. filings, with slightly better pseudo- R^2 s and overall fit of the equations. Once again, import penetration is not a statistically significant determinant of affirmative decisions, and the NAFTA dispute settlement filing variables have no statistically significant effects.¹⁵

Econometric Analysis: Alternative Specifications

Several alternative specifications were examined as sensitivity tests. Inclusion of year dummy variables or a trend term did not alter results. Several alternative measures of Chapter 19 activity by Mexico and Canada against the United States were also examined. One such measure is “successful” Chapter 19 cases, or cases remanded to the United States to reconsider the initial decision. In an empirical specification otherwise identical to the main specifications, these NAFTA dispute settlement remand measures have no significantly negative effect on U.S. antidumping and countervailing duty filings or affirmative decisions (table 4, rows 1 and 2). While not reported, the coefficient on import penetration continues to be statistically insignificant, suggesting that increased import

15. A number of alternative import measures were tried as control regressors, including real import growth, with no change in the explanatory power of import activity for U.S. antidumping and countervailing duty outcomes. One possible explanation for the poor performance of the import measures is the aggregate nature of the data. Movement in aggregate imports may mask substantial changes at the industry level.

TABLE 4. Estimated Effects of NAFTA Dispute Settlement Process on U.S. Antidumping and Countervailing Duty Activity for Alternative Negative Binomial Specifications

Regressor	Total Filings		Affirmative Decisions Only	
	Antidumping and Countervailing Duty	Antidumping Only	Antidumping and Countervailing Duty	Antidumping Only
<i>Effect of remands</i>				
Canadian NAFTA dispute settlement remands × dummy variable for Canada	-0.189 (-1.39)	-0.167 (-1.09)	-0.330 (-1.23)	-0.295 (-1.13)
Mexican NAFTA dispute settlement remands × dummy variable for Mexico	0.634* (1.88)	0.398 (0.83)	-0.244 (-0.44)	-0.141 (-0.23)
<i>Effect of cumulative filings</i>				
Canadian NAFTA dispute settlement cumulative filings × dummy variable for Canada	-0.020 (-1.37)	-0.017 (-1.14)	-0.054** (-2.55)	-0.047** (-2.15)
Mexican NAFTA dispute settlement cumulative filings × dummy variable for Mexico	0.021 (0.45)	0.032 (0.67)	-0.005 (-0.08)	0.019 (0.36)
<i>Effect of cumulative remands</i>				
Canadian NAFTA dispute settlement cumulative remands × dummy variable for Canada	-0.050 (-1.42)	-0.044 (-1.24)	-0.135*** (-2.75)	-0.116** (-2.24)
Mexican NAFTA dispute settlement cumulative remands × dummy variable for Mexico	0.096 (0.51)	0.156 (0.78)	-0.033 (-0.14)	0.068 (0.30)

*Significant at the 10 percent level (two-tailed test).

**Significant at the 5 percent level (two-tailed test).

***Significant at the 1 percent level (two-tailed test).

Note: Numbers in parentheses are *t*-statistics. These are selected coefficient estimates of interest from full empirical specifications as in Table 3 that include control variables, regional fixed effects, and a constant term.

Source: Author's analysis based on data described in the text.

penetration from NAFTA, as in the main specification, does not affect U.S. antidumping and countervailing duty activity.

Another alternative measure of Chapter 19 activity is the cumulative number of dispute settlement cases to date, rather than just in the previous year. While there continues to be no effect on U.S. activity for Mexican filings and remands, cumulative Canadian filings and remands, although not affecting U.S. antidumping and countervailing duty filings, do significantly decrease the likelihood of affirmative decisions (table 4, rows 3–6). There are a number of possible explanations for this difference. One possibility may be that there has been a longer history of the dispute settlement process for Canada and the United States, and it takes time for various agents to understand the impact of the dispute settlement process on their incentives to file cases or rule affirmatively. A related explanation is that the history of the process to date has been one of quick decisions in Canadian dispute settlement petitions and long delays for Mexican petitions. Delays may make the process less effective in reducing U.S. antidumping and countervailing duty activity against Mexico.

A further sensitivity test is the examination of whether U.S. antidumping activity is affected by recent Canadian and Mexican antidumping activity.¹⁶ To examine this, the numbers of Mexican and Canadian filings and affirmative decisions against the United States were included as regressors in the specification with a one-year lag.¹⁷ As with most of the results with respect to Chapter 19 filings and determinations, Canadian and Mexican antidumping filings against the United States had no statistically significant effect on U.S. filings and affirmative decisions.

A final alternative specification examined U.S. antidumping and countervailing duty activity for steel cases only, which make up more than a third of all U.S. antidumping and countervailing duty cases for 1980–2000. This specification included explanatory variables specific to the steel industry, such as a steel industry growth variable rather than the real GDP growth variable. Results are qualitatively identical to those for the overall sample, including no evidence for any effect of Chapter 19 dispute settlement activity on U.S. antidumping and countervailing duty filings against Canada or Mexico.

16. Blonigen and Bown (2003) find evidence that the incidence of U.S. antidumping petitions and affirmative outcomes is generally lowered by the potential for retaliation threats, but they do not examine this specifically for NAFTA countries. Prusa and Skeath (2002) find evidence of tit-for-tat antidumping filing behavior in worldwide patterns.

17. The author thanks Tom Prusa for sharing data on these Mexican and Canadian antidumping and countervailing duty filings since 1980. Such activity for more recent years can be found on the WTO web site http://www.wto.org/english/tratop_e/adp_e/adp_c.htm.

IV. CONCLUSION AND POLICY DISCUSSION

Using a panel database of U.S. antidumping and countervailing duty activity for 1980–2000, this article finds little evidence that either increased import volumes or NAFTA Chapter 19 dispute settlement activity affected the frequency of U.S. antidumping and countervailing duty cases or affirmative determinations against Canada and Mexico. An exception is evidence that cumulative remands by Chapter 19 dispute panels to review U.S. decisions against Canada have led to fewer new affirmative antidumping and countervailing duty decisions against Canada, though this does not hold when examining only steel products. These results contrast with the limited previous literature, which generally suggests that Chapter 19 dispute panels reduce antidumping and countervailing duty activity.

These results have implications for future trade negotiations in preferential trading areas and the WTO since the Chapter 19 dispute settlement process was likely intended to rein in use of antidumping and countervailing duty laws by the United States. In both the CUSFTA and NAFTA, the United States tried to thwart any attempt by partner countries to affect its application of antidumping and countervailing duty laws. The compromise solution of Chapter 19 binational dispute settlement procedures had the potential to affect antidumping and countervailing duty activity because it allowed for timely dispute settlements by panels representing both countries involved in the case. A critical constraint, however, was limiting the Chapter 19 panels to rule only on whether a country has appropriately applied its own laws and practices. In addition, the panels have no ability to enforce judgments. While government agencies from all three countries have largely complied with remands from the panel, this process did not resolve the largest trade dispute it faced, the softwood lumber case with Canada, which required resolution through direct government negotiations.

The ineffectiveness of the compromise Chapter 19 panels to slow down U.S. antidumping and countervailing duty activity against Mexico may be viewed as another way in which preferential trading areas involving industrial and developing countries may not be very effective in freeing trade. This interpretation is consistent with recent literature (for example, Anson and others 2005; Carrere and de Melo 2004) that shows that rules of origin restrictions placed on Mexico through NAFTA limited the amount of effective trade liberalization.

The ineffectiveness of the Chapter 19 panels also raises the question of what avenues current and future partner countries may have to persuade the United States to reform or eliminate its antidumping and countervailing duty laws. One option is more aggressive retaliatory activity against the United States. Both Canada and Mexico have substantial enough trade volumes to retaliate effectively. Of course, such strategies could lead to a trade war rather than to a “disarmament” agreement.

A second option is to try to harmonize competition policies and push for folding antidumping policies into a common competition policy. Were

antidumping and countervailing duty practices subject to the same strong criterion for action as current competition policy (at least in the United States), successful antidumping and countervailing duty cases would likely disappear.

A final alternative may be to argue for U.S. use of safeguard actions rather than antidumping and countervailing duty laws. Safeguard protection allows governments to impose temporary protection for a domestic industry, provided that imports are a significant cause of injury to the domestic industry. The explicit condition that safeguard actions are temporary is a clear improvement over antidumping and countervailing duty cases—the United States is still assessing antidumping duties and countervailing duties from cases as far back as the 1970s. In addition, the injury test for safeguard actions requires a more stringent test to prove that imports are a significant cause of injury, not just a nontrivial one. In addition, safeguards do not require investigations of “unfair trade practices,” which use costly resources to examine criteria that most economists regard with skepticism.

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Has NAFTA Increased Labor Market Integration between the United States and Mexico?

Raymond Robertson

This article analyzes three criteria for labor market integration between Mexico and the United States before and since the North American Free Trade Agreement: the responsiveness of Mexican wages to US wage shocks, the speed at which relative wages return to a long-run differential, and changes in the rate of convergence of absolute wages. Tests for increased integration using these three criteria generate mixed results, which are then explored by directly incorporating trade, foreign direct investment (FDI), and migration. The results suggest that trade and FDI did in fact positively contribute to integration but that the increase in border enforcement depressed Mexican wages, masking the positive benefits.

Labor market integration has been one of the primary hopes and fears for the North American Free Trade Agreement (NAFTA). Most of the debate over the labor market integrating effects of NAFTA has focused on wage equalization, and the persistent gap between Mexican and US wages raises the question of whether NAFTA has enhanced integration between these diverse labor markets. Wage equalization, however, is only one measure of labor market integration. Other measures include the responsiveness of Mexican wages to US wage shocks, the rate of convergence of Mexican and US wages to a long-run differential after a shock, and the rate of convergence of Mexican and US wages to equality. Since Mexican and US wages have not equalized since NAFTA, this article uses household surveys to evaluate labor market integration using these three other measures.

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The article begins with the criteria used by Robertson (2000) in estimating the responsiveness of Mexican wages to US wage shocks and the rate at which Mexican wages returned to the long-run differential over the years 1987–97. This study adds five years of data (through 2002) and shifts the focus to the long-run differential that Robertson (2000) takes as given.¹

Reynolds (1992) summarizes the expectation for wage convergence in the context of NAFTA. Rising trade and foreign direct investment (FDI) as a result of the agreement would increase the demand for labor in Mexico and increase Mexican wages relative to US wages. The presumption that trade raises income has much support. Frankel and Romer (1999) suggest that countries that trade more enjoy higher living standards. Noguer and Siscart (2005) verify and strengthen this result, finding a large and positive effect of trade on income per capita. Trade theory suggests that wages, which are determined by supply, demand, productivity, government policies, and other factors, could equalize as a result of trade liberalization.

In addition to increasing trade, NAFTA was intended to increase the demand for labor by encouraging FDI. The size of Mexico's *maquiladora* sector is used as a proxy for FDI. While both trade and maquiladora activity were rising before NAFTA, the levels and growth rate have increased since NAFTA. To the extent that these factors contribute to labor market convergence, and to the extent that NAFTA contributed to the rise in both flows, it seems reasonable to expect evidence of greater labor market integration since NAFTA.

The peso crisis of December 1994, however, complicates the analysis. The significant recession and income contraction that characterized the crisis could give the impression of less labor market integration. Recovery began relatively quickly, however, giving rise to several possible measures to control for the crisis. This article employs several measures of integration and various controls for the crisis, and the overall results seem robust. While there is some evidence of increased integration since NAFTA, the difference seems to be very small. In fact, in some cases labor markets seem to be less integrated since NAFTA, even when the crisis is controlled for.

Mexican and US wages were converging before NAFTA and the peso crisis. The crisis caused wages to fall significantly in Mexico until about 1998, when they began to recover. While the basic conclusions of Robertson (2000) are evident, the two criteria employed in that study offer, at best, mixed evidence of increased integration since NAFTA. Furthermore, the rate of absolute convergence during the recovery period is generally not significantly higher than the rate of convergence before 1994.

But if trade and FDI have increased since NAFTA, why is there not more evidence of labor market integration? This question is addressed here by including a third

1. Absolute wage convergence has often been used as a proxy for labor market integration. It is useful when discussing the removal of barriers to migration (such as the fall of the Berlin Wall) or in areas in which barriers to migration are relatively small (Boyer and Hatton 1994; Moazzami 1997; Collins 1999).

factor that could contribute to integration: labor migration. Robertson (2000) concludes that migration may be a significant factor integrating labor markets based on the pattern of integration, but he does not formally pursue this hypothesis. Because migration between Mexico and the United States is often illegal,² and therefore difficult to measure, several studies have used border enforcement as a proxy for migration flows.³ Border enforcement hours are used here to formally compare the effects of trade, FDI, and migration in a single regression framework.

This article also seeks to identify forces that integrate labor markets. The relative contributions of trade, migration, and capital flows in integrating labor markets have created significant debate.⁴ Using real wages, GDP per worker-hour, and GDP per capita, Williamson (1996) finds that the main cause of convergence is migration.⁵ Using the coefficient of variation of wages, Mokhtari and Rassekh (1989) find that commodity price convergence (using openness as a proxy) shows a strong impact on factor-price equalization for the period observed (1961–84).

The results here suggest that increased border enforcement may have had the opposite effect on wages as that expected from trade and investment. Therefore, trade and FDI may indeed have had positive effects on wage convergence that were hidden by the large effects of increased US border enforcement.

I. THEORETICAL FOUNDATIONS OF INTEGRATION CRITERIA

This section begins by briefly reviewing the theoretical basis for the two integration measures and the model used in Robertson (2000). Mexican labor demand is posited to be a function of Mexican and US wages, w^{mx} and w^{us} , which capture the effects of forces that integrate markets, such as trade and capital flows, that may not have instant effects on equilibrium wages. Labor supply is also posited to be a function of Mexican and US wages. This specification is based on the assumption that labor supply is a function of migration, which quickly reacts to wage differentials. Assuming an equilibrium in which labor supply equals labor demand, this approach generates an estimation equation whose parameters capture two criteria for evaluating labor market integration. Defining the difference operator as Δ , this equation can be written as

$$(1) \quad \Delta w_{it}^{mx} = \alpha_0 + \alpha_1 \Delta w_{it}^{us} + \alpha_2 [w^{mx} - \lambda w^{us}]_{it-1} + \mu_{it}.$$

2. According to INS (2000), the US Immigration and Naturalization Service apprehended more than 1.8 million aliens in fiscal 2000—approximately 96 percent of them Mexican.

3. For example, see Hanson and Spilimbergo (1999) and Hanson, Robertson and Spilimbergo (2002).

4. See, for example, O'Rourke and Williamson (1994), O'Rourke, Taylor and Williamson (1996), Saint-Paul (1997, 1999), and Mokhtari and Rassekh (1989).

5. The correlation is weaker when capital is allowed to 'chase' labor in the computable general equilibrium models.

The first criterion is the response of Mexican wages to US wage shocks (α_1). The second is the rate of convergence back to the assumed equilibrium differential (α_2). This simple model is then modified to allow for different regions within Mexico in order to analyze the possibility that the Mexican border region is more integrated with the United States than the rest of the country is.

The subscript i indexes different labor types. As in Robertson (2000), the wages of workers who fall into narrowly defined age-education cohorts are considered here. There are several advantages to focusing on specific labor cohorts. It allows wage movements of workers with similar characteristics to be compared without looking at average wages. Assuming strong separability of worker types prevents misinterpreting changes in labor force composition or changes in inequality as wage convergence. For example, a sharp increase in the relative wage of skilled workers may increase average wages while masking wage divergence for other workers. Second, identifying the effects of trade, FDI, and migration (which enters through labor supply) by focusing on narrowly defined cohorts is a natural extension of Borjas (2003), who suggests that such a focus on narrowly defined cohorts is an appropriate way to identify the effects of migration on US wages.

One shortcoming of Robertson (2000) is that he analyzes only 1987–97 data, which does not allow time for a recovery from the peso crisis. Therefore, the first step in the empirical work here is to use this framework to analyze 1987–2002 data, extending the sample period by nearly 50 percent.

A second shortcoming is that it takes the equilibrium differential as given. In the steady state, in which wage changes are zero, equation 1 reduces to

$$(2) \quad w_{it}^{mx} - w_{it}^{us} = -\frac{\alpha_0}{\alpha_2},$$

which is assumed to be a constant. Clearly, an alternative proxy of integration is the evolution of the absolute wage differential over time in both level and trend. Therefore, the evolution of the absolute differential is also considered. The US government dedicates considerable resources to prevent migration from Mexico. Indeed, patrolling the border is commonly justified as necessary to maintain the wage differential.

A third shortcoming is that he does not formally compare the effects of trade, FDI, and migration. The sections that follow compare these effects in two ways. First, the evolution of trade, FDI, and migration are compared with changes in the absolute wage differential. Second, a simple regression framework is used to compare the relative effects of trade, FDI, and migration.

This framework is derived from a simple supply and demand model of the labor market. Labor demand (L) in country n (Mexico or United States) for labor type i at time t in city c can be represented as a function of a constant term, time trend, the log wage (w), total trade (exports plus imports, TT), and FDI :

$$(3) \quad L_{ict}^n = \alpha_0^n + \alpha_1^n w_{ict}^n + \alpha_2^n t + \alpha_3^n TT_t^n + \alpha_4^n FDI_{ct}^n.$$

The wage is assumed to be country-, city-, labor type-, and time-specific. FDI is assumed to be country-, city-, and time-specific, as in Feenstra and Hanson (1997), who examine the link between FDI and wage inequality.

Exports and imports are a problematic proxy for trade because trade theory predicts that prices, rather than quantities, matter for labor markets. Nevertheless, the volume of trade is a commonly used proxy for the effects of trade.⁶ Differentiating exports and imports may seem intuitive, but the increasing importance of production fragmentation makes interpreting these proxies difficult. For example, rising imports of intermediate goods may increase the demand for labor, and rising exports of intermediate goods may be correlated with the loss of domestic production farther down the production chain. To avoid these problems, total trade flows are used as a proxy for the effect of trade on labor demand.⁷

The supply and demand approach used here follows the labor economics tradition of assuming a single industry,⁸ and therefore, changes in relative prices matter less than aggregate imports and exports. The effects of trade are also assumed not to be city-specific for two reasons. First, prices do not vary much across Mexican regions (Rogers and Smith 2001), so trade-induced price changes are unlikely to have large regional effects. Second, trade data are not available by region.

Labor supply is assumed to be a function of the log wage, a time trend, and migration (*MIG*):

$$(4) \quad L_{ict}^n = \beta_0^n + \beta_1^n w_{ict}^n + \beta_2^n t + \beta_3^n MIG_{ict}^n.$$

At each time t country n 's labor supply is assumed to equal its labor demand so that the equilibrium wage in each country can be solved for as a function of the explanatory variables:

$$(5) \quad w_{ict}^n = \frac{1}{(\beta_1^n - \alpha_1^n)} [(\alpha_0^n - \beta_0^n) + (\alpha_2^n - \beta_2^n)t + \alpha_3^n TT_t^n + \alpha_4^n FDI_{ct}^n - \beta_3^n MIG_{ct}^n].$$

This equation can be expressed more simply for Mexico and the United States as

$$(6) \quad \begin{aligned} w_{ict}^{mx} &= \gamma_0 + \gamma_1 t + \gamma_2 TT_t^{mx} + \gamma_3 FDI_{ct}^{mx} + \gamma_4 MIG_{ct}^{mx} \\ w_{ict}^{us} &= \theta_0 + \theta_1 t + \theta_2 TT_t^{us} + \theta_3 FDI_{ct}^{us} + \theta_4 MIG_{ct}^{us}. \end{aligned}$$

6. Robertson (2004) offers a more detailed analysis of the effects of trade-induced price changes on Mexican labor markets by focusing on wage inequality and changes in relative prices.

7. As a robustness check in the estimation section, exports are separated from imports and the results discussed.

8. Examples of the dichotomy between the labor and trade approaches to analyzing the effects of trade on labor markets include Richardson (1995), Freeman (1995), and Slaughter (1999).

Under this system FDI, trade, and migration link labor markets. A useful but extreme simplification of these mechanisms would be to assume that FDI flows from the United States to Mexico, that only trade between these two countries matters, and that migration flows from Mexico to the United States. These assumptions imply the following restrictions:

$$(7) \quad \begin{aligned} TT_t^{us} &= TT_t^{mx} \\ FDI_{ct}^{mx} &= -FDI_{ct}^{us} \\ MIG_{ct}^{mx} &= -MIG_{ct}^{us}. \end{aligned}$$

The conditions in equations 6 and 7 can be combined to generate an expression for the wage gap between Mexico and the United States.

$$(8) \quad w_{ict}^{mx} - w_{ict}^{us} = (\gamma_0 - \theta_0) + (\gamma_1 - \theta_1)t + (\gamma_2 - \theta_2)TT_t^{mx} + (\gamma_3 + \theta_3)FDI_{ct}^{mx} + (\gamma_4 + \theta_4)MIG_{ct}^{mx}.$$

Equation 8 contains several intuitive predictions about labor market integration. First, increases in FDI and migration unambiguously close the wage gap.⁹ The effects of FDI may be small in the United States (θ_3 may be small or zero) and still reduce the wage gap. Migration may also have a large, small, or nil effect on the United States (θ_4 may be large, small, or zero) and still reduce the wage gap.

This framework also suggests that the effects of trade depend on the relative effect on each country. If trade has a greater effect on Mexico than on the United States, the expected effect of trade on the wage gap is positive. This seems likely because trade's share in GDP is higher in Mexico than in the United States and because Mexico trades more with the United States (as a share of Mexico's total trade) than the United States trades with Mexico (as a share of US total trade).

This framework allows testing of several hypotheses about how localized the integration effects are. For example, a local migration shock may affect wages in neighboring regions. Examining the effects of a migration, shock to area c on other areas could explain how localized the effects are. Several researchers (for example, Hanson and Spilimbergo 1999) suggest that increasing border enforcement in one area of the border shifts migration to other areas, which means that increasing border enforcement in one area could depress wages in neighboring regions.

The empirical approach in the next section has three parts. The first focuses on wage shocks and convergence speeds (the first two integration criteria) and shows that there is evidence of wage convergence over time but little, if any, detectable effect from NAFTA on measures of convergence. Given the lack of significant change in convergence since NAFTA, the second part briefly examines

9. FDI may have an ambiguous effect on average wages if low-skilled jobs in the United States are high-skilled jobs in Mexico. In this case, however, these movements would unambiguously close the wage gap between similar workers. Moving a job that requires, say, 10 years of education from the United States to Mexico is an unambiguous change in the demand for workers with 10 years of education in both countries and therefore has an unambiguous effect on the wage gap for these workers.

absolute wage differentials. The third part looks at changes in trade, FDI, and migration before and after NAFTA to compare trends and breaks in these variables with trends and breaks in matched average wages. It also formally estimates equation 8 to identify the effects of these three forces on labor market integration.

II. EVALUATING LABOR MARKET INTEGRATION

The Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS) are used to formally compare wages between Mexico and the United States. While data from the CPS are available since 1979, data from the ENEU are available only since 1987. The ENEU and CPS are similar in many respects, but one important difference is that the ENEU follows households for five quarters before dropping them from the sample. While matching individuals across periods may seem desirable, in practice it is very difficult because households, and not individuals, are revisited. To approximate the panel effect, the pseudo panel approach described by Deaton (1985) is employed here. Wage averages are generated for different groups in the population and tracked over time. This approach has the advantage of allowing ‘individuals’ to be followed over the entire sample period.

The data used to estimate equation 1 are the mean log wages for matched Mexican–US age-education cells. As in Robertson (2000), Mexican wages are converted to dollars using the nominal peso–dollar exchange rate. To implement the pseudo-panel technique, workers in each city were divided into 40 groups defined by five education levels and eight age groups. The education levels are based on a continuous years of education variable that is sorted into the following categories: 0–6 years, 7–9 years, 10 years, 11–12 years, and more than 12 years. The age groups span five years each, starting at age 15, except for the last group, which includes workers aged 50–65 years.¹⁰ As is customary in the pseudo-panel technique, the age group boundaries advance through time to follow cohorts. Using the CPS, the average wages were calculated for the same age-education groups in the United States, and then cohorts were paired with their demographic counterparts in Mexico. National US data were then matched with data for six Mexican urban areas.¹¹ The four border cities (Tijuana, Ciudad Juarez, Matamoros, and Nuevo Laredo) and Monterrey (an intermediate city) were included as interaction effects, leaving the main effects to reflect Central Mexico.¹² As in Robertson (2000), relatively high rates of migration and FDI in the border

10. The results were very similar when six education groups (for a total of 48 categories) were used.

11. One may prefer to match US border cities with Mexican border cities. The problem with this is the relatively small sample size of US border cities. Using matched US state data generates similar results.

12. Central Mexico includes Mexico City, Mexico State, and Guadalajara. Monterrey was also included in these regressions as a separate city but was not reported because the results are very similar to those for Central Mexico.

cities explain the difference in results between the border and the interior.¹³ The data are quarterly and run from 1987 to 2002.

Shock and Convergence Speed Results

Equation 1 can be modified to formally test the differences in the estimated coefficient values across regions. The significance and sign of coefficients estimated from region dummy variables interacting with the relevant variables reveals whether differences across regions are statistically significant and whether certain regions are more integrated with the United States.

The results for the basic model (table 1), which includes regional effects for the entire sample period¹⁴ for all workers, workers with more than 12 years of education (more education), and workers with 12 or fewer years of education (less education), are basically consistent with those of Robertson (2000). The shock term is positive and significant for Central Mexico for more educated

TABLE 1. Effects of NAFTA on Shock and Convergence Estimates

Variable	All Education	More Education	Less Education
Shock (Central Mexico)	-0.015 (0.034)	0.332 (0.092)**	-0.042 (0.035)
Tijuana	0.025 (0.068)	-0.077 (0.139)	0.052 (0.075)
Ciudad Juarez	0.033 (0.055)	0.258 (0.174)	0.037 (0.060)
Matamoros	0.059 (0.061)	0.029 (0.092)	0.069 (0.064)
Nuevo Laredo	-0.056 (0.046)	-0.172 (0.160)	-0.022 (0.051)
Convergence (Central Mexico)	-0.038 (0.011)**	-0.206 (0.023)**	-0.012 (0.010)
Tijuana	-0.060 (0.019)**	-0.154 (0.017)**	-0.002 (0.016)
Ciudad Juarez	-0.038 (0.019)	-0.121 (0.022)**	0.007 (0.022)
Matamoros	-0.030 (0.014)*	-0.132 (0.020)**	0.011 (0.011)
Nuevo Laredo	-0.053 (0.013)**	-0.153 (0.031)**	-0.023 (0.014)
Constant	-0.018 (0.025)	-0.435 (0.057)**	0.038 (0.019)
Number of observations	13,683	5,993	7,690
R ²	0.14	0.25	0.14

*Significant at the 5 percent confidence level.

**Significant at the 1 percent confidence level.

Note: All equations include year effects. Robust standard errors are in parentheses. Monterrey, which exhibits less integration than the border cities, is included but not reported. Three time trend terms and a dummy variable for the peso crisis are also included as described in the text.

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

13. Traditionally, Tijuana has the highest rates of migration and *maquiladora* establishments and Ciudad Juarez the most *maquiladora* employment. It is important to note that migration from these cities is likely to be 'stage' migration, in which migrants from other parts of Mexico first migrate to the border before entering the United States. See Robertson (2000) for more details.

14. The regressions also included broken trend terms and a dummy variable to account for the peso crisis. These components are justified later in the text.

workers, and the estimated effects of US wage shocks are generally larger (although not significantly so) in the border cities. The convergence term is negative and significant, as expected, and the rate of convergence is larger for the border cities. The cities with the highest rates of migration and most maquiladora establishments (Tijuana and Ciudad Juarez) have the highest rates of convergence to the equilibrium differential. These results are weakest for less educated workers.

The peso crisis in 1994–95 may affect the results because the nominal value of the peso is used to calculate the dollar value of Mexican wages. In addition, the extreme movements of the peso may have affected wages in ways that could be mistaken for the effects of trade liberalization because the peso crisis occurred in the first year of NAFTA. Wages fell sharply during the crisis but started to recover in 1996. Two approaches were employed as a robustness check to control for the crisis. First, a control variable for the fourth quarter of 1994 and all of 1995 was included, as noted earlier. Second, data for 1995 were dropped, which generated stronger results in the sense that the main shock term was positive and significant for more educated workers and border effects were also somewhat larger for all three groups. The basic results are robust to both crisis controls.

The effects of NAFTA are estimated by modifying the basic model equation to include a dummy variable equal to 1 for the post-NAFTA years (1994 and later). In addition to the main effect, the NAFTA dummy variable is interacted with the shock and convergence terms from table 1. Two main conclusions can be drawn from these results (table 2).¹⁵ First, the main effects are qualitatively similar to those for the basic model (table 1). Second, the NAFTA effects are ambiguous at best. The NAFTA interaction with the main shock term is negative for all groups—and large and significantly negative for more educated workers—which suggests that Mexican wages are less responsive to US shocks since NAFTA. By contrast, the estimate of the rate of convergence since NAFTA suggests faster convergence in the pooled sample but slower convergence for more educated workers. In general, the evidence of a change in the rate of wage convergence during the NAFTA period is mixed.

The results are also mixed when the data are broken down by industry. As an alternative specification, age-education categories were redefined to accommodate industries using four education groups (0–6 years, 7–10 years, 11–12 years, and more than 12 years), two age groups (ages 15–34 and ages 35–65), and five industry groups: construction (the base industry), machinery and transport equipment, other manufacturing, commerce (wholesale and retail trade), and other services. The manufacturing industries were subdivided because the

15. Every analysis of NAFTA is complicated by the contemporaneous peso crisis, but this complication may be mitigated by the fact that the crisis seems to have been a temporary event with a relatively quick recovery. By contrast, the effects of NAFTA are probably more lasting because NAFTA was gradually phased in and has not been reversed. Both the crisis controls from table 1 were applied to the analysis in table 2 and yielded similar results.

TABLE 2. Effects of NAFTA on Shock and Convergence Estimates

Variable	All Education	NAFTA Dummy Variable	More Education	NAFTA Dummy Variable	Less Education	NAFTA Dummy Variable
Shock (Central Mexico)	0.027 (0.044)	-0.089 (0.061)	0.553 (0.090)**	-0.514 (0.184)*	-0.023 (0.042)	-0.038 (0.062)
Tijuana	0.095 (0.091)	-0.102 (0.095)	0.291 (0.139)	-0.576 (0.319)	0.113 (0.099)	-0.100 (0.098)
Ciudad Juarez	0.007 (0.095)	0.054 (0.110)	0.013 (0.274)	0.682 (0.551)	0.032 (0.102)	0.011 (0.107)
Matamoros	0.122 (0.069)	-0.129 (0.116)	0.184 (0.208)	-0.366 (0.410)	0.131 (0.077)	-0.122 (0.124)
Nuevo Laredo	-0.120 (0.055)*	0.139 (0.079)	-0.436 (0.186)*	0.636 (0.314)	-0.062 (0.055)	0.081 (0.075)
Convergence (Central Mexico)	-0.014 (0.008)	-0.043 (0.012)**	-0.260 (0.037)**	0.036 (0.023)	-0.009 (0.008)	-0.006 (0.012)
Tijuana	-0.046 (0.017)**	-0.022 (0.006)**	-0.142 (0.017)**	-0.021 (0.008)*	0.000 (0.015)	-0.001 (0.005)
Ciudad Juarez	-0.032 (0.019)	-0.011 (0.001)**	-0.132 (0.021)**	0.023 (0.005)**	0.013 (0.023)	-0.009 (0.002)**
Matamoros	-0.028 (0.014)*	-0.005 (0.003)	-0.129 (0.018)**	-0.000 (0.006)	0.009 (0.011)	0.004 (0.003)
Nuevo Laredo	-0.045 (0.015)**	-0.020 (0.004)**	-0.139 (0.028)**	0.050 (0.011)**	-0.009 (0.014)	-0.028 (0.003)**
Constant	0.030 (0.017)		-0.582 (0.091)**		0.046 (0.015)**	
Number of observations	13,683	5,993	7,690			
R ²	0.15	0.27	0.15			

*Significant at the 5 percent confidence level.

**Significant at the 1 percent confidence level.

Note: Robust standard errors are in parentheses. Monterrey, which exhibits less integration than the border cities, is included but not reported. Three time trend terms are also included as described in the text. NAFTA and main city effects are included but not reported.

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

majority of *maquiladora* employment is in metal products, machinery, and equipment.¹⁶ Regional controls were not included.

These results, available upon request, generate two main conclusions. First, the model works well in the sense that the main shock and convergence terms have the expected signs and are statistically significant for more educated workers. Second, no consistent evidence emerges of increased integration during the NAFTA period. Integration does not seem to differ across industries, suggesting either that workers are very mobile across industries¹⁷ or that industry-specific mechanisms (such as industry-concentrated FDI) are not driving labor market integration.

These mixed results might seem to be more consistently explained by inadequate crisis controls. If Mexican wages are simply recovering from the crisis, they may seem to be less responsive to wage shocks and to converge more quickly because they are ‘catching up.’ This hypothesis suggests that absolute wages are converging more quickly to US wages after the crisis. Since absolute wage convergence is an alternative proxy for labor market integration, the next section focuses on the evolution of absolute wages.

Absolute Wage Convergence, 1982–2002

When comparing wages across countries with very different monetary and exchange rate policies, it is important to address exchange rates. With freely floating exchange rates, different currencies are easily compared using the nominal exchange rate because it accounts for inflation differences between the two countries. The Mexican exchange rate, however, has been freely floating only since the peso crisis in December 1994. Fixing the peso increases dollar-valued Mexican wages (Robertson 2003) and may suggest a bias toward convergence.

Comparing the ratios of Mexican wages to US wages in dollars and in real terms shows the adverse effect of the ‘Lost Decade’ of the 1980s on Mexican wages (figure 1). The recovery from the debt crisis began in 1986, coinciding with the availability of ENEU data, which are used here to more formally analyze wage convergence.

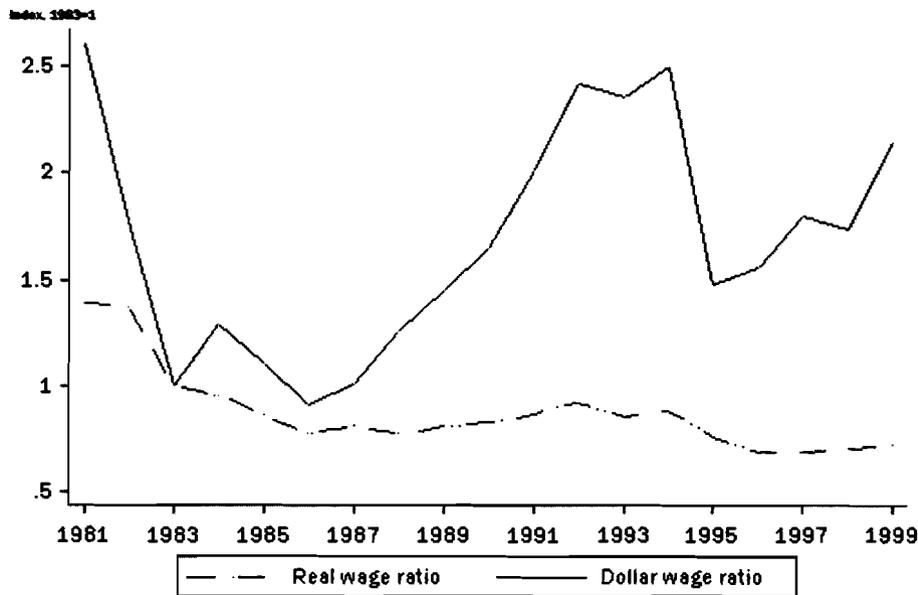
To generate comparable quarterly wage measures, ENEU and CPS data are used to calculate real wages in the United States and Mexico using the consumer price index of each country (with 1992 as the base year).¹⁸ Figure 2 shows the evolution of the ratio of the Mexican (normalized) wages (for Tijuana, Central Mexico, Ciudad Juarez, and Matamoros) to US (normalized)

16. The average share of *maquiladora* employment in metal products, machinery, and equipment over 1990–2001 is 65.3 percent.

17. Robertson and Dutkowsky (2002) estimate labor market adjustment costs for Mexico and find that labor market adjustment costs are an order of magnitude smaller in Mexico than in developed countries.

18. Although city-specific price indices are available, the national price index is used here to deflate wages. The correlation coefficient of the city-specific price indices for the cities used here is above 0.999 for each city pair.

FIGURE 1. Long-run Comparison of Mexican–US Average Wages



Note: The real wage series for each country is deflated by the domestic inflation index. The dollar wage series uses real US wages and nominal Mexican wages converted to dollars using the nominal peso–dollar exchange rate.

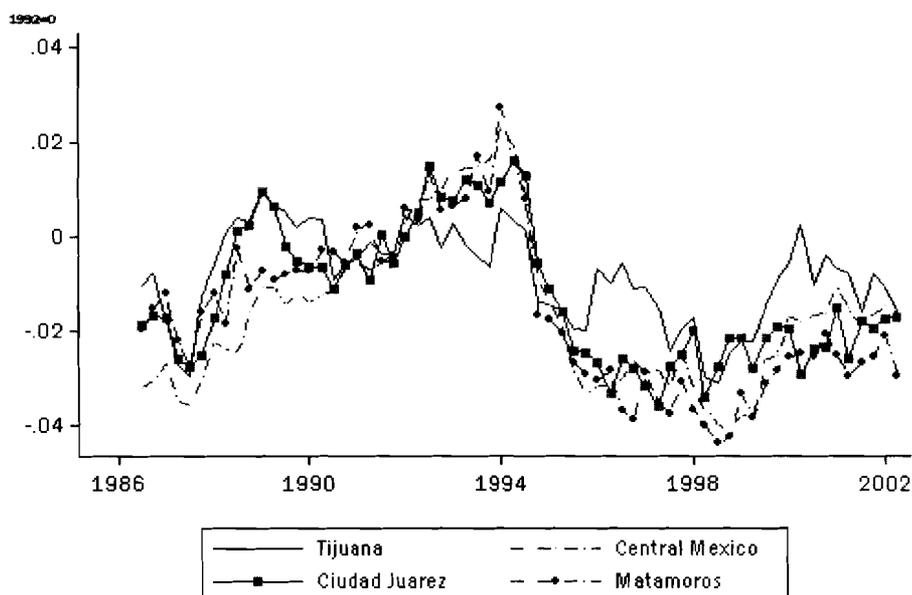
Source: Author's analysis based on Mexican wage data from Wilke, Alemán, and Ortega (1999), Mexican inflation data from Banco de México (various years), and US wage and inflation data from IMF (various years).

wages. Wages in Central Mexico are more volatile. They rise more before the crisis and fall more during the crisis, raising the possibility that proximity to the US economy mitigates domestic economic fluctuations much like living next to the ocean mitigates domestic temperature fluctuations.¹⁹ Relative wages in Tijuana begin to decline around 1991, while wages in the other cities rise until the crisis.

The general pattern that emerged in the average wage series remains when the wage series are decomposed by industry and education. Before NAFTA wages rose more quickly in the interior (Central Mexico) than in the border region. The drop in wages because of the peso crisis was larger in the interior. To illustrate this point, the evolution of relative wages by industry (figure 3) and by education group (figure 4) is examined for Central Mexico

19. Wages exhibit more recovery in dollar terms than in peso terms, again suggesting that perhaps the peso is not fully adjusting to offset domestic inflation.

FIGURE 2. Mexican-US Normalized Wage Ratios



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker-category wage ratio for each metropolitan area. Nuevo Laredo, excluded here for clarity, is more similar to Central Mexico than to Tijuana.

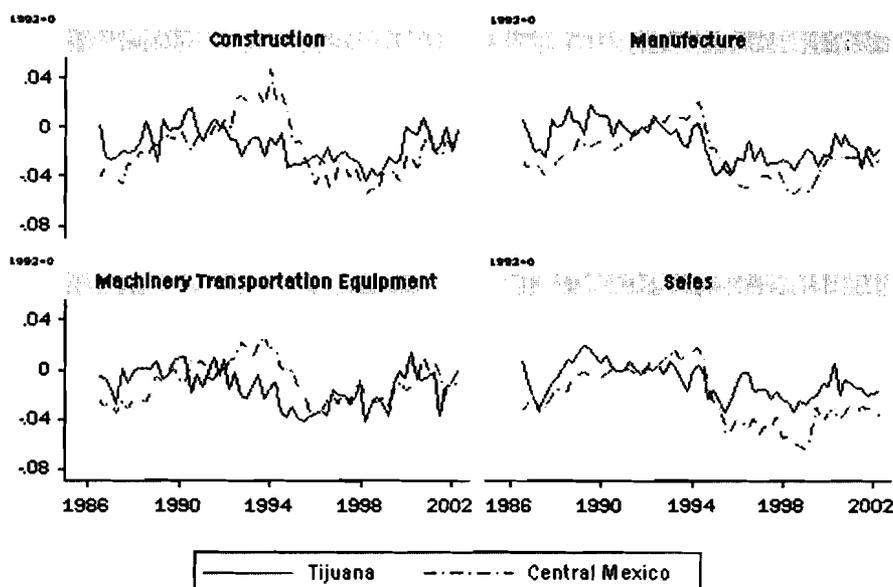
Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

and Tijuana.²⁰ While there are some differences across industries and education groups, the basic pattern is very similar. Wages in the interior rise faster before, and fall more during, the peso crisis. In all industries and education groups the decline in relative wages in Tijuana begins before the crisis.

If NAFTA did contribute to increased labor market integration, it seems likely that the rate of wage convergence would have increased during the recovery from the peso crisis. The first step in comparing trends before and after the crisis is to determine the actual trend breaks, recognizing that the timing of the trend breaks may differ across regions. There are three ways to determine the breaks. The most obvious way is to use prior information. The December 1994 peso crisis is an obvious candidate, but using this date for all regions rules out the possibility that the effects of the crisis differed

20. Figure 2 suggests that wage patterns in Matamoros and Ciudad Juarez fall between the wage series for Tijuana and Central Mexico. Since this also holds for the education and industry breakdowns, figures 3 and 4 show the wage series only for Central Mexico and Tijuana.

FIGURE 3. Normalized Wage Ratios by Industry for Tijuana and Central Mexico



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker–category wage ratio for each metropolitan area and industry.

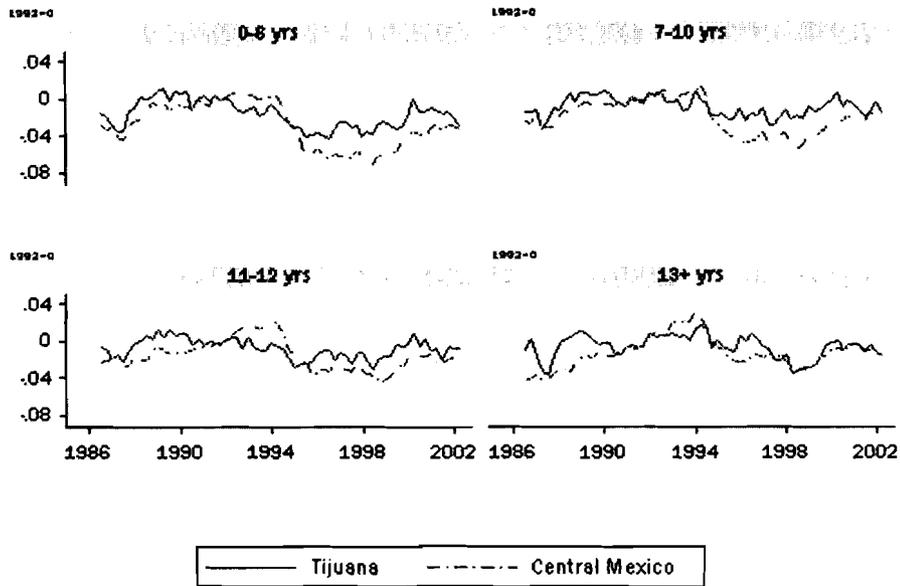
Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (FNEU) and the US Current Population Survey (CPS).

across regions. Alternatively, one could guess at the breaks for different regions based on the analysis of the series in figure 2. This approach is arbitrary and subjective. Vogelsang and Perron (1998) propose a more formal approach, which they employ in the unit root context. The basic purpose of their tests is to evaluate the statistical significance of successive t -statistics on estimated parameters of trend break terms that are moved through the sample using the following equations:

$$(9) \quad \begin{aligned} y_t &= \mu + \beta_t + \theta DU_t + \gamma DT_t + \tilde{y}_t^2 \\ \tilde{y}_t^2 &= \sum_{i=0}^k \omega_i D(T_b)_{t-i} + \alpha \tilde{y}_{t-1}^2 + \sum_{i=0}^k c_i \Delta \tilde{y}_{t-i}^2 + u_t. \end{aligned}$$

For a time-series variable at time t represented by y_t and defining the break period as T_b , $DU = 1(t > T_b)$, $DT = 1(t > T_b)(t - T_b)$, and $D(T_b) = 1(t = T_b + 1)$. The variables μ , β , θ , γ , ω , α , and c are estimated parameters, and u is an error term.

FIGURE 4. Normalized Wage Ratios by Education Level for Tijuana and Central Mexico



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker-category wage ratio for each metropolitan area and education group.

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

Figure 2 suggests that the wage series may actually exhibit two trend breaks that surround the peso crisis. The test described above supports this idea. Table 3 shows the break points suggested by the t -statistic on the trend break terms for both dollar and indexed wage ratios. Dollar wages are included because the earlier analysis left open the possibility that those results are driven by a more rapid rate of convergence after the peso crisis. Indexed wages are included because of the previously described problems with the Mexican peso.

The test statistics in both wage categories (dollars and indexes) roughly match the intuition about where the breaks in the series occur. The first break occurred very close to the peso crisis. Two notable exceptions are that relative wages in Tijuana began falling in 1990, and in Ciudad Juarez the break occurred in 1993.

Using these data-determined trend break points, testing whether the recovery trend is steeper than the pre-NAFTA trend is straightforward. The last two columns of table 3 compare the slope before NAFTA with the slope since NAFTA

TABLE 3. Trend Breaks in Relative Wages

Wage Ratio	Break 1	Break 2	Net Recovery Trend	<i>p</i> -value
Dollar wages				
Central	1994q4	1998q2	0.0018	0.028
Monterrey	1994q4	1998q1	0.0014	0.070
Tijuana	1993q1	1998q2	0.0001	0.889
Ciudad Juarez	1993q3	1997q3	0.0000	0.991
Matamoros	1994q4	1998q2	0.0017	0.036
Nuevo Laredo	1994q4	1998q2	0.0015	0.033
Indexed wages				
Central	1994q4	1998q3	0.0007	0.025
Monterrey	1995q1	1998q3	0.0004	0.233
Tijuana	1990q4	1997q4	-0.0011	0.003
Ciudad Juarez	1993q4	1997q3	-0.0004	0.054
Matamoros	1995q1	1998q2	0.0007	0.026
Nuevo Laredo	1994q3	1998q2	-0.0001	0.867

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

by testing the difference of the trend coefficients before and after the first trend break.²¹ A positive value suggests that the trend coefficient was larger during the recovery. All values for dollar wages are positive, but three of six are statistically insignificant at the 5 percent level. The statistically significant higher net recovery trends in Central Mexico and Matamoros are consistent with the possibility that the results in table 2 for these cities are driven by inadequate control for a faster rate of recovery from the crisis, even though a separate trend term for the city-specific recovery period was included. In all cases, however, the difference in trends is very small (less than 0.2 percent).

The results for indexed wages suggest that the recovery trend for most cities is slightly greater than before NAFTA and the crisis, but, again, the difference is very small. The recovery trend for Tijuana and Ciudad Juarez is less steep during the NAFTA and recovery period. That is, wage convergence in real terms is slower in Tijuana and Ciudad Juarez during the recovery period (and the difference is statistically significant at the 1 percent level for Tijuana and the 6 percent level for Ciudad Juarez). By contrast, Central Mexico and Matamoros exhibit the steepest recovery trends.

The difference between dollar wages and indexed wages is due to the relative lack of adjustment in the peso (see Robertson 2003 for a more detailed discussion of the peso movements). Inflation rises more than the peso falls during the recovery period, allowing wages, in dollar terms, to rise relatively more. Therefore, the

21. Each series was regressed with three linear trend terms. The first is a linear trend increasing from 1 at the beginning of the sample, the second starting at 1 (and 0 earlier) at the first trend break, and the third starting at 1 (and 0 earlier) at the second trend break.

dollar wage results are biased toward convergence to the degree that the peso does not move to offset relative inflation in Mexico.

Overall, however, the recovery trends for every city are positive, suggesting that Mexican and US wages are converging (due more to rising Mexican wages than to falling US wages), but there is little evidence of economically significant increases in convergence rates since NAFTA once the peso crisis is taken into account. This result suggests that the mixed results in the previous section are not likely to be driven by more rapidly converging wages in the NAFTA period. Even if they were, however, the lack of stronger and more consistent evidence of increased integration (especially wage convergence) is surprising, given the rise in FDI and trade that has occurred since NAFTA. Thus, the next section directly compares the effects of the various forces that affect labor market integration.

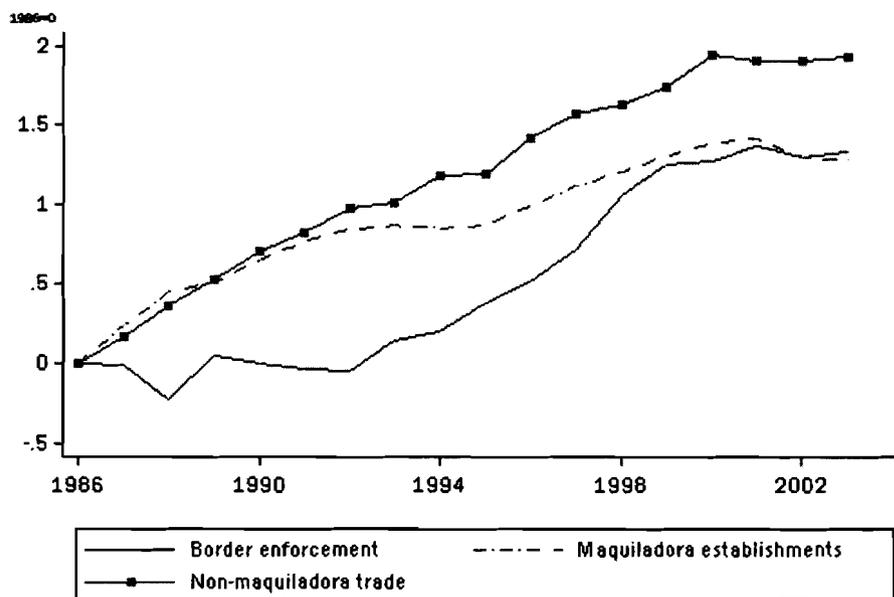
Forces That Contribute to Wage Convergence

The theoretical model hypothesizes that trade, FDI, and migration can integrate labor markets. Dollar-valued monthly Mexican exports and imports are available from the Banco de México (www.banxico.org.mx). Data on monthly maquiladora employment and establishments, a proxy for FDI, are available from the Instituto Nacional de Estadística, Geografía, e Informática data bank (<http://dgcnesyp.inegi.gob.mx/bdiesi/bdie.html>). Robertson (2005) shows that the level and growth rate of total Mexican trade has increased since NAFTA. Maquiladora employment and number of establishments have also risen, with a sharper rate of increase since NAFTA than in the years immediately before 1994. Using the same methodology to identify the trend break point suggests that the trend in total non-maquiladora trade increased in the first quarter of 1994. Growth in maquiladora establishments increased in the fourth quarter of 1994, while employment growth increased in the third quarter of 1993. These increases are both statistically significant and correlated with NAFTA, which is not surprising because increasing these factors was an explicit goal of the agreement.

While finding trade and FDI data is relatively easy, obtaining migration data is more problematic because much of the migration from Mexico to the United States is illegal. Instead of actual migration flows, border enforcement hours by the US Border Patrol are used. Ideally, an increase in enforcement hours would lead to a decrease in successful migration, which is required for migration to affect labor markets. Between 1990 and 2000 the United States implemented three major border-control initiatives: Operation Hold the Line, Operation Gatekeeper, and Operation Rio Grand.²² Operation Hold the Line was implemented in 1993 and focused on El Paso, Texas. Operation Gatekeeper went into effect in October 1994 in San Diego, California. Operation Rio Grand in

22. See <http://uscis.gov/graphics/publicaffairs/factsheets/bpops.htm> for more information about these initiatives.

FIGURE 5. Factors That Affect Integration over Time



Note: Each series is the log of the difference between the contemporary value and the value of that series in 1986. Border enforcement is the total number of linewatch hours on the Mexican-US border (in El Centro, CA; El Paso, TX; Del Rio, TX; Laredo, TX; Marfa, TX; McAllen, TX; San Diego, CA; Tucson, AZ; and Yuma, AZ).

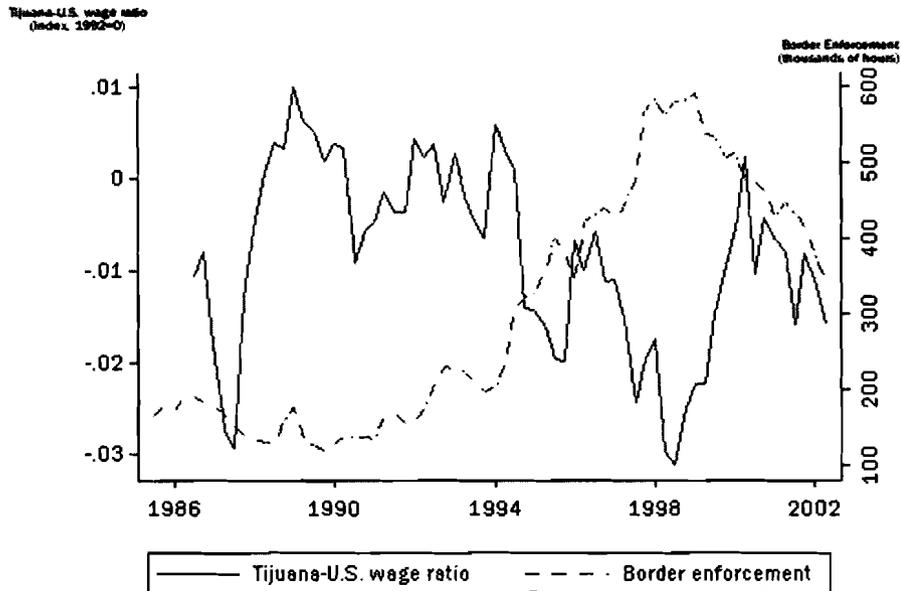
Source: Author's analysis based on trade data from Banco de México, *maquiladora* establishments data from Instituto Nacional de Estadística, Geografía, e Informática data bank, and border enforcement data from the US Department of Homeland Security.

McAllen, Texas, was launched in August 1997. The initial result of these initiatives was an increase in apprehensions and the cost of migration.

Time-series plots of normalized non-maquiladora trade, maquiladora establishments, and total linewatch border enforcement hours along the Mexican-US border show very similar patterns of steady increases throughout the sample period (figure 5). The rise in the rate of maquiladora establishments starting in 1994 is evident. Border enforcement hours also increased, but the rate of increase for some border sectors rose earlier. Formal tests reveal that the break in the total border enforcement hours occurred in the second quarter of 1994. However, the increase in border enforcement occurred in the second quarter of 1993 in El Paso and in the third quarter of 1991 in San Diego.

The earlier break in the San Diego enforcement series is relatively close to the earlier break detected in the Tijuana-US wage series. A plotting of the Tijuana-US wage gap and changes in border enforcement over the sample period shows

FIGURE 6. Tijuana–US Wages and San Diego Border Enforcement



Note: Wage ratios are the difference between the Mexican and US normalized wage values, with 1992 as the base year and Central Mexico as the base region for Mexico. The wages are the population-weighted average of the worker–category wage ratio for each metropolitan area and industry. Border enforcement is the total number of linewatch hours for the San Diego, CA, sector.

Source: Author's analysis based on wage data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS) and border enforcement data from the US Department of Homeland Security.

that the two move in opposite directions over 1988–2001 (figure 6). In 1993, just over 42 percent of all apprehensions by the US Border Patrol were in the San Diego sector, so it seems possible that changes in US border enforcement have a particularly strong effect on wages in Tijuana. Figures 5 and 6 therefore have two main implications. First, the rise in border enforcement is concurrent with a rise in trade and the number of maquiladora establishments. Second, theory suggests that the rise in trade and in maquiladora establishments, reasonably attributed to NAFTA, would have opposite effects on the wage gap from an increase in enforcement that was separate from NAFTA.

The timing of the breaks in trade, FDI, border enforcement, and wages seem consistent with the hypothesis that the concurrent increase in border enforcement may have affected wages in the opposite direction of trade and FDI. This hypothesis is formally tested by estimating the effects of these factors on wages

in a single estimation equation (equation 8), modified by adding an error term with the usual assumptions, using both dollar-valued and indexed Mexican-US wage ratios for each of the matched age-education categories described in the previous section (table 4). For migration, border enforcement in San Diego, Ciudad Juarez, Del Rio, Texas, and Laredo, Texas, were jointly included to capture the possibility that increases in border enforcement in one sector divert migration to other parts of the border (Hanson and Spilimbergo 1999).

An increase in the dependent variable, Mexican wages relative to US wages, represents wage convergence. The regressions all include main city effects for all non-Central Mexico cities (but are not shown to conserve space) and the broken trend terms using the endogenously determined breaks as previously described (also not shown to preserve space). Formal tests of linear combinations of the estimated effects of border enforcement were also conducted.

The independent variables are the log of the sum of imports and exports of non-maquiladora trade, the log of the number of maquiladora establishments, and the log of border enforcement (linewatch) hours for San Diego, El Paso, Del Rio, and Laredo. Also included in two of the specifications are interactions of the city dummy variables with maquiladora establishments to allow for the possibility that the effects of changes in maquiladora establishments vary across regions (columns 2 and 4 of table 4).

The regression estimates show large, positive, and statistically significant effects of total trade. Combined with the fact that the level and trend of trade have increased since NAFTA, this suggests that NAFTA has begun to close the wage gap between Mexico and the United States in both dollar and real terms.

The estimated effect of maquiladora establishments is negative, generally statistically significant (three of four cases), and small. When interacted with city effects, the effect of maquiladora investment emerges positively in Monterrey and Tijuana, but negatively everywhere else. The positive effect seems large in Tijuana, especially when wages are measured in dollars. In real terms, however, the positive effect in Tijuana, while statistically significant, is smaller in absolute value than the estimated negative effects in the other border cities. Tijuana has the largest number of maquiladora establishments, so it is not surprising that the positive effects are strongest there, but the estimated negative effects in the other cities remain puzzling.

The estimated effects of border enforcement are mixed. Enforcement is positively correlated with dollar and real wage indices in El Paso and Laredo, but negatively correlated with relative wages in San Diego and Del Rio. The combined effect, however, is negative, statistically significant, and comparable in size to the estimated effect of trade. Given the ambiguous effect of maquiladora investment, these results suggest that border enforcement has worked against the positive effects of the increase in trade since NAFTA.

What about the possible endogeneity of US border enforcement? In early 1994, before the peso crisis, the then US Immigration and Naturalization Service announced a major new border enforcement initiative to increase border

TABLE 4. Comparing Factors That Affect Labor Market Integration

Variable	Dollar Wages		Indexed Value of Wages	
Log of total trade	0.302 (0.047)**	0.351 (0.048)**	0.016 (0.005)**	0.025 (0.005)**
Log of number of <i>maquiladora</i> establishments	-0.005 (0.015)	-0.037 (0.017)*	-0.011 (0.002)**	-0.013 (0.002)**
Monterrey × number of <i>maquiladora</i> establishments		0.072 (0.030)*		0.003 (0.003)
Tijuana × number of <i>maquiladora</i> establishments		0.406 (0.042)**		0.039 (0.004)**
Ciudad Juarez × number of <i>maquiladora</i> establishments		-0.306 (0.067)**		-0.054 (0.007)**
Matamoros × number of <i>maquiladora</i> establishments		-0.075 (0.068)		-0.044 (0.007)**
Nuevo Laredo × number of <i>maquiladora</i> establishments		-0.263 (0.121)*		-0.053 (0.012)**
El Paso	0.038 (0.023)	0.035 (0.023)	0.007 (0.002)**	0.005 (0.002)*
San Diego	-0.339 (0.021)**	-0.251 (0.022)**	-0.020 (0.002)**	-0.010 (0.002)**
Del Rio	-0.642 (0.025)**	-0.581 (0.027)**	-0.036 (0.003)**	-0.029 (0.003)**
Laredo	0.404 (0.022)**	0.359 (0.023)**	0.018 (0.002)**	0.014 (0.002)**
Constant	-0.348 (0.915)	-2.199 (0.930)*	0.154 (0.094)	-0.122 (0.095)
Combined border enforcement	-0.540** (0.033)	-0.438** (0.035)	-0.031** (0.003)	-0.020** (0.004)
Number of observations	13,187	13,187	13,187	13,187
R ²	0.29	0.29	0.14	0.16

*Significant at the 5 percent confidence level.

** Significant at the 1 percent confidence level.

Note: Robust standard errors are in parentheses. Main city effects, broken time trends, and a dummy variable for the peso crisis are included but not reported.

Source: Author's analysis based on data from the Mexican National Survey of Urban Employment (ENEU) and the US Current Population Survey (CPS).

enforcement. The US government may have anticipated the crisis and announced heightened border enforcement in advance, but this seems unlikely. Before the crisis, the expectation was for NAFTA to reduce pressure for migration because migration might have been due to wage differentials that were expected to fall as a result of NAFTA (Hanson and Spilimbergo 1999), so it seems more likely that the US government did not make border enforcement decisions based on Mexican wages *per se*. First, the timing of the announcement of increased enforcement in early 1994 is not consistent with the idea that enforcement responds to Mexican wages. Alternatively, Hanson and Spilimbergo (2001) suggest that enforcement responds to US sectoral shocks (that is, US demand for illegal immigrants). Second, the correlation of the timing of enforcement with wages (especially in Tijuana) seems more consistent with the idea of enforcement driving wages. Third, Hanson, Robertson, and Spilimbergo (2002) use instrumental variables to control for the possible endogeneity of enforcement and still find that increases in border enforcement are correlated with falling Mexican wages, especially in Tijuana.

III. CONCLUSIONS AND POLICY IMPLICATIONS

This article evaluates labor market integration between Mexico and the United States using three different criteria. All three measures reveal limited, if any, support for the hypothesis that Mexican and US labor markets are significantly more integrated since NAFTA. If trade and FDI integrate markets, this result is puzzling because both the level and rate of increase of trade and FDI (proxied by maquiladora establishments) have increased since NAFTA. One possible explanation is that migration is an important third force integrating labor markets and that the increases in US border enforcement that occurred apart from, but roughly at the same time as, NAFTA mitigated the integrating effects of trade and FDI.

By both examining the timing of trend breaks and directly comparing trade, FDI, and border enforcement in a single regression framework, this article finds support for the hypothesis that migration is an important force integrating North American labor markets. The timing of increases in border enforcement is close to the timing of changes in wages, and, when compared with trade and FDI in a single estimation equation, the effects of border enforcement are negative, significant, and comparable in magnitude to the estimated effects of trade and FDI.

One intriguing conclusion policymakers may draw is that, in fact, NAFTA began to integrate labor markets and close the wage gap and, if not for rising border enforcement, the positive effects of trade might have been more evident. These results provide room for some optimism about the role of trade agreements in other countries with less migration to the United States.

Of course, one may also conclude that trade and investment have not increased enough to have the expected effects. Thus, further investments in infrastructure to promote trade, and institutions to reduce economic risk, as well as additional measures to facilitate investment, may yet yield positive effects. The time frame

studied here may also be too brief to detect the kinds of changes implied by trade and investment. The overall trend in Mexican wages—measured in either dollars or real pesos—is positive, and therefore in the long run one can confidently conclude that, in terms of wages, Mexico is catching up to the United States.

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Migration, Trade, and Foreign Direct Investment in Mexico

Patricio Aroca and William F. Maloney

Part of the rationale for the North American Free Trade Agreement was that it would increase trade and foreign direct investment (FDI) flows, creating jobs and reducing migration to the United States. Since poor data on illegal migration to the United States make direct measurement difficult, data on migration within Mexico, where census data permit careful analysis, are used instead to evaluate the mechanism behind predictions on migration to the United States. Specifications are provided for migration within Mexico, incorporating measures of cost of living, amenities, and networks. Contrary to much of the literature, labor market variables enter very significantly and as predicted once possible credit constraint effects are controlled for. Greater exposure to FDI and trade deters outmigration, with the effects working partly through the labor market. Finally, some tentative inferences are presented about the impact of increased FDI on Mexico–U.S. migration. On average, a doubling of FDI inflows leads to a 1.5–2 percent drop in migration.

“Mexico wants to export goods, not people.”

—Former Mexican President Carlos Salinas de Gortari

Mexican President Carlos Salinas de Gortari promoted the North American Free Trade Agreement (NAFTA) partly on the grounds that it would reduce incentives for Mexicans to migrate north. While this rationale is intuitively appealing, several studies have suggested possible slips “twixt cup and lip.” Razin and Sadka (1997) note that dropping the assumption of identical production technologies or permitting increasing returns to scale allows trade and migration to be complements rather than substitutes.¹ Markusen and Zahniser (1999), drawing on models and empirical evidence by Feenstra and

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1. More generally, Faini (2004) notes the complex feedback among trade, FDI, and migration that can obscure the final impact on migration of liberalizing one sector. See also Faini, Grether, and De Melo (1999).

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Hanson (1995) and Markusen and Venables (1997), suggest that the foreign direct investment (FDI) and trade effects of NAFTA are likely to increase the relative earnings of skilled workers but not those of unskilled workers, who are most likely to migrate. Much of the migration literature has failed to find a significant impact on migration of wages or unemployment rates in the initial location (Greenwood 1997; Lucas 1997), casting some doubt on the strength of any trade or FDI effects working through the home country labor market. Perhaps most worrisome, there is increasing evidence that liquidity constraints are a barrier to migration—it takes resources to move (Stark and Taylor 1991). If FDI or trade flows relax this constraint, however, the expected substitution effect may be partially or completely offset, leading to more migration (López and Schiff 1998).

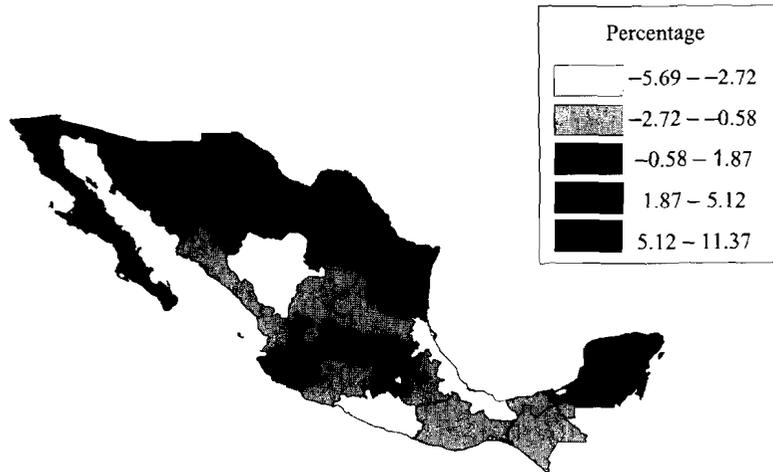
The illicit nature of Mexican–U.S. migration flows means that they are poorly measured. Thus, indirect approaches are needed. A small detailed case study literature on individual municipalities offers some suggestive evidence that NAFTA-related phenomena—female manufacturing employment and proximity to a *maquila*—might reduce migration.² In a times-series context, Hanson and Spilimbergo (1999) find that border apprehensions are responsive to U.S.–Mexico wage differentials, a finding confirmed by McKenzie and Rapoport (2004) using a retrospective survey. Davila and Saenz (1990) find a negative relationship between lagged *maquila* employment on the border and monthly border apprehensions as a proxy for migration pressures. Unfortunately, more direct data on FDI and trade with adequate periodicity or span are unavailable to offer enough degrees of freedom to permit inference with any confidence. Further, the massive peso crisis beginning roughly with the signing of NAFTA led to a sharp spike in unemployment and a 25 percent drop in wages. These likely induced migration flows to the United States that complicate inference on the more modest effects that NAFTA might have had in the opposite direction.

For these reasons, this article focuses on the mechanisms through which NAFTA-related variables might work, using data on migration flows within Mexico, across its 32 states. The 2000 census data permit careful analysis, and the 32 by 32 permutations offer substantial degrees of freedom.

A casual look at maps showing rates of net migration (net flows as a share of the population in the initial period) by state (figure 1) and FDI by state (figure 2) suggests a relationship between the magnitude of FDI and migration. By more rigorously investigating this possibility for FDI and other trade variables, this article makes three contributions to the literature on migration generally and, more specifically, on the impact of trade and FDI flows on migration.

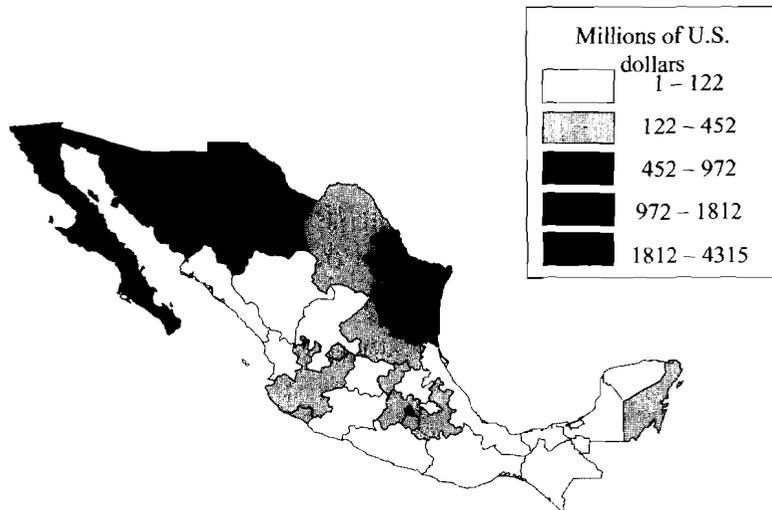
2. Using data gathered in 25 Mexican communities, Massey and Espinosa (1997) create histories of migrants to the United States and find initial migration to be negatively related to the wage rate and the proportion of women in manufacturing. Jones (2001) examines 17 emigrant municipalities and argues for an association between proximity to *maquiladoras* and employment growth and, in turn, declining migration to the United States.

FIGURE 1. Net Migration in Mexican States, 2000



Source: General Census of Population and Housing 2000.

FIGURE 2. Foreign Direct Investment per Capita by Mexican States, 1994–2000



Source: Central Bank of Mexico.

First, the analysis produces the first estimates of determinants of migration flows within Mexico and advances the literature on developing country migration. In line with recent innovations in the literature on industrial countries, the analysis generates proxies for the level of amenities and costs of living and finds their influence to be statistically significant. Further, contrary to much of the literature

for both industrial and developing countries noted above, the specification applied here allows disentangling the relative expected earnings effect from the liquidity effect. The results are highly significant, with intuitively plausible signs on labor market variables. Finally, network effects are introduced and also found to be strongly significant.

Second, the article offers evidence that both FDI and trade variables are substitutes for labor flows, are likely to work through the labor market, and have substantial deterrent effects. Even without the application to international migration, this finding is of intrinsic interest for the literature exploring the nexus of national spatial income disparities and migration (Barro and Sala-Martin 1992; Gabriel, Shack-Marquez, and Wascher 1993; Esquivel 1997) and the literature on how trade liberalization may affect regional disparities (Hanson 1997; Aroca, Bosch, and Maloney forthcoming). However, by establishing that the mechanisms through which NAFTA was expected to affect migration indeed function at the domestic level, the article supports President Salinas's claim for international migration as well. Further, the analysis implicitly addresses Markusen and Zahniser's (1999) concern that the skills demanded by FDI and trade are higher than those possessed by the majority of migrants to the United States and hence that NAFTA may have no effect. Finally, the results are also consistent with Robertson's (forthcoming) that trade is a force for wage convergence between the United States and Mexico more generally.

Third, the article offers some tentative back of the envelope inferences about the impact on Mexico-U.S. migration, implicitly treating the United States as the 33rd Mexican state. The magnitude of the impacts are found to be significant.

I. METHODOLOGY

A potential migrant faces j possible destinations, where i is the region of origin and k is the migration region chosen, so that a worker's internal migration decision is reflected by the sign of the index function:

$$(1) \quad I^* = V_k - V_i - C.$$

where V is an indirect utility function in the context of random utility theory (Domencich and McFadden 1975; Train 1986) and C is a measure of costs. Utility is a function of a linear combination of location characteristics X .

$$(2) \quad V_j = X_j\beta + \varepsilon_j.$$

If a migration destination is more desirable than the origin location, measured along several dimensions, and if the migrant has sufficient resources to move, then migration should occur. The probability that the indicator will be larger than zero is equal to the probability that the difference between V s is greater than transport costs:

$$(3) \quad P(I^* > 0) = P(V_k - V_i - C > 0) = P(\varepsilon_i - \varepsilon_k \leq X_k\beta - X_i\beta - C).$$

This specification nests many standard estimated functions (Greenwood 1997) including Borjas' (1994, 2001), where the only argument in the utility function is the wage.³ The actual specification depends on the assumptions about the error term.

The β s may be allowed to vary, and in fact the literature tends to find a greater role for destination variables than for origin variables. This may be because of asymmetric information about locations (Gabriel, Shack-Marquez, and Wascher 1993) or because the individual variables are correlated with omitted variables that may have a greater impact on one end of the migration move. As discussed in more detail later, many variables could be correlated with unmeasured wealth or liquidity, which would determine whether the worker has the savings to pay the fixed cost of moving, C .

The matrix X contains the variables capturing the relative expected incomes, Y , in the two areas (wages, unemployment, and price indices) and the set of characteristics of the two areas (amenities) that may also affect the migration decision. Any impact of FDI and trade would be expected to occur through Y .

Following Ben-Akiva and Lerman (1985), as generalized in Gourieroux (2000), for aggregate data:

$$(4) \quad F^{-1}[P(I^* > 0)] = X_k\beta_d - X_i\beta_o - C.$$

where F is the probability function that is determined by the structure of the errors.

The overall approach is to estimate a broadly standard specification augmented by some additional proxies and modified to better capture liquidity effects. Integration-related variables are then introduced to explore the degree to which their effects are channeled through the labor market.

II. DATA

Data were collected on migration specifications and on trade and investment flows. Data sources and shortcomings are described in the following sections. None of the variables is ideal, but they are complementary in the sense of some being strong where others are weak. Together, this may provide a reliable picture of the impact of trade and investment variables.

Migration Specifications

Data were collected on interstate migration flows, moving costs, networks, population by state, labor markets, cost of living, and amenities.

3. Borjas (2001) argues that $I^* = \max_j \{w_j\} - w_i - C$, where I^* is an indicator variable, w is the wage, and C is the cost of transportation to the new location. This function must satisfy $w_k = \max_j \{w_j\}$, where j represents all possible destinations, i the region of origin, and k the chosen destination. For other recent approaches to migration questions, see Davies, Greenwood, and Li (2001); Dahl (2002); and Ham, Li, and Reagan (2004).

MIGRATION FLOWS. The 2000 General Census of Population and Housing generates migration data from a question that asks in what state the interviewee resided five years earlier. Though this approach is standard, it has the drawback of failing to count migrants who may have left and returned over the five-year period. Flows to the United States are derived from a question asking whether a member of the household has gone to the United States in the last five years.

MOVING COSTS. Following the literature (see Greenwood 1997), the costs of transportation are approximated by a quadratic function of distance.⁴ This proxy for the costs of migration includes moving costs; the opportunity costs of moving, which rise with the length of the journey; and rising communication costs with the family in the point of origin, including the increased costs of return visits. In general, the literature expects a negative impact on migration but with decreasing effect.

NETWORKS. An emerging literature stresses the importance of existing diaspora networks for lowering transaction and information costs. The Mexico-U.S. literature has particularly expanded on this point (see Zabin and Hughes 1995; Massey and Espinosa 1997; Winters, de Janvry, and Sadoulet 2001; McKenzie and Rapoport 2004). As in the literature on within-country migration, the share of the population that arrived in destination j more than five years earlier and that was born in state of origin i is used as a proxy for networks.

POPULATION. Population by state in 1995 is taken from the census. As Greenwood (1997) summarizes, population is often used as a measure of the availability of public goods. However, larger states offer more potential matches than small states and so, in a random reallocation, will attract more migrants. Shultz (1982) also argues that larger states may have smaller rates of outmigration simply because there are more places to migrate to within the state. The 1995 value is used to eliminate any problems of simultaneity with migration flows in subsequent years.

LABOR MARKETS. The unemployment rate and nominal wage variables are generated as the average of their quarterly values in 1995, 1996, and 1997 from the National Urban Employment Survey (ENEU).

COST OF LIVING. Though presumably a potential migrant focuses on real rather than nominal expected wages, the relevant deflator may not be that of the

4. Though the indirect utility function is assumed to be linear and the weight of each variable to be similar in each region, this assumption can be easily relaxed to differentiate the origin and destination parameters.

destination place of work. For instance, a migrant who plans to retire in a low-cost area may conceivably generate real savings measured in the retirement destination faster by earning a lower real wage in a high-cost area than by continuing to work in the area of origin (see Lucas 1997 for a survey of this literature). Further, a high cost of living may point to a larger potential income over the long run even if that is not realized by the individual making the decision (Spencer 1989; Pagano 1990). Certainly, in an intertemporal context, taking a lower real wage in the United States is still likely to offer the migrant's descendants far better options than would have been available in Mexico.⁵

Official price indices for Mexican states do not allow cost of living comparisons across states. For this reason, two indices were created using the 1992 National Survey of Household Income and Spending (ENIGH). Since food generally constitutes a large share of the consumption basket in developing countries, a Laspeyres index of a consumption basket of 200 items is generated using the national average in 1992 for price and reference basket. The housing price index was created using hedonic prices for rented houses only and is analogous to housing indices used in the industrial country literature. Housing characteristics include number of rooms; presence of kitchen, bathroom, electricity, telephone, sewerage, and potable water; types of walls, floors, and ceilings; and community size.⁶ Both indices are included separately and as an average measure of the cost of living. They are included as freestanding variables to allow for the effects described above. The specifications with the most predictive power were those using an average measure, and these are the results reported here.

AMENITIES. Price indices may simply reflect amenities available in the destination area, implying a positive relation with migration decisions. Further, as Roback (1982) shows, amenities affect equilibrium wages as well and hence should be included as part of the net utility change in moving from one location to another. A measure of amenities across Mexican states was created by the National Institute of Statistics, Geography, and Informatics (INEGI) using the 2000 census. However, that measure includes indicators of labor market tightness as well as migration variables (share of resident population born in other states and share residing in other states)—variables whose influence this analysis is trying to separate out. Therefore, a new index was created incorporating information on the share of the population living in urban areas, mortality rates, health infrastructure (number of nurses, doctors, hospitals per capita, and

5. The literature provides mixed evidence. Cameron and Muellbauer (1998), in studying UK migration, find strong “deflator” effects that they argue dominate any expectation effects. Thomas (1993), however, also looking at UK migration, finds no impact of regional house price difference on destination choice of any group except retirees.

6. The ENIGH includes information on house characteristics, which permit estimating housing costs.

number of hospital beds), education (students per teacher in primary and secondary schools), and infrastructure (share of houses with electricity, share with sewerage). Four significant factor loadings were identified, with the first having the strongest interpretation as capturing amenities. The correlation of this measure with wages is 0.37, and the correlation with the INEGI's welfare index is 0.77

Trade and Investment Variables

Data were collected on FDI, *maquila* value added, exports, and imports.

FOREIGN DIRECT INVESTMENT. Data on FDI per capita for 1995–99 are from the Central Bank of Mexico, as reported to the government by the investing firms. The Federal District of Mexico City shows vastly higher FDI rates than other states because much of the FDI destined for other states is registered at firms' company headquarters in Mexico City. A dummy variable is included in the regressions to account for this measurement error. As figure 2 suggests, FDI is highly concentrated along the northern border with the United States.

MAQUILA VALUE ADDED. The *maquila* value-added variable may be seen as a proxy for FDI, but since *maquilas* are primarily exporters, it can also be seen as a proxy for *maquila* exports per capita, which brings it closer to being a trade variable. Since the data are collected from industrial surveys, the variable does not suffer from the "headquarters" effect of the FDI variable. The two variables are moderately correlated (0.64), and so *maquila* value added may be a serviceable proxy for FDI more generally. One problem, however, is that the government of Mexico lumps data on *maquila* value added for 12 states into an "other" category, and the loss of data for these individual state implies reduced information and potential selection bias. The regressions are run with the substantially reduced sample.

EXPORTS. Data on exports are provided by the Ministry of Finance. As with the FDI data, the exports reported by firms are assigned to their headquarters location, often the Federal District of Mexico City, which may not be the actual location of production. The ministry therefore reassigns each firm's aggregate exports proportionally, using data on the location of plants and number of employees from the Mexican Institute of Social Security (IMSS) database. The methodology does not include oil or electricity exports and may miss smaller firms that do not register with IMSS.

IMPORTS. Import data came from Bancomex. This variable could have multiple and conflicting effects. It could simply reflect a state's degree of integration with external economies and hence be a proxy for exports. But if imports are seen as representing competition to import-substituting firms, the short-run labor market impact could be negative and hence imports could conceivably lead to more migration.

III. RESULTS

Preliminary regressions estimated a multinomial logit model for aggregate data. Though the results were plausible, the Fry and Harris (1998) test suggests that the data violate the independence of irrelevant alternatives principle. Thus a multinomial probit model was estimated following Gourieroux's (2000) weighted least squares procedure. Summary statistics are provided in the appendix.

Overall, the specifications are very satisfactory, with the coefficients on the core variables generally statistically significant and of the predicted sign (table 1). The costs of movement variables—distance and network—are significant in all specifications, and the coefficients for distance are well within the usual range found in the literature (Greenwood 1997; see also Fields 1982; Shultz 1982; Gabriel, Shack-Marquez, and Wascher 1993). The population of the destination location is significant with a positive sign in all specifications, a result consistent with a connection point interpretation, a residuals amenity effect, or perhaps congestion externalities. The coefficient on the origin population is unstable across specifications.

The cost of living variable enters very significantly and is of important magnitude in the location of origin. The strong positive coefficient on the destination cost of living variable is unexpected. That may perhaps be consistent with cost of living being a measure of expectations of future income growth, as discussed earlier. Alternatively, as with many of the explanatory covariates, the cost of living is likely to be endogenous to immigration flows—a growing population pushes up the cost of housing, goods, and services—and therefore potentially biased. However, the lack of credible instruments precludes attempts to deal with simultaneity bias, so this possibility is posited as a caveat.

There appears to be some interaction between the amenities and network variables. In specifications without the network variable, the amenities variable enters with predicted sign, but the relative and freestanding specifications suggest that amenities may be correlated with an omitted credit constraint variable. Including the network term reduces the significance of the relative amenities term in virtually all specifications. The reason is not clear, although it may be that the cumulative migration from origin to destination state represented by the network term is especially related to relative amenities.

Labor Market Variables

Preliminary estimations 1a and 1b (see table 1) found both unemployment and wage level in the origin state to be insignificant, as has frequently been found in the literature (Greenwood 1997; Lucas 1997). Attempts were made to isolate two countervailing effects, one a substitution effect among states and the other a wealth or liquidity effect that allows a potential migrant to cover the fixed cost of moving. This second effect has been found for U.S. unemployment by Goss and Schoening (1984) and Herzog, Schlottmann, and

TABLE 1. Determinants of Migration from State i to State j

Variable	Basic	Reduced-Sample	FDI		<i>Maquila</i>		Export		Import	
	Regression	Regression ^a	Regressions	Regressions	Value-Added	Reduced-Sample	Regressions	Regressions	Regressions	Regressions
	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b
<i>Migration</i>										
Distance	-0.039 (15.61)	-0.0553 (10.38)	-0.037 (13.99)	-0.0421 (16.97)	-0.0581 (10.53)	-0.0564 (10.94)	-0.0359 (14.11)	-0.0399 (16.45)	-0.0345 (13.77)	0.0389 (15.99)
Distance squared	0.0005 (8.92)	0.0007 (6.12)	0.0005 (9.04)	0.0005 (9.81)	0.0008 (6.85)	0.0008 (6.63)	0.0005 (8.49)	0.0005 (9.24)	0.0004 (8.30)	0.0005 (9.16)
Network	0.004 (12.58)	0.0045 (9.78)	0.0034 (9.64)	0.0041 (12.67)	0.0042 (8.68)	0.0042 (9.43)	0.0037 (11.12)	0.0035 (11.19)	0.0041 (12.55)	0.0039 (12.60)
Population i	-0.0014 (0.33)	-0.0175 (2.08)	0.0034 (0.71)	-0.0086 (1.92)	-0.0268 (3.26)	-0.0141 (1.72)	0.0055 (1.24)	0.0085 (1.91)	0.0087 (1.96)	0.0111 (2.41)
Population j	0.0456 (9.61)	0.0286 (3.12)	0.0473 (9.18)	0.0384 (7.95)	0.0224 (2.39)	0.035 (3.91)	0.0415 (8.41)	0.0492 (10.38)	0.0366 (7.55)	0.0436 (9.13)
Log prices i	0.3079 (3.45)	0.0905 (0.55)	0.2764 (3.21)	0.3374 (3.84)	0.4605 (3.67)	-0.125 (0.73)	0.2079 (2.65)	0.1563 (1.74)	0.2356 (3.05)	0.1697 (1.88)
Log prices j	0.2843 (3.71)	0.1632 (1.10)	0.7152 (9.89)	0.2582 (3.45)	0.9122 (7.95)	0.1718 (1.14)	0.7792 (11.68)	0.3036 (3.98)	0.6542 (9.72)	0.3045 (4.04)
Relative amenities	0.003 (1.47)	-0.0277 (0.93)	0.0019 (0.83)	-0.0013 (0.62)	0.0038 (0.13)	-0.0096 (0.33)	-0.0005 (0.24)	-0.0029 (1.38)	0.0004 (0.17)	-0.0013 (0.62)
Amenities l	0.0225 (1.91)	-0.0155 (0.64)	0.0471 (4.04)	0.0211 (1.82)	-0.0005 (0.02)	-0.0214 (0.90)	0.0459 (3.82)	0.0368 (3.16)	0.0654 (5.15)	0.0533 (4.35)

(Continued)

TABLE 1. Continued

Variable	Basic	Reduced-Sample	FDI		<i>Maquila</i>		Export		Import	
	Regression	Regression ^a	Regressions		Reduced-Sample	Regressions	Regressions		Regressions	
	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b
<i>Labor market</i>										
Relative unemployment	-0.1161 (4.20)	-0.1506 (2.17)		-0.1391 (5.12)		-0.1454 (2.16)		-0.1097 (4.10)		-0.1212 (4.51)
Unemployment <i>i</i>	-0.0335 (2.21)	-0.134 (3.10)		-0.0609 (3.99)		-0.136 (3.24)		-0.0322 (2.21)	-0.0205 (1.38)	
Relative nominal wage	0.8025 (12.46)	1.0515 (8.22)		0.8902 (12.00)		0.8513 (5.56)		0.753 (10.02)	0.6188 (7.65)	
Log nominal wage <i>i</i>	0.6903 (6.72)	1.2762 (6.05)		1.044 (8.98)		1.5221 (6.08)		1.012 (8.29)	0.899 (7.02)	
<i>Investment and trade</i>										
Relative {FDI/ <i>maquila</i> / exports/imports}			0.0291 (6.40)	-0.0091 (1.81)	0.0293 (2.51)	0.0535 (4.00)	0.0614 (10.27)	0.0195 (2.88)	0.0673 (11.83)	0.0309 (4.40)
Log {FDI/ <i>maquila</i> / exports/ imports} <i>i</i>			0.0085 (1.36)	-0.0407 (5.78)	0.0447 (2.51)	-0.0236 (1.17)	0.0136 (1.50)	-0.0458 (4.31)	0.0174 (1.96)	-0.033 (3.02)
Federal District and Mexico State	-0.2147 (5.26)	0.0119 (0.16)	-0.266 (6.02)	-0.1219 (2.85)	-0.099 (1.29)	-0.0247 (0.33)	-0.2531 (6.05)	-0.2558 (6.39)	-0.2664 (6.54)	-0.2382 (6.03)
Constant	-10.3586 (13.94)	-12.6053 (9.56)	-7.3816 (14.23)	-12.6744 (15.64)	-9.0691 (11.73)	-13.2986 (9.86)	-7.4026 (14.94)	-11.9351 (15.31)	-7.0175 (14.45)	-11.315 (13.83)
Number of observations	992	306	992	992	306	306	992	992	992	992
R-squared	0.7	0.84	0.66	0.72	0.83	0.85	0.68	0.72	0.69	0.72

^aResults with a reduced sample of states with data on *maquila* value added.

Note: Numbers in parenthesis are *t* statistics. Estimates are least squares weighted by group (gprobit). The amenities, labor, and investment and trade variables are included as a relative measure ($\log X_i - \log X_j$) and a freestanding value at the origin, $\log X_i$.

Source: Authors' analysis based on data sources discussed in the text.

Boehm (1993), who find that the probability of moving decreases with the duration of unemployment. The literature on the wage effect is also extensive. (Stark and Taylor 1991 discuss credit constraints.) Relative wage ($\ln w_j - \ln w_i$) and relative unemployment (U_j/U_i) variables capture substitution effects, and freestanding initial wage and unemployment variables capture credit constraint effects. In the complete sample all but freestanding unemployment enter significantly, while in the restricted sample regression the coefficient has the predicted sign and is significant at the 10 percent level. This overall strong performance suggests that the poor results for origin labor market variables in many previous studies arise precisely because they capture two contradictory tendencies.

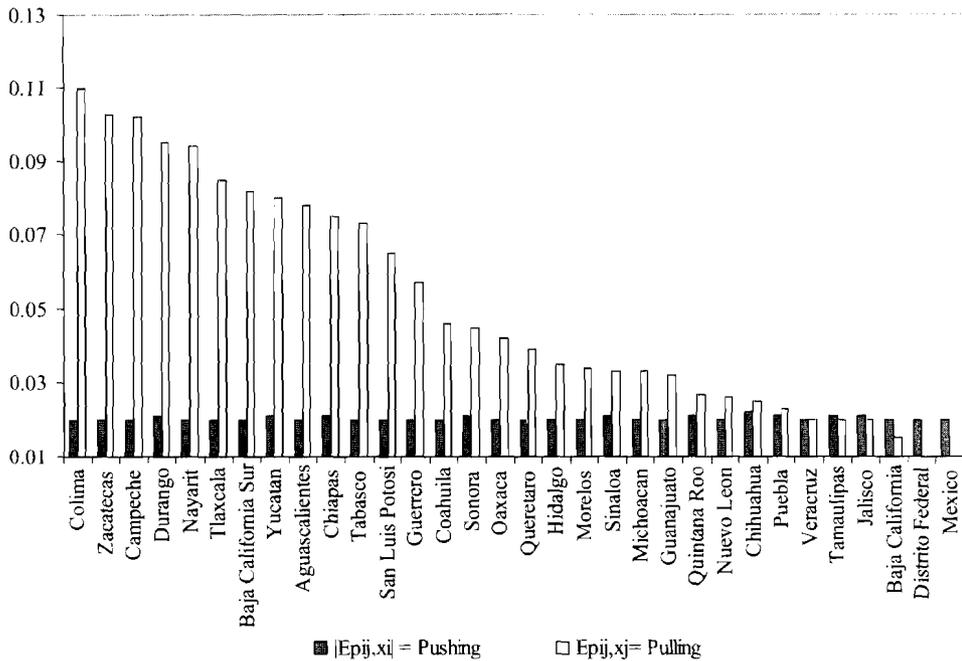
Integration Variables

Four specifications drop the labor force variables and replace them with the trade and investment variables, again in relative and freestanding form (table 1, columns 2a, 3a, 4a, and 5a). In all cases there is evidence of a strong substitution effect: FDI and trade reduce migration. The freestanding term is significant in half the cases, consistent with López and Schiff's (1998) concern that trade and investment integration may increase migration flows by releasing liquidity and wealth constraints. In the case of *maquilas* and imports, this liquidity effect appears to offset to some extent the substitution effect found with the relative term.

When the labor force variables are added, the results suggest that some of the effects of the trade and investment variables work through the labor market (table 1, columns 2b, 3b, 4b, and 5b). This interpretation is consistent with Hanson's (forthcoming) finding that the distribution of conditional labor income was shifted to the right in states with high exposure to similar trade and investment variables relative to states with low exposure. The substitution effect diminishes by at least a factor of 2 in most cases and in the case of FDI becomes insignificant. The exception is the *maquila* variable, which appears to strengthen. Whether this is due to the selection bias caused by the grouping of official data for states with a small *maquila* presence is not clear.

The freestanding trade and investment variables also show a propensity to flip sign in all cases, suggesting that they were capturing the initial wealth and liquidity now captured by initial wages and unemployment. Minus this effect, the deterrent effect of the trade and investment variables is more powerful than the attraction effect of the destination. The fact that all relative trade and investment variables retain an effect outside of the contemporaneous labor market variables may reflect an independent disincentive effect to migrate, perhaps through expectations of future growth. In all cases the possible endogeneity between local labor market variables and the location of trade and FDI is left largely unexplored due to the lack of credible instruments. Further, it is possible that both migrants and FDI are attracted by the same characteristics, an issue at least partially addressed by the invariance of the results to the inclusion

FIGURE 3. Estimated Migration Push and Pull Elasticities to Foreign Direct Investment by State



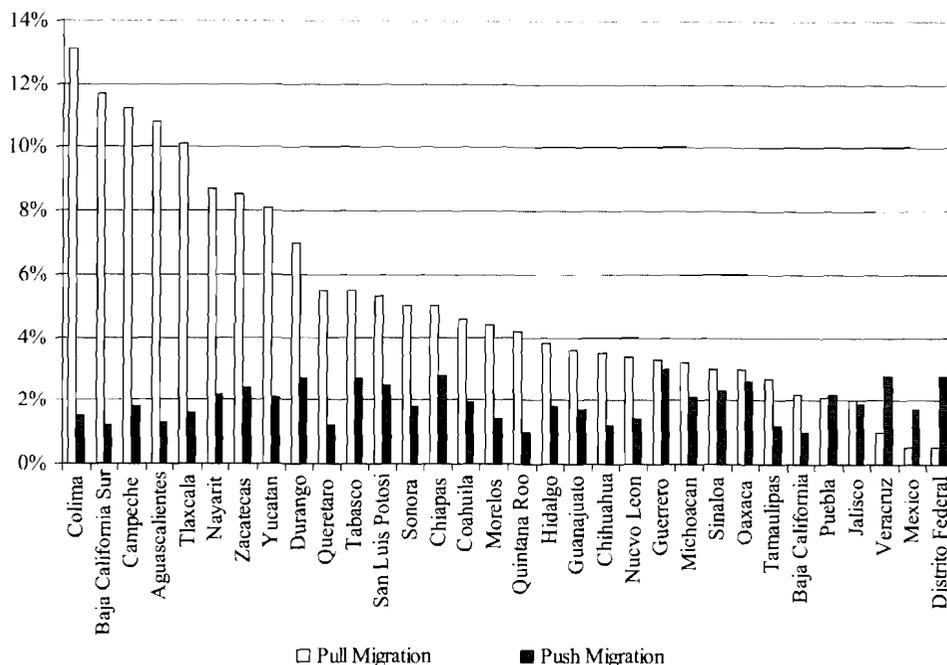
Source: Authors' analysis based on data sources discussed in the text.

of fixed effects.⁷ For these reasons, the results may suggest that part of the impact of these variables on migration works through the labor market.

As an example of the implied magnitudes, estimated migration elasticities in response to an increase in FDI were calculated by state for both a reduction in push migration forces from the state and an increase in pull forces from other states (figure 3). Though in theory the liquidity effect identified in the *maquila* and export cases could dominate and cause an increase in push migration, in the FDI case the coefficient is small and insignificant, and push forces are clearly reduced in all states with elasticities averaging 0.02. Pull elasticities are

7. Two more variants of the base and FDI regressions were run as additional robustness tests. One regression, which included a full set of state dummy variables, both origin and destination, showed the predictable effects of the substantially reduced degrees of freedom but had relatively little effect on the magnitudes of the core variables. In the key specification on which the simulations are based (table 1, column 2b), the relative FDI term changed little, falling from 0.029 to 0.021 and the *t* statistic from 6.4 to 3.6. The freestanding term remained insignificant. A second regression included a measure of relative education levels, measured as average years of schooling. The relative and freestanding initial terms enter insignificantly and have little impact on the other covariates with the exception of a perhaps predictable slight lowering of the relative wage term and a rendering insignificant of the freestanding amenities term.

FIGURE 4. Estimated Impact on Push and Pull Migration of a 10 Percent Rise in Foreign Direct Investment as a Share of Total Migration from State



Source: Authors' analysis based on data sources discussed in the text.

substantially higher, averaging 0.05 and reaching as high as 0.1 in Colima, Zacatecas, and Campeche. A doubling of FDI in these states leads to a 10 percent increase in migrants attracted to the state and a 2 percent decline in outflows.

To see whether these magnitudes are important, the impact of a 10 percent rise in each state's FDI on the magnitude of push and pull migration forces is divided by total outmigration to the United States and to other Mexican states, as a measure of scale. Both effects are of nontrivial magnitude. Push migration falls by 1–3 percent of total migration, while the rise in pull migration ranges from under 0.5 percent to more than 10 percent in Colima, Zacatecas, and Campeche (figure 4). Inflows of FDI thus have a potentially substantial impact on migratory flows.

Further, Markusen and Zahniser's (1999) concern that FDI and trade would not prove a disincentive to migration because they do not affect the relevant migratory population is addressed by comparing the internal migrant population and the population migrating to the United States in educational attainment, age, and gender (table 2).⁸ Men in the two populations have similar

8. These findings are similar to those of Chiquiar and Hanson (2003) using U.S. census data.

TABLE 2. Migration Patterns by Education and Age for Nonmigrants and Migrants within Mexico and to the United States

Variable	Men			Women			Total		
	Nonmigrants	Migrants within Mexico	Migrants to the United States	Nonmigrants	Migrants within Mexico	Migrants to the United States	Nonmigrants	Migrants within Mexico	Migrants to the United States
Schooling (percent)									
No schooling	14.1	10.5	8.0	16.0	11.0	9.6	15.1	10.7	8.6
1-4 years	27.9	19.7	5.3	26.8	19.5	5.6	27.3	19.6	5.4
5-8 years	28.9	25.5	32.1	29.2	28.2	29.6	29.1	26.9	31.1
9 years	12.9	16.4	12.4	12.3	16.6	11.3	12.6	16.5	11.9
10-11 years	4.0	5.1	7.3	3.9	5.2	6.2	3.9	5.1	6.9
<12 years	87.8	77.2	65.1	88.2	80.5	62.2	88.0	78.9	64.0
12 years	5.2	8.7	24.6	6.0	9.5	24.8	5.6	9.1	24.7
13-15 years	2.4	4.2	6.1	2.4	3.7	7.4	2.4	3.9	6.6
>15 years	4.6	9.9	4.2	3.4	6.3	5.6	4.0	8.0	4.7
Age	31.2	28.6	28.3	32.2	27.8	30.7	31.7	28.2	29.2
Number	4,008,334	159,712	694,206	4,288,508	172,192	461,990	8,296,842	331,904	1,156,196

Source: Authors' analysis based on data from the 2000 General Census of Population and Housing for migrants within Mexico and on the 2000 U.S. Census for migrants to the United States.

age profiles, although women who migrate to the United States tend to be somewhat older than women who migrate internally, perhaps reflecting delayed migration to the United States after their spouse. A key finding among both men and women, however, is that domestic migrants are somewhat less educated than migrants to the United States, suggesting that Markusen and Zahniser's concern is unfounded.

Simulations of the Impact on Migration to the United States

Ideally, the estimates for internal migration could be used to approximate the magnitude of the impact on migration to the United States. Clearly, for such an exercise to be valid, the types of people who decide to migrate to the United States must not differ too much from those who decide to migrate within Mexico, or, put differently, the factors motivating the decision to migrate must not differ too much between the two destinations. As discussed, the demographics of the two groups are similar (see table 2). While the literature is mixed, it is not necessarily inconsistent with this assumption.⁹ It does appear, however, that women are more likely than men to migrate within Mexico rather than to the United States. This may reflect a household strategy of migrating to the border region and sending the husband across to the United States to engage in the riskier and more intensive work, while the wife stays on the Mexico side of the border working in less risky, less demanding jobs that permit easier balancing of family responsibilities (Zabin and Hughes 1995). The literature stresses the importance of accumulated networks, which appear to have caused some Mexican states to generate a disproportionate number of U.S.-bound migrants. To the extent possible, the domestic regressions control for such effects, and as detailed below, additional adjustments were made in the simulations.

A second concern is whether the U.S. variables are too "out of sample" to permit treating the United States as a 33rd Mexican state. The ratio of the per capita income of Mexico's richest state, the Federal District of Mexico City, relative to its poorest state, Chiapas, is about 6.4 in nominal terms and 5.6 in real terms, while the ratio of the average for the United States relative to Mexico

9. Rivera-Batiz (1986, p. 265), in an often-cited article, implicitly suggests migrants' indifference between destinations: "The impact of the *maquiladoras* on migration to the United States is dependent on whether they are able to raise employment by more than they increase the labor supply in the border areas through induced migration from southern regions. If an excess supply of labor is generated at the border with surplus workers becoming either openly unemployed or underemployed, it is likely that there will be a spillover into illegal migration to the United States." The fieldwork on "staged migration" can be read both ways. On the one hand, workers in the first stage, moving, for instance, from Oaxaca to jobs in Baja California, have less information and capital and fewer contacts than workers who decide to make a second-stage crossing to the United States. On the other hand, the underlying objective function is arguably the same for both workers, and migration costs (embodied in information or networks) and credit constraints are standard in the migration specifications. See Durand and Massey (1992) for a review of the field literature on migration and Cornelius and Martin (1993) and Zabin and Hughes (1995).

TABLE 3. Monthly Wages and GDP per Capita, Mexico and United States

Item	Mexico		United States (Current U.S. Dollars)
	Current U.S. Dollars	Purchasing Power Parity (U.S. Dollars Adjusted by State CPI)	
GDP per capita			
Average	5,393	8,349	29,451
Minimum	2,368	3,617	20,856
Maximum	15,226	20,268	40,870
Ratio of maximum to minimum	6.4	5.6	2.0
Ratio of average U.S. to Mexican maximum	1.9	1.5	
Monthly wage			
Average	372	575	1,716
Minimum	218	375	
Maximum	551	825	
Ratio of maximum to minimum	2.5	2.2	
Ratio of average U.S. to Mexican maximum	3.1	2.1	

Source: Authors' calculations based on data from the Mexican National Urban Employment Survey, National Institute of Statistics, Geography, and Informatics, U.S. Bureau of Economic Analysis (<http://www.bea.doc.gov>), and U.S. Bureau of Labor Statistics (<http://www.bls.gov/cps/cpsaat37.pdf>). See text for details.

City is only about 1.9, or 1.5 in purchasing power parity terms adjusted by the state consumer price index (table 3). That is, in terms of development the United States is closer to Mexico City than Mexico City is to Chiapas. Nor are wage differentials radically different. The ratio of the Hispanic real wage in the United States to the mean wage of Mexico City adjusted for purchasing power parity is roughly the same as the ratio of the real wage in Mexico City to that in Chiapas.

There may be some concern that the importance of the U.S. border is not well represented by the transport costs variable. In fact, there is strong evidence that the cost of border crossing is more a difference in magnitude than in kind. Donato, Durand, and Massey (1992, pp. 152, 155) argue that "our data from Mexico reveal a fairly high probability of apprehension by [the U.S. Immigration and Naturalization Service] combined with a near-certain probability of ultimately entering the United States" and that "*every* migrant who attempted a border crossing, whether apprehended or not, eventually gained entry" [*italics in original*]. This suggests that border control serves more as a tariff than a quota.

The costs of moving across states or to the United States are substantially different, but perhaps not as different as might at first be thought. In 2002 the cost of second-class bus fare from Quintana Roo to Coahuila, one of the longer

trips in the sample, was roughly US\$100, whereas transportation between Mexico State and Mexico City cost very little.¹⁰ Anecdotal evidence puts the cost of direct transportation across the border in the 1980s at US\$150 (US\$244 in 2002; Conover 1987 cited in Hanson and Spilimbergo 1999), again, not so far out of sample.¹¹ The cost of a smuggler-guide appears to have held steady in real terms since the 1960s at around US\$350 (US\$2,075 in 2002; Donato, Durand, and Massey 1992),¹² although Crane and others (1990, as cited in Hanson and Spilimbergo 1999) suggest that only 8.3 percent of those apprehended in the United States in 1993 had employed one.

Despite some differences, therefore, the overall magnitudes of the migration variables for the United States and Mexican states are not “too different.” Of total migration, roughly two-thirds is internal and one-third is to the United States. As a crude first approximation, making no adjustments for any likely covariates such as distance or relative wages, a simple χ^2 statistic suggested by Bickenbach and Bode (2003) cannot reject the hypothesis that the same Markov process is driving both United States and intra-Mexican migration for 12 of the 32 states.¹³

To generate back of the envelope calculations, note first that total emigration from any state is the sum of migration to other states plus to the United States:

$$(5) \quad M_i = \sum_{j=1}^{32} m_{ij} + m_{iUS} \quad \text{for all } i = 1, \dots, 32$$

$$M_i = \sum_{j=1}^{32} \text{Pop}_i^* p_{ij} + m_{iUS}.$$

Total migration in Mexico is

$$(6) \quad M = \sum_{i=1}^{32} \left(m_{iUS} + \text{Pop}_i \sum_{j=1}^{32} p_{ij} \right) = M_{US} + \sum_{i=1}^{32} \left(\text{Pop}_i \sum_{j=1}^{32} p_{ij} \right)$$

where M_{US} is total migration from Mexico to the United States. As shown above, the probability of migrating from state i to state j depends on the characteristics

10. White Star Bus line.

11. Inflated from 1985 figure with CPI.

12. This showed little change with the Immigration Reform and Control Act of 1986, suggesting that it is a fairly robust number. The 2002 figure was reached by inflating the 1960 figure by the CPI. Smuggler-guides get paid only for successful crossings.

13. Mexico State and the Federal District are dropped from the sample since they are effectively the same unit and have very high flows between them.

in X , $p_{ij} = \Phi(X\beta)$ and hence on $\Phi^{-1}(\hat{p}_{ij}) = z_{ij} = Xb$. The percentage change in immigration to the United States is thus obtained from:

$$(7) \quad \frac{\partial \ln M_{US}}{\partial \ln X_k} = -\frac{1}{M_{US}} \sum_{i=1}^{32} \text{Pop}_i \sum_{k=1}^{32} \frac{\partial \Phi(Xb)}{\partial \ln X_k} + \frac{1}{M_{US}} \frac{\partial M}{\partial \ln X_k} \quad \text{for } k = \{i, j\}.$$

The first term captures the substitution effect—how much existing migrant flows will be reallocated across destinations given the change in X_k . The second term captures the aggregate percentage change in migration, a component that cannot be captured from domestic data. Given the liquidity effect detected earlier, this variable has the potential to be positive. However, the liquidity effect was not significant in the FDI regressions, and there was no increase in outmigration for any state in response to FDI. Thus, the effects generated by the first term can be considered to offer a lower bound of the total effect on U.S. migration.

The estimator used in the previous regressions weighted all states equally, beyond the necessary correction for heteroskedasticity brought on in the binomial context by differential state sizes (Domencich and McFadden 1975). This is not necessarily the case when estimating the function implicitly to include the United States as the 33rd state:

$$(8) \quad \hat{P}_{ij} = \Phi(X\hat{\beta}) \quad \text{subject to} \quad \sum_{j=1}^{32+USA} \hat{P}_{ij} = 1.$$

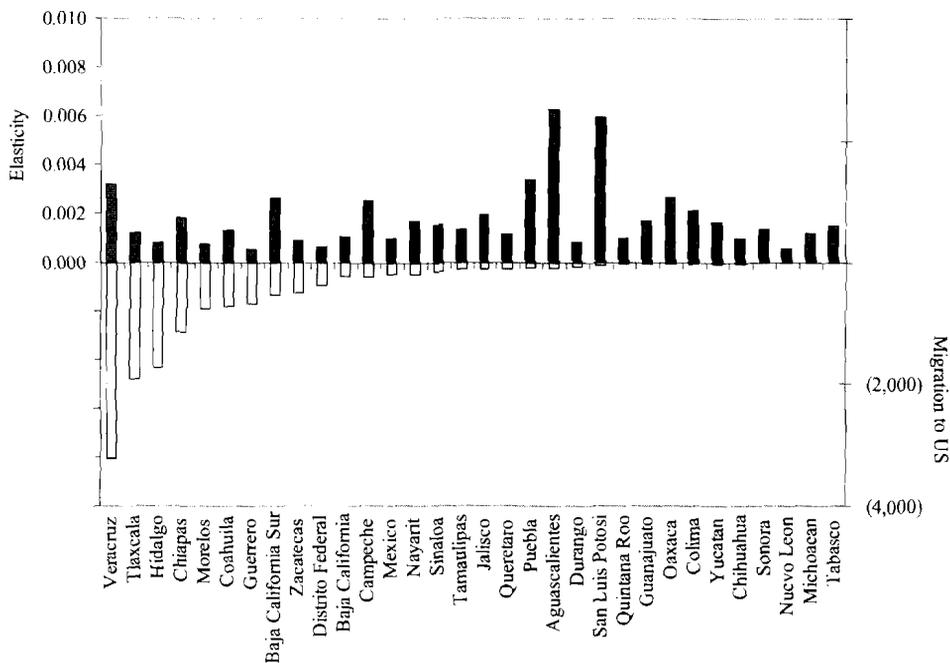
Clearly, the determinants of \hat{P}_{iUSA} are lacking, but information is available on which states send more migrants to the United States, particularly those with long-established networks, which allows more precise estimation. The constraint can be easily rewritten as:

$$(9) \quad \frac{1}{1 - \hat{P}_{iUSA}} \sum_{j=1}^{32} \hat{P}_{ij} = 1.$$

where the first term, a function of the share of each state that migrates to the United States, becomes the weight of the estimated function. In practice, the estimates differ somewhat, but not greatly, from the previous estimates.

The elasticity of migration to the United States with respect to FDI is quite low—on average, a doubling of FDI leads only to a 1.5–2 percent reduction in migration (figure 4). Further, for many states the impact of a single US\$100 million investment in a new plant reduces migration by very little (figure 5). However, in areas such as Veracruz, where there is little FDI and migration is high, the decline in outflows is substantial, in the case of a doubling FDI, approaching 4,000 people.

FIGURE 5. Estimated U.S. Migration Elasticity to Foreign Direct Investment and Migration Response of a US\$100 Million Investment in the State



Source: Authors' analysis based on data sources discussed in the text.

Again, these are intended simply as back of the envelope calculations. They rely heavily on the assumption that the United States is considered broadly as the 33rd destination for a potential migrant. Further, since the analysis captures only the impact of the redirection of existing migration to other Mexican states, not the overall decline in migration, these results must be seen as lower bounds.

IV. CONCLUSIONS

This article evaluated the mechanisms through which NAFTA-related variables might work to reduce migration to the United States, using data on migration within Mexico. The analysis makes three contributions to the literature on migration, especially the impact of trade and FDI flows on migration.

First, it offers the first estimates of the determinants of migration flows within Mexico and advances the migration literature on developing countries. In line with recent literature on industrial country migration, the analysis generates proxies for the level of amenities, costs of living, and networks and generally finds them to be significant. Contrary to much of the literature, the specifications

here generate intuitive signs and significant results for origin state labor market variables: a rise in home earnings or employment levels deters migration. Part of the reason for the poor performance of place of origin variables in previous studies is that they capture a mix of deterrent effects and credit constraints.

Second, FDI, *maquila* value added, exports, and imports are substitutes for labor flows. They appear to work at least partly through the labor market, and their effects are substantial. Further, though there is evidence that greater investment or trade may release credit constraints and increase migration, as suggested by López and Schiff (1998), that effect does not dominate in the case of FDI examined here.

Third, the article generates some tentative inferences about the impact on Mexico–U.S. migration, treating the United States implicitly as a 33rd Mexican state.

APPENDIX

TABLE A-1. Summary Statistics te_j

Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Migrants from state i to state j	992	3,890	17,208	16	470,693
Population	992	2,848,697	2,440,552	375,494	11,170,796
Distance	992	19.27	12.42	1	64.88
Distance squared	992	525.98	660.95	1.00	4,209.00
Prices	992	100.00	16.55	66.99	138.15
Log prices	992	4.59	0.16	4.20	4.93
Unemployment	992	2.99	1.04	1.46	6.64
Nominal wages	992	1,787	345	1,208	3,036
Log nominal wages	992	7.47	0.18	7.07	8.01
Amenities	992	2.11	1.00	0.10	4.72
FDI	992	268.00	386.00	0.04	1,617.00
Log FDI	992	4.35	2.15	-3.11	7.38
Exports	992	1,452	2,130	19.82	8,578
Log exports	992	6.14	1.69	2.98	9.05
Imports	992	844	1,219	5.52	4,176
Log imports	992	5.51	1.84	1.7084	8.33
<i>Maquila</i>	306	97,681	129,480	1,029	453,211
Log <i>maquila</i>	306	10.57	1.51	6.93	13.02

Source: Authors' analysis based on data sources discussed in the text.

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Foreign Direct Investment in Mexico since the Approval of NAFTA

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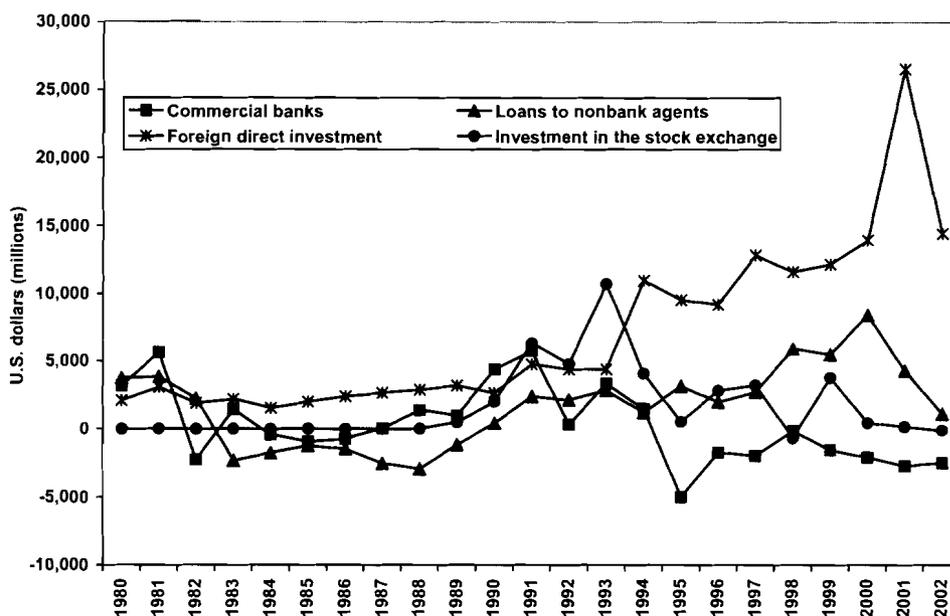
Cross-country panel data are used to assess the effect of free-trade agreements on flows of foreign direct investment (FDI). Free-trade agreements are found to have a significant positive effect on FDI flows, and free-trade agreements are found to matter more for the smaller members of the agreement. For example, the North American Free-Trade Agreement's (NAFTA) effect on FDI flows into Mexico is much larger than its effect on flows into the United States. These cross-country results are used to assess NAFTA's effect on FDI flows into Mexico. After controlling for a set of other factors—such as an increase in worldwide FDI flows—the trade agreement is found to generate FDI flows nearly 60 percent higher than they would have been without the agreement.

The composition of the capital account of Mexico's balance of payments changed significantly at the same time that the North American Free-Trade Agreement (NAFTA) came into effect in 1994. In particular, there is a well-documented increase in the importance of foreign direct investment (FDI). This contrasts sharply with the dominant role of portfolio flows and external borrowing by the banking sector during the early 1990s (figure 1).

In principle, the effect of a free-trade agreement on FDI need not be positive. In the simplest Heckscher–Ohlin world, when free trade achieves factor-price equalization, capital has no incentive to cross borders. Under this logic, a free-trade agreement could reduce the incentives for FDI if the original purpose of FDI was to bypass trade barriers to supply the protected domestic market. By contrast, when countries' factor endowments are sufficiently unequal, capital has incentives to relocate to the labor-intensive country, and these incentives are strengthened when the flow of goods between countries becomes unimpeded. Moreover, there could be a diversion effect, as third-country corporations may desire to invest in one of the trade agreement members to take advantage of the lower tariffs imposed by the partners in the agreement.

In addition, NAFTA contains specific provisions for liberalizing international investment in the region. The most important are national treatment and most-favored-nation privileges for any investor residing in North America—both of which should promote FDI. In fact, many observers argued that promoting the

FIGURE 1. Main Components of Mexico's Private Capital Flows



Source: Bank of Mexico (various years).

growth of foreign capital flows was Mexico's main purpose in joining the agreement: it was not a matter of further liberalizing trade but of creating a legal and economic environment conducive to FDI. This article attempts to test that idea.

The objective here is to assess whether the observed change in financing patterns, and concretely the increase in FDI, can be explained to a significant extent by NAFTA. The analysis controls for general changes in the patterns of international capital flows, because global FDI surged during the 1990s. Mexico also faced other domestic factors that are harder to control for in the analysis. It undertook substantial structural reforms during the late 1980s and early 1990s,¹ and shortly after NAFTA went into effect it suffered a banking crisis, which might have left firms with no other option than to obtain foreign financing.

The strategy here is to identify the typical behavior of FDI in a sample of countries and then to apply that model of behavior to Mexican data. Statistical analysis of an international data set is used to disentangle the effects of various determinants of FDI and to assess whether free-trade agreements generally promote FDI.² The results suggest that FDI responds positively to free-trade agreements and

1. These reforms include Mexico's entry into the General Agreement on Tariffs and Trade (GATT) in 1986, the restructuring of Mexican sovereign debt in 1990, the privatization program, and the financial liberalization process that took place during the late 1980s and early 1990s. See Morley, Machado, and Pettinato (1999).

2. This analysis is related to the literature on gravity models, though with some important differences.

that the effect can be substantial. When these results are applied to Mexico, NAFTA appears to be responsible for increasing FDI by about 70 percent. However, the increase in FDI during the second half of the 1990s seemed disappointing relative to what the model predicts. Tentative explanations for this disappointing performance are offered, but the issue remains part of the agenda for future research.

I. THE EFFECT OF FREE-TRADE AGREEMENTS ON FDI FLOWS

This section reviews theoretical arguments about the effect of free-trade agreements on FDI flows and previous empirical studies that try to estimate the determinants of FDI.

FDI and Free Trade: Theory

Levy-Yeyati, Stein, and Daude (2001) offer a useful taxonomy of theoretical links between changes in FDI and the freeing of external trade, based on a distinction between “vertical” and “horizontal” FDI. With vertical FDI, multinational corporations establish the stages of production in different countries to take advantage of specific conditions in local factor markets. This is the typical case of “outsourcing,” with central management functions at the corporate headquarters and basic manufacturing in countries that offer cheap labor. This type of operation presumes reasonably unimpeded trade, because the manufacturing facilities must also be able to supply the corporation’s home market. With horizontal FDI, by contrast, the multinational firm establishes similar production facilities in several countries, each one serving the local market. This is a rational strategy when obstacles to trade (natural or artificial) are significant. Horizontal FDI does not require any specific degree of similarity or difference in factor endowments among the countries, as long as production becomes feasible and economically viable after investment has taken place. Under this typology, liberalizing trade will make horizontal FDI unnecessary while facilitating vertical FDI.

These arguments suggest that NAFTA must have promoted FDI for Mexico. In some cases, NAFTA may have led to some reduction in horizontal FDI, to the extent that planned or ongoing North American investment in Mexico was motivated by a desire to circumvent old trade restrictions. However, the vertical FDI argument points in the opposite direction: Mexico’s cost advantages, mainly from its low wages, may have been muted by trade barriers before NAFTA but became more obvious to investors after trade in goods was liberalized.³ Thus,

3. Krugman and Hanson (1993) explain this effect with the following example. Imagine a product with such economies of scale that it ought to be produced in only one location. Suppose that unit production and transport costs are \$9 if production is located in Mexico and \$10 if in the United States and that both countries apply a tariff of \$1.50 per unit. If the bulk of the good is consumed in the United States, locating production there would achieve the lowest overall cost by avoiding the tariff that would fall on units imported from Mexico. But when both tariffs are removed, cost differences make production in Mexico the optimal choice.

vertical FDI should increase. Clearly, the difference in size between Mexico and its NAFTA partners strongly suggests that any reduction in horizontal FDI would be offset many times over by the increase in vertical FDI.

The effects of trade liberalization on FDI should have been enhanced by the stability brought on by the high level of the agreement. The U.S. Congressional Budget Office (1993, p. 29) noted that as a result of NAFTA labor-intensive Mexican producers would “face lower tariffs, fewer quotas, and greater certainty that the United States would not suddenly put up protectionist barriers if they expanded exports.” Stability in the region’s policy toward Mexican exports was expected to make Mexico more attractive for investment in export-oriented activities. Similarly, policy stability in Mexico was expected to be a key benefit of NAFTA. The locking in of structural reforms begun with membership in the General Agreement on Tariffs and Trade in 1986 was widely considered a key promise of the agreement (Kehoe and Kehoe 1994). By strengthening the legal status of the Mexican government’s commitment to open markets, NAFTA was expected to consolidate an investment-friendly policy environment, which would ultimately boost FDI.⁴

In addition, the investment chapters in the agreement were expected to facilitate the decision to establish production facilities in Mexico by firms headquartered in Canada and the United States. According to Serra Puche (1992), the key principles incorporated in the free-trade agreement include the most-favored-nation principle, which ensured that no investor from outside North America would be granted benefits exceeding those available to North American investors; the national treatment principle, which guaranteed no discrimination among investors from each of the three NAFTA members; the absence of trade-related performance requirements for foreign investors; and the freedom to buy foreign exchange and to transfer funds across countries. Moreover, the Foreign Investment Law was liberalized to bring it into accord with NAFTA (Dussell Peters, Galindo Paliza, and Loría 2002).

Finally, when NAFTA was launched, investors outside North America were expected to see Mexico as a more promising export platform to the United States and thus to locate some of their production facilities in Mexico. This is just an extension of the well-known tariff-jumping argument. In this variation investment locates in low-wage Mexico to “jump” the U.S. tariff. Given the general character of federal legislation, some of the reforms of the Foreign Investment Law induced by NAFTA would also be beneficial to investors from other regions.

4. NAFTA contains a provision that it can be canceled by any member with six months’ notice. Given the increase in trade and financial integration among the three members, it seems unlikely that the provision will ever be invoked. That said, if investors feel that reforms are still reversible, they may be more cautious than if they perceived the free trade agreement to be truly permanent. In a broad statistical study of FDI, the inability to measure this intensity of belief may lead to the underestimation of strong free trade agreements’ general effect on FDI, and in a particular country where policies may seem reversible to the overprediction of FDI.

Existing Empirical Research

Recent cross-country panel models of FDI have been estimated by, among others, Levy-Yeyati, Stein, and Daude (2001) and Albuquerque, Loayza, and Serven (2003). Waldkirch (2003) uses panel data by source country of FDI stocks in Mexico to estimate NAFTA's effect. His approach and results are discussed in detail in the next section.

Levy-Yeyati, Stein, and Daude (2001) fitted a gravity model to bilateral FDI flows data. In their basic model, the stock of direct investment by residents of country A in country B depends on each country's GDP, geographic distance, and economic and cultural proximity, represented by dummy variables for common membership in a free-trade agreement and common language. In addition, the model includes two variables that measure extended market effects. The first, expected to make investment in country B more attractive, is the total GDP of all countries that have free-trade agreements with country B. The second is the total GDP of countries that have free-trade agreements with country A. This last variable, therefore, represents the menu of options open to investors residing in country A, and its growth is expected to divert investment away from country B. The model's results support the idea that regional integration and membership in a free-trade agreement promote bilateral FDI.

Albuquerque, Loayza, and Serven (2003) differentiate between global and local drivers of investment. Global drivers simultaneously affect decisions concerning investment in many receiving countries. These factors include, for example, global financing conditions, represented in the empirical analysis by a rich structure of financial indicators. Local factors, by contrast, affect investment only in specific receiving countries and are exemplified by expropriation risk, local macroeconomic stability, and other idiosyncratic variables.

II. EMPIRICAL ANALYSIS OF THE EFFECT OF FREE-TRADE AGREEMENTS ON FDI

This section uses regression techniques to identify the effect of membership in a free-trade agreement on FDI and then uses those estimates to gauge the relative contribution of regional integration, globalization, and other factors to the evolution of FDI in Mexico. The model used here combines features of two existing models. As in Levy-Yeyati, Stein, and Daude (2001), one of the main forces of attraction for FDI is represented by an extended market variable that reflects the overall economic size of the free-trade area. The model used here is not strictly a gravitational model, however, in that it is not restricted to bilateral investment flows and it does not explicitly incorporate a measure of distance. As in Albuquerque, Loayza, and Serven (2003), the model used here takes into account both local and global factors to explain FDI flows into a country.

Panel Regressions of FDI

A panel model is estimated to explain the behavior of total inflows of FDI into each country in the sample. This differs from previous panel studies, which have focused mostly on bilateral stocks. In addition, as in Albuquerque, Loayza, and Servén (2003), indicators of macroeconomic stability and a direct measure of the globalization process are included. The data set is a panel of 44 countries with observations over 1980–99.⁵ The free-trade agreements considered for the construction of these variables are largely the same as those in other studies of regional integration, such as Frankel and Wei (1998): the Association of South-east Asian Nations, the European Free-Trade Association, the European Union, NAFTA, the Group of Three, the Andean Group (in its recent revival), and Mercosur.⁶

The dependent variable is the natural logarithm of total net inflows of FDI into a country.⁷ As in Levy-Yeyati, Stein, and Daude (2001), extended market variables were constructed to capture the positive and negative effects of integration on FDI mentioned above. FTAGDP is the sum of the total GDP of all countries with which a country has free-trade agreements and the GDP of the index country, divided by the index country's GDP. This is to capture the fact that the effect of a free-trade agreement on the FDI received by a country varies with the size of the country relative to its trading partners—for example, NAFTA could have a large effect on FDI flows to Mexico but is likely to have a much smaller effect on FDI flows to the United States. Naturally, FTAGDP is expected to have a positive coefficient.

To capture the investment diversion effect, an overall measure of integration, INTEGRATION, was constructed as the weighted total GDP of all countries in the sample that belong to a free-trade arrangement. The weights are the share of total sample GDP covered by each country's trade agreements. Thus, Chile's GDP is included in this measure because, toward the end of the sample period, it joined free-trade agreements with Mexico and other Latin American countries. But if it had had an agreement with the United States, its weight would have been higher. INTEGRATION is defined so that if all countries in the sample signed free-trade agreements with one another, it would equal the value of aggregate GDP in the sample. For an individual country, an increase in INTEGRATION with

5. The countries included in the estimation are Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Canada, Colombia, Chile, China, Denmark, Ecuador, Egypt, Finland, France, Germany, Hungary, Iceland, India, Israel, Italy, Japan, the Republic of Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Paraguay, Peru, Poland, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, Uganda, United Kingdom, United States, Uruguay, and Venezuela.

6. The European Free Trade Association includes Iceland, Lichtenstein, Norway, and Switzerland. The Group of Three includes Colombia, Mexico, and Venezuela. And the Andean Group includes Bolivia, Colombia, Ecuador, Peru, and Venezuela. In addition, the free trade agreement between Chile and Mexico was included.

7. The "net" in "net inflows" indicates the subtraction of repatriations of capital by foreign investors, not the investment abroad undertaken by domestic investors.

FTAGDP held constant would signal stronger competition from other countries, which have become better integrated with one another. This should, other things being equal, make the concerned country less attractive to global investors.⁸ Therefore, the coefficient of INTEGRATION is expected to be negative.⁹

It is well known that the bulk of FDI flows among rich countries, perhaps reflecting the quality of their institutions and their high financial development. The ratio of a country's per capita GNI to that of the United States, RELGNIPH, was included to control for this effect.¹⁰ Size, measured by GDP and EXPORTS (which also captures outward orientation), should have a positive impact on FDI inflows thanks to a simple scale effect and the possibility of economies of scale or transport costs. These variables represent the "gravitational" element in the model. The ratio of the external current account balance to GDP (CURRENT), the ratio of the budget surplus to GDP (BUDGETBAL), consumer price inflation (INFLATION), and real growth of output (GDPGRWTII) are meant to capture such elements of the investment environment as macroeconomic stability and good economic policy management. The average years of education of the population aged 25 or older, EDUCATION, was included as a regressor because FDI might complement a highly skilled labor force. Finally, the ratio of mining to GDP, MIN/GDP, was also included, because FDI may be higher in countries with important mineral resources, irrespective of their institutional environment. The rate of real growth in global output, WORLDGRTH, and the one-year Treasury bill rate in the United States, US1YTBILL, are used as controls for the state of the world in a given year. The aggregate level of inward FDI flows in the world, FDIWORLD, is included to control for the increasingly important forces of globalization. (Summary statistics for all the variables are provided in the appendix.)

All the regressions yield positive, significant, and fairly stable coefficients on FTAGDP, strongly supporting the notion that entering a regional trade block should lead to higher FDI inflows (table 1). This suggests that a free-trade agreement has a positive effect on FDI and that the magnitude of the effect depends on the size of the trading partners. For NAFTA in 1994, the regression coefficients imply an increase of 17–26 percent in FDI flows to Mexico—but an increase of only 0.05–0.07 percent for the United States. Once time trends are

8. This variable should handle some cases that might trouble the investment diversion variable in Levy-Yeyati, Stein, and Daude (2001). Their model has the difficulty capturing the adverse competitive effects that might arise among third-party countries. For example, when Argentina and Brazil joined Mercosur in 1991, they became more attractive to third-party investors who might also have been considering investing in other countries in the region (say, Chile). The specification here would show no change in Chile's FTAGDP, while reporting an increase in INTEGRATION.

9. All variables with a monetary dimension, such as INTEGRATION and others mentioned later, are measured in constant dollars and expressed in natural logs.

10. Given that what constitutes a "rich country" changes over time as the level of GNI per capita in rich countries fluctuates, GNI per capita is expressed relative to that of the United States. In a sense, this variable is really an index of how well off a country is at a given point in time by comparing the country's performance with that of the leading market economy.

TABLE 1. Fixed-Effects Regressions of the Log of FDI Against Membership in a Free-Trade Agreement and Other Variables

Variable/Model	Regression 1	Regression 2	Regression 3	Regression 4
RELGNIPH	0.452 (0.420)	2.779 (1.420)	5.253 (2.910)	1.421 (0.530)
GDPGRWTH	0.030 (2.940)	0.018 (1.850)		0.016 (1.620)
INFLATION	0.000 (-0.330)	0.000 (-0.070)	0.000 (-0.080)	0.000 (0.100)
BUDGETBAL	-0.015 (-1.130)	0.030 (1.990)	0.035 (2.380)	0.025 (1.390)
CURRACCT	-0.038 (-3.870)	-0.023 (-1.89)		-0.031 (-2.410)
WRLDGRWTH	-0.043 (-1.150)	-0.019 (-0.55)	0.014 (0.430)	-0.046 (-1.180)
US1YTBILL	0.026 (1.400)	0.037 (1.450)	0.055 (2.360)	0.050 (1.710)
EXPORTS	0.659 (3.470)	0.737 (2.270)		0.904 (2.650)
FDI:WORLD	0.642 (5.690)	0.424 (2.950)	0.356 (2.520)	0.522 (3.180)
GDP	0.113 (0.530)	0.404 (1.650)	0.709 (3.460)	0.462 (1.750)
FTAGDP	0.009 (2.800)	0.010 (2.150)	0.011 (2.460)	0.013 (2.420)
INTEGRATION	0.047 (0.350)	-0.157 (-1.200)	-0.010 (-0.080)	0.241 (-1.650)
EDUCATION	0.505 (1.050)	4.451 (3.530)	5.272 (4.230)	6.209 (4.510)
MIN/GDP				0.045 (2.260)
R ²	0.8329	0.8807	0.8801	0.8945
F-test regressors	59.09	46.31	48.37	40.82
Degrees of freedom	56,664	99,621	97,623	98,472
Number of observations	721	721	721	571

Note: Numbers in parentheses are *t*-statistics. Regressions 1–3 exclude the ratio of mining to GDP because only few observations are available. Regressions 2–4 include country-specific time trends because of the possibility of unit roots in several variables. Regression 3 excludes GDP growth, current account balance, and exports because of the possibility of reverse causation.

Source: Authors' analysis based on World Bank (2002) and global FDI data from UNCTAD (various years).

included, the coefficients on *INTEGRATION* become negative, though they are not significant. This suggests that if there is any diversion effect from free-trade agreements, it is quite small.

The sign of the coefficient on *RELGNIPH* is positive, as expected, but generally not significant. It is significant when *GDP* growth is excluded (regression 3). This suggests that a high degree of collinearity exists between the two variables in a panel setting and, in a broad sense, that being rich may be seen as the result of possessing other characteristics that make a country attractive to investors (such as a relatively stable economic environment and high levels of education), and once these are controlled for it ceases to be a key factor. Globalization forces have the expected positive sign and are significant; in fact, *FDIWORLD* is one of the key determinants of net *FDI* inflows into any given country in any given year, and the elasticity of net *FDI* with respect to globalization forces is 0.35–0.64 in all regressions.

The elasticity of *FDI* inflows with respect to exports is 0.65–0.9 in all regressions. This is consistent with expectations, but a simultaneity problem may affect exports if *FDI* targets traded sectors and improves export performance. The use of annual data reduces this risk because there is likely a long gestation period between new investment and increased exports. The purchase of existing production facilities through mergers and acquisitions accounts for a significant share of *FDI*. As Calderón, Loayza, and Servén (2002) note, this accounts for the majority of *FDI* in developed countries and a substantial share of *FDI* in developing countries, and it is only with a lag that such operations tend to lead to new investments in additional physical capital. This extra lag further reduces the risk of simultaneity. Finally, excluding *EXPORTS* does not affect the significance of *FTAGDP*, the main focus of this study.

GDPGRWTH is more likely to experience a simultaneity problem. But the variable's significance tends to decrease once a time trend and the share of mining in *GDP* are included, and its exclusion does not affect the significance of *FTAGDP*.

Most coefficients of the control variables for economic environment have the expected signs. High economic growth seems to facilitate *FDI*. The budget balance seems to have a positive effect on *FDI*, controlling for time trends, but the coefficient is not significant when *MIN/GDP* is included. With a negative coefficient, the current account balance seems to represent financing need rather than an unstable environment in all four regressions. The coefficient on the rate of economic growth of the world is insignificant, and its negative sign is opposite to the one expected. This may be due to episodes in which capital flowed out of the largest countries during slowdowns, though the coefficient is clearly unstable. A more educated workforce seems to have a very significant positive effect on *FDI* flows, suggesting strong complementarities between *FDI* and a skilled workforce.

Finally, some regressions included other variables that turned out not to be significant and thus are not included in the reported results. In particular, to capture the possibility that free-trade agreements may have a stronger effect

when they occur between contiguous countries, a dummy variable (equal to 1 when a free-trade agreement included countries with a common border) was interacted with $FTAGDP$. Unfortunately, many free-trade agreements include at least one bordering country; thus, the correlation of the dummy variable with $FTAGDP$ is high, and its inclusion renders both variables insignificant. The real effective exchange rate was also included in the regressions to assess whether FDI flows increase when the real exchange rate is at a depreciated level. The coefficient has the expected sign in the regressions with time trends, but it is never significant, and its inclusion does not affect the level or significance of the other variables.

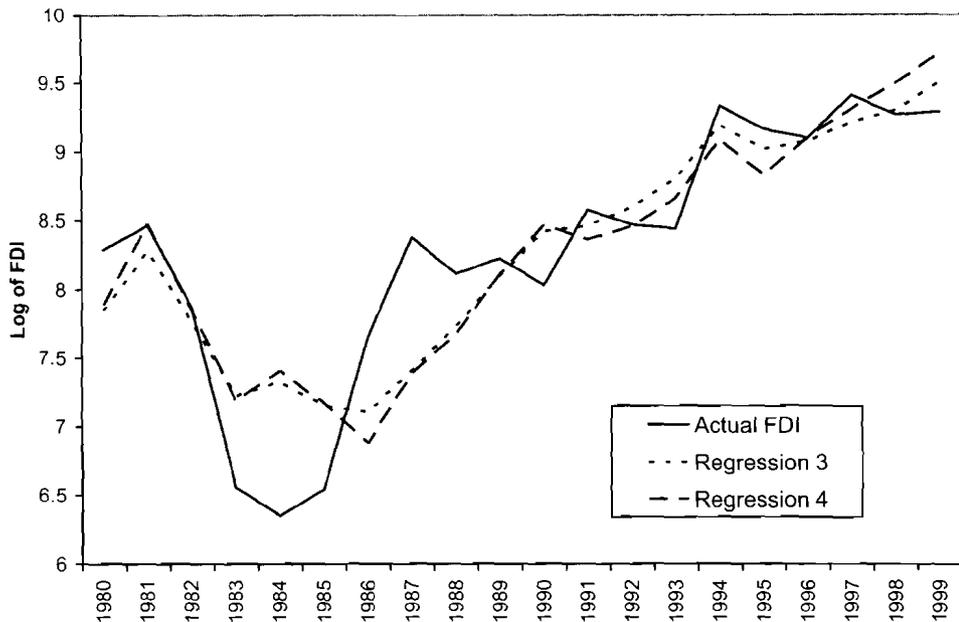
To test whether a free-trade agreement has a one-time effect on the desired stock of FDI and thus only a temporary effect on FDI flows, a dummy variable was created for each age of the trade agreement and multiplied by $FTAGDP$ —that is, a dummy variable for all first free-trade agreement years, a dummy variable for all second free-trade agreement years, and so on. These dummy variables are also insignificant, suggesting that the effect of a free-trade agreement is not pure stock adjustment but a permanent increase in FDI flows. To test whether the effect of a free-trade agreement is modified by cultural affinity, a dummy variable equal to 1, if another member of the agreement has the same official language, was interacted with $FTAGDP$, but its coefficient was not significant. Finally, some regressions included World Bank indexes of government stability, law and order, and the bureaucracy's quality. The coefficients of these variables have positive signs as expected, but they are not significant. The effect of these variables may be captured by other variables—they have a very high correlation with $EDUCATION$ and show less variability over time.

Application of Results from FDI Regressions to the Mexican Case

The estimates of the relationship between FDI and the explanatory variables of the regressions are now combined with Mexican data to determine the contribution of various factors to the growth of FDI inflows in Mexico. The main conclusion of this analysis: participating in NAFTA during the second half of the 1990s may have resulted in FDI inflows to Mexico roughly 60 percent higher than would have been received without participating. A second conclusion: factors not included in the regressions caused exceedingly slow growth of FDI inflows in Mexico in the late 1990s. Two possible explanations of this disappointing performance are a low level of mergers and acquisitions activity in Mexico's FDI and the halt in economic reforms in Mexico since the mid-1990s, which has placed the country at a disadvantage relative to countries that have continued reforming.

The fit of the predicted values from regressions 3 and 4 with the actual Mexican data is quite good (figure 2). The correlation coefficient is above 0.85. Because the Mexican data are only a subset of the data used to estimate the regressions, the variance of $\ln(FDI)$ cannot be decomposed into the variances of the fitted values and of the estimated errors to compute a sort of R^2 for the

FIGURE 2. Actual and Predicted FDI in Mexico



Source: Authors' analysis based on the regressions reported in table 1.

Mexican data. The estimated error term and the fitted values are not orthogonal for any given subset of the observations, although they are mutually orthogonal by construction for the whole set of observations.¹¹

Between 1991 and 1999, real FDI inflows in Mexico approximately doubled. With the coefficients estimated in regressions 3 and 4 and the data for Mexico, the different forces behind the overall increase in FDI can be distinguished. Regression 3 is used because it presumably avoids endogenous effects that may be present in the other regressions, and regression 4 is used because it enables the inclusion of the potential effect of NAFTA on exports and a possible indirect effect of the greater integration on FDI. Overall, the regressions clearly tend to overpredict FDI in Mexico in 1999 (table 2). This is simply a numerical representation of the fact that the regressions overpredict FDI toward the end of the sample (see figure 2)—that is, the error term turns large and negative.¹² With regression 3, FDI after joining NAFTA was nearly 25 percent higher than it

11. The estimated error and the fitted values are almost orthogonal for regressions 2–4, with the correlation coefficient between -0.09 and 0.03 . The correlation coefficient for regression 1 is -0.45 .

12. The calculations in table 2 are illustrative, since the regressions estimated, being linear in logs, are multiplicative in levels, and thus the order in which each independent effect is presented influences the apparent (additive) magnitude of its contribution to the change in FDI.

TABLE 2. Illustrative Decomposition of the Rise in FDI in Mexico between 1991 and 1999 (millions of 1995 U.S. dollars)

Concept	FDI (Regression 3)	FDI (Regression 4)
Predicted FDI in 1991	4,724	4,724
Predicted FDI in 1999 with change in country factors	5,842	6,748
Predicted FDI in 1999 with increase due to global processes	10,724	14,018
Predicted FDI in 1999 with increase due to NAFTA	13,394	18,262
Actual FDI in 1999	10,782	10,782

Note: The difference between lines 4 and 5 is the regression error.

Source: Authors' analysis based on World Bank (2002) and global FDI data from UNCTAD (various years).

would have been if Mexico had remained outside any regional arrangements; with regression 4, it is 30 percent higher.

FDI was 60 percent higher once NAFTA-induced exports were taken into account.¹³ This estimate is similar to that obtained by Waldkirch (2003), who concluded that FDI from North America would have been some 42 percent lower without NAFTA (that is, NAFTA led to a 72 percent increase in FDI from Canada and the United States). Echoing other researchers such as Borja Tamayo (2001), Waldkirch (2003) argues that NAFTA has not brought about a significant increase in FDI from outside North America.¹⁴ This rough similarity is interesting, given that Waldkirch's approach is quite different from the one here. He uses panel data on FDI stocks in Mexico by source country to assess NAFTA's effect on the FDI stocks owned by nationals of NAFTA and non-NAFTA countries. By contrast, this article uses a cross-country panel data to assess the effect of all free-trade agreements in general and applies the results to the particular quantification of NAFTA's effect in Mexico. The results here are not strictly comparable to Waldkirch's (2003) because the model used here cannot distinguish NAFTA's

13. The idea is to assess the effect of export growth due to NAFTA and then transfer this quantity to the estimation of the free trade agreement effect. NAFTA's effect on exports is assumed to have stimulated the growth of nonoil exports beyond its traditional rate of growth. Thus, the 9.6 percent growth rate of real nonoil exports between 1980 and 1991, just before NAFTA negotiations started, is used to project a NAFTA-free level of exports in 1999. This amount is \$35 billion less than the actual level of exports observed in 1999. The additional, NAFTA-induced exports' effect on FDI is then calculated using the coefficient from regression 4. Adding this effect to the direct effect of the change in FTAGDP yields a total increase of 53–65 percent associated with NAFTA.

14. The *maquiladora* program, used to give U.S. firms an advantage over other foreign firms, predates NAFTA by decades. NAFTA might have been expected to reduce the relative advantage of *maquiladora* establishments, since other firms would be able to enjoy similar benefits. But investment in the sector has significantly increased since the mid-1990s. Most *maquiladora* establishments are close to the Mexico–U.S. border, which suggests that just-in-time production and distribution are important factors driving investment in Mexico, given that other countries have much lower labor costs in manufacturing. However, as explained, contiguity effects are hard to identify in the sample.

effects on FDI from different regions. In sum, according to the regression results here, FDI would grow by a factor of 3, with a 20 percent increase due to domestic factors, a 100 percent increase due to Mexico's participation in global currents of investment, and a 67 percent increase due to joining NAFTA.

The level of FDI forecasted by the regressions for 1999 is substantially higher than the actual level of FDI (see figure 2 and table 2). Clearly, the model is not a dynamic one, and it is not fitted using only Mexican data, which could lead to autocorrelation in the error terms during certain periods. But factors not included in the regressions might explain why FDI grew less than predicted.

Several events could help explain the seemingly lackluster performance of FDI during the last few years of the 1990s. First, there could be lingering effects from volatility occasioned by the Tequila crisis. Second, as noted by Calderón, Loayza, and Servén (2002), during the 1990s a growing share of global FDI took the form of mergers and acquisitions of existing firms. The share of mergers and acquisitions investment in Mexico's FDI was atypically low, but this indicates only which form of FDI Mexico failed to receive; it does not explain why Mexico did not receive more FDI in the first place. A possible explanation of the low level of mergers and acquisitions is the limited size and early end of the Mexican government's privatization program.¹⁵ Third, even though the free-trade agreement age dummy variables included in some specifications (but not reported) were not significant, NAFTA may still be responsible for only a brief stock adjustment starting in 1994, in which case that adjustment is over and FDI is settling toward more "normal" levels. Bajo-Rubio and López-Pueyo (1997) and Fernández de Cordoba and Kehoe (2000) suggest that this was the case after Spain's entry into the European Community. The free-trade agreement age dummy variables here may be too simple to capture this nonlinear process.

Another possibility is that the regressions do not handle country contiguity correctly for Mexico. Gravity models that take explicit account of distance, such as that of Levy-Yeyati, Stein, and Daude (2001), seem to suggest that free-trade agreements with immediate neighbors are likely to be more meaningful than agreements with geographically distant partners. Also, because those models focus on bilateral flows, they handle contiguity more naturally. Most free-trade agreements comprise nearby countries. However, the variable FTAGDP makes no

15. The strengthening of the pro-competition laws in the mid-1990s may have affected the level of mergers and acquisitions activity in Mexico. These laws limit mergers between companies to prevent excessive concentration, and perhaps their more competitive environment reduced the expected profit from buying a Mexican company. By contrast, restrictions on domestic alliances could have led firms to seek alliances with foreign companies. While the planned acquisition of Bancomer by Banamex in 2000 may have been impeded by concerns about industry concentration, this was not the case in the acquisition of these banks by foreign institutions. In fact, the peak in the series of FDI in Mexico reflects Citicorp's acquisition of Mexico's Banamex in 2001.

distinction between contiguous and noncontiguous partners. This is not a systematic problem, and so there is no reason to regard the parameters of the regressions as suspect. Moreover, the dummy variable for common border in a free-trade agreement was not significant because almost all the sample countries have a border with at least another member of the agreement. There are too few agreements between noncontiguous countries to draw any conclusions from. However, it could be an issue in Mexico's case because the United States, which is very large geographically, is located between Mexico and Canada. When considering only the United States as a partner of Mexico's, the prediction error of the late 1990s was in fact reduced, but only marginally. This likely reflects the fact that Canada is much smaller than the United States and thus that the distance between Mexico and Canada is only a very small part of the story.

In addition to the arguments presented here, however, a policy issue also exists. The weakening growth of FDI flows into Mexico seems to have coincided with the perceived decline of that country's competitiveness. Between 1999 and 2001, in fact, Mexico's position in the World Economic Forum's (2000, 2001) global competitiveness ranking dropped from 31 to 43. A partial list of the emerging market countries that overtook Mexico by 2001 is quite suggestive: Hungary, Poland, the Czech Republic, Turkey, and the Slovak Republic were all upgrading their institutions with a view to joining the European Union, and Greece was trying to strengthen its macroeconomic policies to meet the Maastricht criteria for monetary integration. These countries were working on structural reforms and deepening their regional bonds. Mexico offers a clear contrast: the pace of structural reform slowed drastically after 1997 (when a Congress in which no political party had enough votes to pass any law by itself was elected), and NAFTA is and will remain for the foreseeable future a trading bloc.

III. CONCLUSIONS

NAFTA's arrival coincided with a transformation of the capital account of the balance of payments in Mexico. Initially, a boom in portfolio flows into the stock exchange was observed during the agreement's negotiation. It is difficult to gauge, however, the extent to which these inflows were motivated by investors' desire to take positions in anticipation of the agreement, given the coincidence of a strong privatization program at the time and the normalization of the Mexican government's borrower status. Later, FDI became the most dynamic element of the capital account. In fact, the FDI series shows at least two clear jumps. The first occurs in the early 1990s and reflects the extensive reform process that Mexico followed from the mid-1980s to the mid-1990s. Among the reforms is a change in the investment law that allowed greater FDI in several economic sectors and the beginning of NAFTA negotiations. The second occurs when the agreement goes into effect, and since then FDI has been by far the most important type of capital inflow in Mexico.

Analysis of a multicountry panel data set indicates that free-trade agreements seem to have a strong positive influence on FDI. In addition to membership in a free-trade agreement, a set of global variables, namely world FDI flows, and a set of domestic variables seem to determine FDI. Among the domestic variables, having a more open economy, as measured by the level of exports, increases FDI. A more stable macroeconomic environment, as measured by the ratio of the budget balance to GDP, also increases FDI. Finally, a more educated workforce also attracts higher flows, possibly due to complementarities between FDI and a skilled workforce.

FDI in Mexico under NAFTA was an estimated two-thirds higher than it would have been without NAFTA, despite the winding down of Mexico's privatization program and the banking and currency crises. The effect is so large because trade liberalization's effect on FDI depends on the relative sizes of the trading partners—there is a large asymmetry between Mexico and its NAFTA partners.

A somewhat puzzling result of the model is that in the late 1990s FDI in Mexico is lower than expected. This was likely partly the result of the apparent halt in the country's structural reform process. Nevertheless, a fuller explanation of this shortfall could not be offered here, and it remains an important area for additional research.

APPENDIX

TABLE A-1. Summary Statistics of Variables Used in Estimation

Variable	Mean	Standard Deviation	Minimum	Maximum
FDI (log)	7.19	1.94	0.03	12.44
RELGNIPH	0.50	0.28	0.03	1.07
GDPGRWTH	3.52	3.72	-11.89	14.82
INFLATION	55.21	253.68	-0.13	3,763.31
BUDGETBAL	-3.21	4.13	-21.85	15.53
CURRACCT	-1.25	4.54	-16.35	25.02
WRLDGRWTH	2.75	1.12	0.60	4.80
US1YTBILL	6.65	2.74	3.02	14.08
EXPORTS (log)	10.11	1.52	5.60	13.46
FDIWORLD (log)	12.26	0.68	11.24	13.80
GDP (log)	11.93	1.48	8.32	15.94
FTAGDP	11.97	23.19	1.00	138.05
INTEGRATION	14.08	0.75	12.77	14.86
EDUCATION (log)	1.92	0.37	0.79	2.51
MIN/GDP	12.33	4.80	0.00	30.39

Note: The number of observations for MIN/GDP is 571. The number of observations for all other variables is 721.

Source: Authors' analysis based on World Bank (2002) and global FDI data from UNCTAD (various years).

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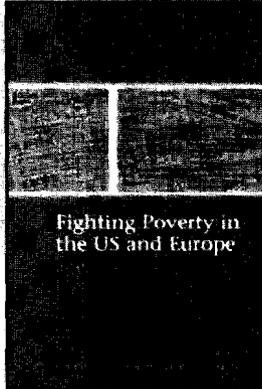
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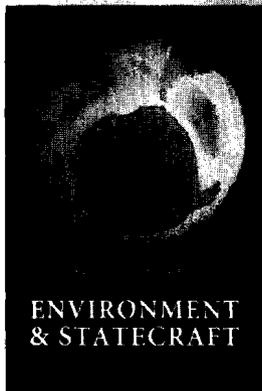
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