The Long and Short of the Canada-U.S. Free Trade Agreement

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The Canada-U.S. Free Trade Agreement provides a unique window onto the effects of a reciprocal trade agreement on an industrialized economy (Canada). For industries that experienced the deepest Canadian tariff cuts, the contraction of low-productivity plants reduced employment by 12 percent while raising industry-level labor productivity by 15 percent. For industries that experienced the largest U.S. tariff cuts, plant-level labor productivity soared by 14 percent. These results highlight the conflict between those who bore the short-run adjustment costs (displaced workers and struggling plants) and those who are garnering the long-run gains (consumers and efficient plants). (*JEL* F13, F14, F15, F16, D24)

The central tenet of international economics is that free trade is welfare improving. We express our conviction about free trade in our textbooks and we sell it to our politicians. Yet the fact of the matter is that we have one heck of a time explaining these benefits to the larger public, a public gripped by Free Trade Fatigue.

Why is the message of professional economists not more persuasive? To my mind there are two reasons. First, in examining trade liberalization we treat short-run transition costs and long-run efficiency gains as entirely separate areas of inquiry. On the one hand are those who study the long-run productivity benefits of free trade policies, e.g., James R. Tybout et al. (1991), James Levinsohn (1993), Ann E. Harrison (1994), Tybout and M. Daniel Westbrook (1995), Pravin Krishna and Devashish Mitra (1998), Keith Head and John Ries (1999a, b), and Nina Pavcnik (2002). On the other hand are those who study the impacts of freer trade on short-run worker displacement and earnings, e.g., Noel Gaston and Trefler (1994, 1995), Ana Revenga (1997), Levinsohn (1999), Eugene Beaulieu (2000), and Krishna et al. (2001). Only Janet Currie and Harrison's (1997) study of Morocco examines both labor market outcomes and productivity. In assessing free trade policies there is clearly a bias introduced when looking only at the long-run benefits or only at the short-run costs. Nowhere is this more apparent than for the Canadian experience with the Canada-U.S. Free Trade Agreement (FTA) and its extension to Mexico. The FTA triggered ongoing and heated debates about freer trade. This heat was generated by the conflict between those who bore the *short-run adjustment costs* (displaced workers and stakeholders of closed plants) and those who garnered the *long-run efficiency gains* (stakeholders of competitive plants and users of final and intermediate goods).

There is another reason why the free trade message is not more persuasive. While case-study

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evidence abounds about efficiency gains from liberalization (e.g., Anne O. Krueger, 1997), solid econometric evidence for industrialized countries remains scarce. When I teach my students about the effects of free trade on productivity I turn to high-quality studies for Chile (Tybout et al., 1991; Pavcnik, 2002), Turkey (Levinsohn, 1993), Côte d'Ivoire (Harrison, 1994), Mexico (Tybout and Westbrook, 1995), and India (Krishna and Mitra, 1998) among others. I find these studies compelling, but I wonder whether they can be expected to persuade policy makers and voters in *industrialized* countries such as Canada and the United States. What is needed is at least some research focusing on industrialized countries.

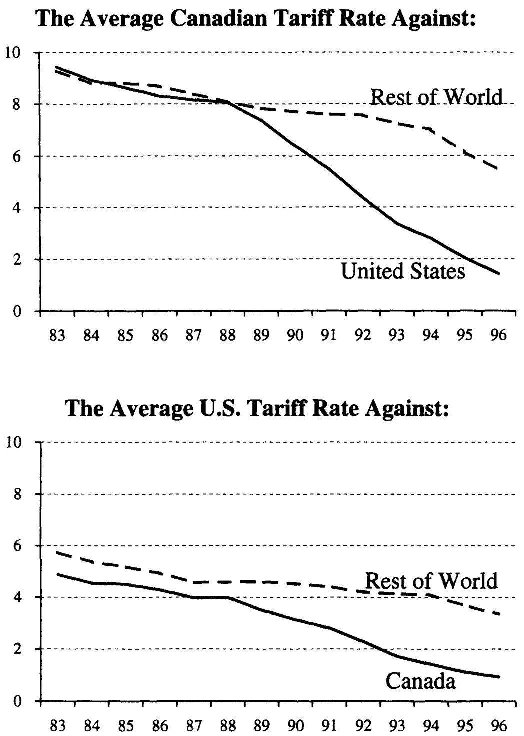
The Canada-U.S. Free Trade Agreement offers several advantages for assessing the short-run costs and long-run benefits of trade liberalization in an industrialized country. First, the FTA policy experiment is clearly defined. In developing countries, trade liberalization is typically part of a larger package of market reforms, making it difficult to isolate the role of trade policy. Further, the market reforms themselves are often initiated in response to major macroeconomic disturbances. Macroeconomic shocks, market reforms, and trade liberalization are confounded. Indeed, Gerald K. Helleiner (1994, p. 28) uses this fact to argue that "Empirical research on the relationship between total factor productivity (TFP) growth and ... the trade regime has been inconclusive." His view is widely shared, e.g., Harrison and Gordon H. Hanson (1999) and Francisco Rodriguez and Dani Rodrik (2001). In contrast, the FTA was not implemented as part of a larger package of reforms or as a response to a macroeconomic crisis. Second, as Harrison and Revenga (1995, abstract) note, "Trade policy is almost never measured using the most obvious indicators—such as tariffs." Tybout (2000) echoes this criticism. My study of the FTA is particularly careful about constructing pure policy-mandated tariff measures.

Third, the FTA is not just about import-liberalizing policies. It is a reciprocal agreement that includes export-liberalizing policies as well. It should therefore be expected to induce a pronounced general-equilibrium relocation of resources out of import-competing sectors and into export-oriented sectors. I will examine these FTA effects on a large number of Canadian plant and industry outcomes. At the plant and industry levels the outcomes include employment and earnings of both production and nonproduction workers, skill upgrading, earnings inequality, hours of work, plant size, and labor productivity.

Fourth, the FTA is a preferential trading arrangement. Such arrangements need not be welfare-improving. I will examine the two conditions usually put forward as sufficient—at least informally—for welfare gains. These are that trade creation must dominate trade diversion and that import prices must not rise (Arvind Panagariya, 2000; Krishna, 2003). Both conditions are satisfied.

The backdrop of the FTA—an industrialized country, a clean policy experiment, the direct policy lever of tariffs, general-equilibrium reciprocity effects, and the long list of outcomes including employment, productivity, and prices—will be my basis for a rigorous and detailed examination of the short-run costs and long-run benefits of trade liberalization.

The FTA has been the subject of several studies since its implementation on January 1, 1989. Gaston and Trefler (1997) found that the FTA had no effect on earnings and only a modest effect on employment. Beaulieu (2000) found that the employment effect was primarily driven by modest nonproduction worker employment losses. Kimberly A. Clausing (2001) found evidence that the FTA raised U.S. imports from Canada (trade creation), but did not divert U.S. imports away from other U.S. trading partners. John Romalis (2004) found both trade creation and diversion. The most intriguing FTA study is by Head and Ries (1999b). They found that the FTA had little net effect on industry-level average output per plant (which they take as a proxy for scale) and a puzzling effect on Canadian plant exit (exit was induced by falling Canadian tariffs *and* by falling U.S. tariffs). Unfortunately, none of these papers uses plant-level data. Further, I will argue below that at least some of these papers (including my own), suffer specification issues that substantively mar the inferences drawn about the effects of the Canada-U.S. Free Trade Agreement.


The Average Canadian Tariff Rate Against:

The Average U.S. Tariff Rate Against:

FIGURE 1. CANADIAN AND U.S. BILATERAL TARIFFS IN MANUFACTURING (In Percents)

I. The FTA Tariff Cuts: Too Small to Matter?

This paper deals with the impact of FTA-mandated tariff cuts. The top panel of Figure 1 plots Canada's average manufacturing tariff against the United States (solid line) and Canada's average manufacturing tariff against the rest of the world (dashed line). The bottom panel plots the corresponding U.S. tariffs against Canada (solid line) and the rest of the world (dashed line). In 1988, the average Canadian tariff rate against the United States was 8.1 percent. The corresponding effective tariff rate was 16 percent.[1] Perhaps most importantly, *tariffs in excess of 10 percent sheltered one in four Canadian industries.* Given that these industries were almost all characterized by low wages, low capital-labor ratios, and low profit margins, the 1988 tariff wall was indeed high. Similar comments apply to the U.S. tariff against Canada, albeit with less force since the average 1988 U.S. tariff was 4 percent.

That one in four Canadian industries had tariffs in excess of 10 percent depends crucially on the level of aggregation. I am working with 4-digit Canadian SIC data (213 industries). If one aggregates up even to 3-digit data (105 industries), almost no industries had 1988 tariffs in excess of 10 percent. This is important because studies of trade liberalization typically do not work with such disaggregated tariff data. For example, papers by Tybout et al. (1991), Levinsohn (1993), Harrison (1994), Tybout and Westbrook (1995), Gaston and Trefler (1997), Krishna and Mitra (1998), and Beaulieu (2000) are never at a finer level of aggregation than 3-digit ISIC with its 28 manufacturing sectors.

The core feature of the FTA is that it reduced tariffs between Canada and the United States without reducing tariffs against the rest of the world. Graphically, the FTA placed a gap between the dashed and solid lines of Figure 1. Letting i index industries and t index years, my measures of the FTA policy levers will be

τ_{it}^{CA}: The FTA-mandated Canadian tariff concessions granted to the United States. In terms of the top panel of Figure 1, this is the solid line minus the dashed line.

τ_{it}^{US}: The FTA-mandated U.S. tariff concessions granted to Canada. In terms of the bottom panel of Figure 1, this is the solid line minus the dashed line.

τ_{it}^{CA} and τ_{it}^{US} capture the core textual aspects of the FTA.[2]

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[1] Both the nominal and effective tariff rates were aggregated up from the 4-digit SIC level using Canadian production weights. The standard formula used to calculate the effective rate of protection appears in Trefler (2001, p. 39). Details about construction of the tariff series appear in Appendix A.

[2] Given that tariffs are positively correlated with effective tariffs and nontariff barriers to trade (NTBs), the coefficients on τ_{it}^{CA} and τ_{it}^{US} will capture the effects of FTA-mandated reductions in tariffs, effective tariffs, and nontariff barriers. This is exactly what I want: When

II. Econometric Strategy

In this section, I lay out econometric strategies for analyzing the plant- and industry-level data. I begin with the latter. Let i index industries, let t index years, and let Y_{it} be a Canadian outcome of interest such as employment or productivity. The FTA mandates that tariffs be reduced once a year on January 1, starting in 1989. I have data for the FTA period 1989–1996. In what follows I will define the pre-FTA period as the years 1980–1986. As will be shown in detail, this choice is useful for dealing with business fluctuations. Let Δy_{is} be the average annual log change in Y_{it} over period s where $s = 1$ indexes the FTA period and $s = 0$ indexes the pre-FTA period. That is,

$$(1)\quad \Delta y_{i1} \equiv (\ln Y_{i,1996} - \ln Y_{i,1988})/(1996 - 1988)$$

and

$$\Delta y_{i0} \equiv (\ln Y_{i,1986} - \ln Y_{i,1980})/(1986 - 1980).$$

The FTA period changes use 1988 data because I am interested in comparing the FTA-period outcome $Y_{i,1996}$ with its baseline level, i.e., with its level *before* the first round of tariff reductions on January 1, 1989.[3] For $k = CA$ and $k = US$, define

$$(2)\quad \Delta\tau_{i1}^{k} \equiv (\tau_{i,1996}^{k} - \tau_{i,1988}^{k})/(1996 - 1988).$$

$\Delta\tau_{i1}^{CA}$ measures the change in the FTA-mandated tariff concessions extended by Canada to the United States. Likewise, $\Delta\tau_{i1}^{US}$ measures the change in the FTA-mandated tariff concessions extended by the United States to Canada.

What of pre-FTA period tariff concessions, which I denote by $\Delta\tau_{i0}^{k}$? Except for the 1965 Canada-U.S. Auto Pact, all tariff rates were extended on a Most Favored Nation (MFN) basis prior to 1988. Thus, define $\Delta\tau_{i0}^{k} \equiv (\tau_{i,1986}^{k} - \tau_{i,1980}^{k})/(1986 - 1980)$ when industry i is in the automotive sector and $\Delta\tau_{i0}^{k} = 0$ otherwise. As will be shown, setting $\Delta\tau_{i0}^{k} = 0$ for all i or omitting the automotive sector entirely from the analysis makes no difference to the results. Additional details about $\Delta\tau_{i1}^{k}$, including a list of industries with large absolute values of $\Delta\tau_{i1}^{CA}$ and $\Delta\tau_{i1}^{US}$, appear in Appendix A.

I am interested in a regression model that explains the impact of the FTA-mandated tariff concessions on a variety of industry outcomes:

$$(3)\quad \Delta y_{is} = \theta_s + \beta^{CA}\Delta\tau_{is}^{CA} + \beta^{US}\Delta\tau_{is}^{US} + \varepsilon_{is}, \quad s = 0, 1$$

where θ_s is a period fixed effect. There is an obvious problem with estimating equation (3). I have no deeply satisfying way of controlling for the lack of randomization in the tariff concessions. I must thus take particular care to control both for the endogeneity of tariffs and for sources of industry-level heterogeneity that might contaminate the estimates of β^{CA} and β^{US}. I turn to this task now.

A. *The Secular Growth Control*

For political economy reasons, one might expect declining industries to have high tariffs and hence deep FTA tariff concessions, e.g., Trefler (1993). To prevent mistakenly attributing secular growth trends to the FTA tariff concessions, I introduce a growth fixed effect α_i into equation (3):

$$(4)\quad \Delta y_{is} = \alpha_i + \theta_s + \beta^{CA}\Delta\tau_{is}^{CA} + \beta^{US}\Delta\tau_{is}^{US} + \varepsilon_{is}, \quad s = 0, 1.$$

As a result, β^{CA} and β^{US} only pick up FTA

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analyzing tariff concessions I am actually capturing a broader set of FTA trade-liberalizing policies.

[3] Since this may cause some confusion, consider by analogy a cholesterol-reducing drug trial in which the drug is given once a year on January 1 (starting in 1989) and the patient's cholesterol level Y_{it} is measured once a year on December 31 (starting in 1988). To measure the long-term effects of the drug one looks at $Y_{i,1996} - Y_{i,1988}$ rather than $Y_{i,1996} - Y_{i,1989}$ because $Y_{i,1988}$ describes the patient cholesterol baseline without drugs. The same logic holds for the "drug of free trade." The FTA mandates that tariffs be reduced once a year on January 1 (starting in 1989) and the plants are surveyed once a year as closely as possible to December 31. Therefore, the appropriate baseline is $Y_{i,1988}$.

impacts on industry growth that are departures from industry trend growth.

B. *Industry-Specific Shocks*

A number of Canadian industries experienced reversals of fortune in the sense that employment growth in the pre-FTA and FTA periods had opposite signs. For these industries similar reversals also appeared in their U.S. counterparts. This is indicative of industry-specific demand and supply shocks. If these reversals of fortune are a characteristic of highly protected industries, the reversals might contaminate the estimates of β^{CA} and β^{US}. Controlling for reversals of fortune begins with the observation that many industry-specific shocks that appeared in Canada also appeared in Canada's major trading partners. For example, higher oil prices affected the petroleum industry in Canada and all its major trading partners. I have industry-level data for Canada's three largest trading partners: the United States, Japan, and the United Kingdom. I use these data to control for industry-specific shocks.

More formally, let Δy^j_{is} be data on Δy_{is} for economy *j*, e.g., if Δy_{is} is Canadian employment growth then Δy^j_{is} is country *j*'s employment growth. I control for industry-specific shocks by including Δy^j_{is} in equation (4). Note that Δy^j_{is} may be endogenous, especially for $j = US$, so I will employ instrumental variables (IV) techniques. Finally, for expositional ease I will refer to Δy^j_{is} as the "U.S. control" and simply write Δy^{US}_{is}.

C. *The Business Conditions Control*

A key issue for examining the FTA is the treatment of the early 1990's recession. Figure 2 plots GDP in year *t* for Canadian manufacturing (gdp_t). The data are in logs relative to a 1980 base, i.e., $\ln(gdp_t/gdp_{1980})$. The FTA period recession stands out. This is a problem if the industries that experienced the deepest tariff concessions share a common sensitivity to changes in business conditions. General business conditions can be introduced into equation (4) by including a regressor Δb_{is} that captures how movements in GDP and the real exchange rate affect industry *i*. I will explain how Δb_{is} is constructed shortly. Introducing Δb_{is} and Δy^{US}_{is} into equation (4) yields

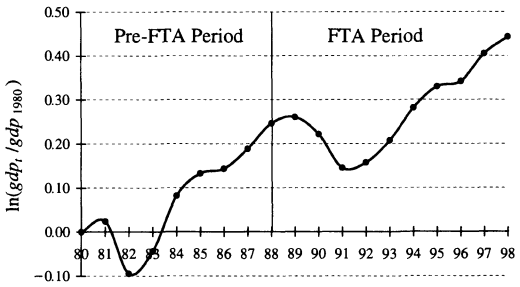

FIGURE 2. REAL CANADIAN MANUFACTURING GDP

Note: gdp at fa4ctor cost, 1992 dollars.

$$(5)\quad \Delta y_{is} = \alpha_i + \theta_s + \beta^{CA}\Delta\tau^{CA}_{is} + \beta^{US}\Delta\tau^{US}_{is} + \gamma\Delta y^{US}_{is} + \delta\Delta b_{is} + \varepsilon_{is}, \quad s = 0, 1.$$

D. *Estimation*

Differencing (5) across periods yields my difference-of-differences baseline specification:

$$(6)\quad (\Delta y_{i1} - \Delta y_{i0}) = \theta + \beta^{CA}(\Delta\tau^{CA}_{i1} - \Delta\tau^{CA}_{i0}) + \beta^{US}(\Delta\tau^{US}_{i1} - \Delta\tau^{US}_{i0}) + \gamma(\Delta y^{US}_{i1} - \Delta y^{US}_{i0}) + \delta(\Delta b_{i1} - \Delta b_{i0}) + \nu_i$$

where $\theta \equiv \theta_1 - \theta_0$. This specification controls for secular industry trends (by differencing out the α_i), industry-specific demand and supply shocks (the Δy^{US}_{is}), and industry-specific business condition effects (the Δb_{is}). Clearly, I will have to use an IV estimator to deal with the endogeneity of the tariff concessions and $\Delta y^{US}_{i1} - \Delta y^{US}_{i0}$.

It is important to note that the use of long double-differencing means that I need not worry about dynamic panel estimation problems (Manuel Arellano and Bo Honoré, 2001). This is important because *every single* previous FTA study has used annual data without any correction for autocorrelation, e.g., Gaston and Trefler

(1997), Head and Ries (1999a, b), Beaulieu (2000), and Clausing (2001). Yet the fact is that employment and output display strong autocorrelation at lags of up to three years. For example, Canadian employment displays significant three-year autocorrelation in 31 percent of all industries and one-year autocorrelation in an overwhelming 77 percent of all industries. Thus, the estimators used in all previous studies of the FTA (including my own) are inconsistent and yield standard errors that are too small.

E. *Plant-Level Data*

Letting k index plants, my baseline plant-level specification is

$$(7)\quad (\Delta y_{ik1} - \Delta y_{ik0}) = \theta + \beta^{CA}(\Delta\tau_{i1}^{CA} - \Delta\tau_{i0}^{CA}) + \beta^{US}(\Delta\tau_{i1}^{US} - \Delta\tau_{i0}^{US}) + \gamma(\Delta y_{i1}^{US} - \Delta y_{i0}^{US}) + \delta(\Delta b_{i1} - \Delta b_{i0}) + \phi x_{ik,1980} + \nu_{ik}$$

where Δy_{iks} is the change in the outcome of interest for plant k in industry i in period s and $x_{ik,1980}$ is a vector of plant characteristics that includes the log of 1980 employment, the log of 1980 earnings per worker, the log of 1980 labor productivity, and the log of plant age. Since the plant data only go back to 1973, I also include a dummy for whether the plant was older than seven years of age in 1980. There are 3,801 plants in the sample.[4]

There are two selection issues that require attention. First, equation (7) only makes use of plants that were in existence in 1980, 1986, 1988, and 1996. Obviously these "continuing" plants are not representative of all plants. Unfortunately, I have not been able to make even simple corrections for entry and exit because the database available to me cannot be used in any simple way to track entry and exit. (Unlike the U.S. longitudinal plant database, the Canadian database has not attracted as many resources for data "cleaning.") Second, I will be working with what are known as "long-form" plants, that is, plants that fill out a detailed survey. In 1988, long-form plants were 2.2 times larger than "short-form" plants. Thus, my plant-level results must be understood as dealing with larger plants. This said, Appendix E provides some evidence that my results apply to small plants as well.[5]

III. The Data

Canadian data are from the Canadian *Annual Survey of Manufactures* (ASM), the *Canadian Labour Force Survey,* as well as Statistics Canada's International Trade Division, Input-Output Division, Prices Division, and Standards Division (for commodity and industry concordances). Almost all the data used involved special tabulations by Statistics Canada. Most of the U.S. data through 1994 are from the NBER Manufacturing Productivity Database (Eric J. Bartelsman and Wayne Gray, 1996) and from Robert C. Feenstra (1996). I updated these sources to 1996. As discussed in Trefler (2001, p. 11), I have been especially careful to build a Canada-U.S. converter that steps down from over 1,000 U.S. products to 213 Canadian industries.

IV. Empirical Results: Employment

Table 1 reports estimates of equations (6) and (7) for the case where the dependent variable is employment growth. The table includes a large number of specifications in order to show that the estimates of β^{CA} and β^{US} are not particularly sensitive to the choice of specification. Row 1 is my industry-level baseline specification. It uses ordinary least squares (OLS) and includes all four regressors. I will explain coefficient

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[4] I am indebted to Alla Lileeva for running these regressions and for sharing her experience as to which plant-level controls to use. Without her, the plant-level analysis would not have been possible.

[5] One final thought on the estimating equation. This paper is unabashedly a reduced-form exercise that allows the inferences to be driven more by the data than by a highly structured model. This has obvious advantages, but it also has a cost. A more structured approach, as in Head and Ries (2001) or Huiwen Lai and Trefler (2002), muzzles the data, but allows for a clearer interpretation of the coefficients and for a richer treatment of general-equilibrium feedbacks.

TABLE 1—DETAILED RESULTS FOR EMPLOYMENT

Construction of Δb	Canadian tariffs $\Delta\tau^{CA}$ β^{CA}	t	U.S. tariffs $\Delta\tau^{US}$ β^{US}	t	Business conditions Δb δ	t	U.S. control Δy^{US} γ	t	Adjusted R^2	Overld/ Hausman	Total FTA impact *TFI*	t
Industry level, OLS												
1 *gdp*, *rer* (2)	−0.12	−2.35	−0.03	−0.67	0.29	6.96	0.15	2.21	0.24		−0.05	−2.66
2 *gdp*, *rer* (0)	−0.11	−2.03	−0.04	−0.91	0.30	3.66	0.21	2.75	0.12		−0.06	−2.58
3 *gdp* (2)	−0.11	−2.08	−0.03	−0.66	0.37	6.60	0.15	2.16	0.23		−0.05	−2.41
4 —	−0.14	−2.40	−0.02	−0.52			0.20	2.58	0.07		−0.06	−2.58
5 *gdp*, *rer* (2)	−0.13	−2.48	−0.02	−0.39	0.28	6.74	0.29	3.00	0.24		−0.05	−1.71
6 *gdp*, *rer* (2)	−0.14	−2.75	−0.03	−0.80	0.30	7.12			0.23		−0.06	−3.16
7 —	−0.17	−2.88	−0.03	−0.66					0.04		−0.07	−3.15
8 *gdp*, *rer* (2)	−0.14	−2.24	−0.02	−0.53	0.29	6.89	0.15	2.11	0.24		−0.06	−2.65
9 *gdp*, *rer* (2)	−0.12	−2.30	−0.06	−1.45	0.30	7.23	0.14	2.04	0.27		−0.06	−3.24
Plant level, OLS												
10 *gdp*, *rer* (2)	−0.12	−3.76	0.00	0.15	0.13	4.59	0.25	5.29	0.04		−0.04	−3.26
11 *gdp*, *rer* (2)	−0.12	−3.60	−0.01	−0.26	0.16	5.63	0.25	5.21	0.02		−0.04	−3.51
Industry level, IV												
12 *gdp*, *rer* (2)	−0.24	−1.45	0.09	0.66	0.29	6.68	0.15	2.06	0.22	0.60/0.65	−0.04	−1.26
13 *gdp*, *rer* (2)	−0.24	−1.43	0.04	0.29	0.31	6.37	−0.16	−0.50	0.20	0.67/0.57	−0.05	−1.57
Plant level, IV												
14 *gdp*, *rer* (2)	−0.19	−2.40	0.07	0.94	0.13	4.30	0.24	4.96	0.04	0.14/0.99	−0.04	−2.55
15 *gdp*, *rer* (2)	−0.19	−2.44	0.07	0.92	0.13	4.17	0.16	0.95	0.03	0.10/0.89	−0.04	−3.10

Notes: The dependent variable is the log of employment. The estimating equation is equation (6) for the industry-level regressions and equation (7) for the plant-level regressions. β^{CA} is scaled so that it gives the log-point impact of the Canadian tariff concessions on employment in the most impacted, import-competing industries. β^{US} is scaled so that it gives the log-point impact of the U.S. tariff concessions on employment in the most impacted, export-oriented industries. The "Total FTA impact" column gives the joint impact of the tariff concessions on employment in all 213 industries. The "Overld/Hausman" column reports p-values for the overidentification and Hausman tests. Rejection of the instrument set or exogeneity are indicated by p-values less than 0.01. The number of observations is 213 for the industry-level regressions and 3,801 for the plant-level regressions. In rows 4 and 7, the business conditions variable is omitted so that business conditions are controlled for implicitly by double-differencing $\Delta y_{i1} - \Delta y_{i0}$. In row 5 the U.S. control is replaced by the Japan-U.K. control discussed in the text. In row 8, the 2 "outlier" observations with the largest Canadian tariff cuts are omitted. In row 9, all 9 observations associated with the automotive sector are omitted. In row 11, the plant controls are omitted. In rows 12 and 14, only the Canadian and U.S. tariff variables are instrumented. In rows 13 and 15, the two tariff variables and the U.S. control are instrumented.

magnitudes shortly, but for now treat $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ as the log-point changes in employment associated with the FTA. For example, the Canadian tariff concessions led to a −0.12 log-point change in employment ($t = -2.35$).

The first specification issue handled by Table 1 deals with the sensitivity of $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ to the way in which the business conditions variable Δb_{is} is constructed. In order to explain how Δb_{is} is constructed, define $z_t \equiv (\ln gdp_t, \ln rer_t)$ where rer_t is the real exchange rate and let Δ_1 be the annual difference operator so that $\Delta_1 z_t = z_t - z_{t-1}$ and $\Delta_1 y_{it} = y_{it} - y_{i,t-1}$. To construct Δb_{is}, I first regressed $\Delta_1 y_{it}$ on $(\Delta_1 z_t, \ldots, \Delta_1 z_{t-J})$ for some lag length J. This is a time-series regression that was estimated separately for each i. The regression generates an industry-specific prediction $\widehat{\Delta_1 y_{it}}$ of the effect of current and past business conditions on current annual employment growth. Second, note from equation (1) that Δy_{i1} can be written as $\Sigma_{t=1989}^{1996} \Delta_1 y_{it}/8$. This motivates the definition of Δb_{i1} as $\Delta b_{i1} \equiv \Sigma_{t=1989}^{1996} \widehat{\Delta_1 y_{it}}/8$. Δb_{i1} is just an industry-specific prediction of the effect of business conditions on FTA-period employment growth. For the pre-FTA period, I use $\Delta b_{i0} \equiv \Sigma_{t=1981}^{1986} \widehat{\Delta_1 y_{it}}/6$. Note that there is a different Δb_{is} for each outcome. For example, when Δy_{is} is earnings growth then Δb_{is} is the portion of industry i earnings growth driven by movements in GDP and the real exchange rate. See Appendix C for further details.

Row 1 of Table 1 uses my baseline specification of Δb_{is} in which the lag length is $J = 2$. I chose $J = 2$ because the industry-specific autocorrelation functions only vanish at longer lags. Row 2 of Table 1, which uses $J = 0$, illustrates that $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ are not sensitive to the choice of lag length. Row 3 uses $J = 2$, but drops the real exchange rate (rer_t) from z_t. This does not dramatically alter the estimates either. In fact, as row 4 shows, the estimates rise only slightly when $\Delta b_{i1} - \Delta b_{i0}$ is omitted from the baseline specification. This requires some explanation as it might be misinterpreted to mean that business conditions are playing only a minor role.

Returning to Figure 2, the 1980–1986 and 1988–1996 periods are very similar in terms of business conditions. Each began a year before the peak, each entered a deep recession in the third year, and each ended in the midst of a prolonged expansion. Further, my decision to end the pre-FTA period in 1986 ensures that the two periods are similar as judged by GDP growth over the period and by the number of years into the expansion. That is, I have purposely chosen the pre-FTA period so that, after double-differencing, my estimating equations have a built-in, implicit control for business conditions. This explains why omitting $\Delta b_{i1} - \Delta b_{i0}$ does not dramatically alter the results. Also note that the results are similar with the pre-FTA period defined as 1980–1988 or the FTA period defined as 1988–1994. See Appendix Table A2.

Finally, $\Delta b_{i1} - \Delta b_{i0}$ is a generated regressor which means that some care is needed to ensure correct standard errors. Fortunately, it is straightforward to show that my reported OLS standard errors come from the same distribution as the asymptotically "true" (i.e., $\sqrt{N}$-limiting) distribution. This can be shown by verifying that condition (6.3) of Jeffrey M. Wooldridge (2002, p. 116) is satisfied. Further specification tests are discussed in Appendix C.

Consider now the U.S. control variable $\Delta y_{i1}^{US} - \Delta y_{i0}^{US}$. Its coefficient is positive for almost all results reported in this paper. This is to be expected if it is picking up demand and supply shocks that are common to both U.S. and Canadian industries. Row 5 replaces $\Delta y_{i1}^{US} - \Delta y_{i0}^{US}$ with $(\Delta y_{i1}^{Japan} + \Delta y_{i1}^{UK})/2 - (\Delta y_{i0}^{Japan} + \Delta y_{i0}^{UK})/2$. Comparison of row 5 with row 1 reveals that this makes little difference to $\hat{\beta}^{CA}$ or $\hat{\beta}^{US}$. Row 6 shows that the omission of the U.S. control also makes little difference. Clearly, $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ are not sensitive to how the U.S. control is modeled. This conclusion will continue to hold when I instrument the U.S. control in row 13.[6]

Row 7 shows that omission of both the U.S. control and the business conditions control has no effect on $\hat{\beta}^{US}$, but does lower $\hat{\beta}^{CA}$ from -0.12 to -0.17. I conclude from rows 1–7 that my row 1 baseline estimates are not sensitive to the exact treatment of industry-specific shocks (the U.S. control) or the business conditions control provided that at least one of them is included in the specification. This conclusion holds true for all the statistically significant estimates reported in this paper.

Rows 8 and 9 examine the role of particular observations. As Appendix Table A1 shows, the Brewery and Shipbuilding industries have unusually large Canadian tariff concessions and are thus potentially influential observations. In row 8, I delete these observations. This slightly raises $\hat{\beta}^{CA}$. In row 9, I delete the nine industries in the automotive sector. This raises $\hat{\beta}^{US}$, but not significantly.

Row 10 is my baseline plant-level specification. It includes the plant-level controls, i.e., plant age and the 1980 values of the log of employment, the log of earnings, and the log of labor productivity. Notice that the plant-level estimates of β^{CA} and β^{US} are almost identical to the industry-level estimates of row 1. This suggests that, at least for employment, the

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[6] Throughout this paper I will use U.S. data rather than Japan–U.K. data. The disadvantage of using Δy_{is}^{US} is that the Canadian tariff concessions likely raised U.S. employment at the expense of Canadian employment. However, if this were an important feature of the data then I would expect the correlation between Δy_{i1}^{US} and Δy_{i1} to be negative (in fact it is a strongly positive 0.50) and the coefficient on $(\Delta y_{i1}^{US} - \Delta y_{i0}^{US})$ to be negative (in fact, it also is strongly positive). The disadvantage of $(\Delta y_{is}^{Japan} + \Delta y_{is}^{UK})/2$ is that these data are only available at the 3-digit ISIC level (28 industries). This means that I must concord data on 28 industries into data on 213 4-digit Canadian SIC industries. The result is noisy data. I thus prefer using U.S. data. Clearly, however, it does not matter which I use. Finally, the Japanese and U.K. data are from the UNIDO database.

industry-level regressions are capturing within-plant effects rather than between-plant effects.[7]

The U.S. tariff concessions had no effect on employment at the plant level, but modestly reduced employment at the industry level. This means that the U.S. tariff concessions must have forced more labor-intensive plants to contract. My student Alla Lileeva has refined this observation by showing that the plant-level result reflects the effect of pooling across exporters (for which $\beta^{US} > 0$) and nonexporters (for which $\beta^{US} < 0$). She has linked the Canadian plant-level data to data on the exporter status of the plant. While the match precludes using my difference-of-differences methodology, she has nevertheless been able to show that $\hat{\beta}^{US}$ is positive for exporters and hugely negative for nonexporters. Why? The U.S. tariff concessions had the unexpected effect of encouraging Canadian exporters to expand their domestic operations at the expense of Canadian nonexporters. Since the majority of plants are nonexporters, pooling across exporters and nonexporters yields estimates of β^{US} that are close to 0.

Returning to the plant-level estimates in Table 1, row 11 excludes the plant-level controls. Comparison with row 10 shows that $\hat{\beta}^{CA}$ or $\hat{\beta}^{US}$ are unaffected by the exclusion of the plant-level controls.

Rows 12–15 report the IV results. A key issue is the identification of variables that satisfy the two requirements of an instrument. The most likely candidates for valid instruments are variables measuring the level of industry characteristics in 1980. For one, these level characteristics are unlikely to be correlated with the residuals because the latter are twice-differenced. Such difference of differences are far removed from levels. For another, the 1980 characteristics determine the 1980 levels of protection which in turn are correlated with the tariff changes. I therefore use an instrument set that consists of 1980 log values for: (1) Canadian hourly wages, which captures protection for low-wage industries as in W. M. Corden's (1974) conservative social welfare function, (2) the level of employment, which captures protection for large industries as in the J. Michael Finger et al. (1982) high-track protection for large industries, (3) Canadian imports from the United States, and (4) U.S. imports from Canada. I also include squares and cross-products as well as any exogenous regressors. The first-stage R^2s are between 0.30 and 0.40 for almost all the results in this paper.

Row 12 repeats the specification of row 1, but with the two tariff regressors instrumented. $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ are now much larger. Also, $\hat{\beta}^{US}$ reverses signs, suggesting that the U.S. tariff concessions raised Canadian employment. However, these results do not pass the Hausman test.

The "OverId/Hausman" column reports p-values for overidentification and Hausman tests. In row 12, both the overidentification test (0.60) and the Hausman test (0.65) are above 0.01 which indicates that the instruments are valid at the 1-percent level and that endogeneity is rejected at the 1-percent level. Given the poor small-sample properties of IV estimators (Charles R. Nelson and Richard Startz, 1990), I use the 1-percent cut-off, i.e., p-values below 0.01.

Row 13 reports the IV estimates for the case where the U.S. control is instrumented along with the two tariff concessions. Comparing row 13 with row 12, it is clear that endogenizing the U.S. control has no impact on the estimates of $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$. Further, endogeneity continues to be rejected.[8]

Rows 14 and 15 repeat the IV exercises of rows 12 and 13, respectively, but starting with

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[7] If this is not clear consider the following. Let x_{ikt} be some characteristic of plant k in industry i in year t, let s_{ikt} be plant k's market share and let $x_{it} \equiv \Sigma_k x_{ikt}s_{ikt}$ be the average value of x_{ikt}. Using obvious difference notation, $\Delta x_{it} = \Sigma_i \Delta x_{ikt}s_{ikt} + \Sigma_i \Delta s_{ikt}x_{ik,t-1}$, i.e., the total industry change can be decomposed into a within-plant change (the first term) and a between-plant or market-share shift change (the second term). The plant-level regressions deal with Δx_{ikt} and thus capture within-plant changes. The industry-level regressions deal with Δx_{it} and thus capture both within-plant and market-share shift changes.

[8] As someone who has tried to build a career on the endogeneity of protection (Trefler, 1993), I am surprised by the rejection of endogeneity. To investigate further, I have experimented with a much larger set of instruments drawn from 1980 and 1988 characteristics of Canadian and U.S. industries. I have also experimented with a drastically reduced instrument set. None of this makes any difference to the conclusion that endogeneity is rejected. As a result, I will report the industry-level IV results, but downplay them. Interestingly, endogeneity only comes into play when the dependent variable is imports. See below.

the plant-level baseline specification of row 10. As with the industry-level results, the $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ are much larger, but endogeneity is rejected. Indeed, endogeneity is easily rejected for every plant-level specification reported in this paper. This likely reflects the fact that tariffs, even if endogenous to the industry, are exogenous to the plant.

V. Coefficient Magnitudes

I have not yet properly explained the magnitudes of $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$. Since the distribution of tariff concessions is skewed, it is of interest to know the effect of the Canadian tariff concessions on the *most impacted, import-competing* group of industries, i.e., on the one-third of industries with the most negative values of $\Delta\tau_{i1}^{CA}$. This group has 71 (=213/3) industries, tariff concessions ranging from -5 to -33 percent, and an average tariff concession of -10 percent. The industries are listed in Appendix Table A1. For any industry i, the Canadian tariff concessions are estimated to change employment by $\hat{\beta}^{CA}\Delta\tau_{i1}^{CA}$ log points. For the most impacted, import-competing group as a whole this change is given by $\hat{\beta}^{CA}\overline{\Delta\tau}_{\cdot 1}^{CA}$ where $\overline{\Delta\tau}_{\cdot 1}^{CA}$ is a weighted average of the $\Delta\tau_{i1}^{CA}$ with weights that depend on industry size. (See Appendix B for details about the weights.) It is $\hat{\beta}^{CA}\overline{\Delta\tau}_{\cdot 1}^{CA}$ that is reported in the β^{CA} column of all the tables in this paper. From row 1 of Table 1, the most impacted, import-competing group as a whole experienced a 12-percent employment loss.

A similar discussion of coefficient magnitudes applies to the *most impacted, export-oriented* group of industries, i.e., the one-third of industries (71 industries) with the most negative values of $\Delta\tau_{i1}^{US}$. For this group the estimated impact of the U.S. tariff concessions on employment is given by $\hat{\beta}^{US}\overline{\Delta\tau}_{\cdot 1}^{US}$ where $\overline{\Delta\tau}_{\cdot 1}^{US}$ is the weighted average of the $\Delta\tau_{i1}^{US}$. $\hat{\beta}^{US}\overline{\Delta\tau}_{\cdot 1}^{US}$ is reported in the β^{US} column of all the tables in this paper. From row 1 of Table 1, this group experienced a statistically insignificant and nonrobust 3-percent employment loss.

The "Total FTA impact" (TFI) columns in this paper present the joint effect of the tariff concessions on manufacturing employment as a whole. This effect is just

$$TFI \equiv \hat{\beta}^{CA}\overline{\Delta\tau}_{\cdot 1}^{CA} + \hat{\beta}^{US}\overline{\Delta\tau}_{\cdot 1}^{US} \tag{8}$$

where $\overline{\Delta\tau}_{\cdot 1}^{CA}$ and $\overline{\Delta\tau}_{\cdot 1}^{US}$ are now defined as averages across all 213 industries. From the TFI column of row 1 in Table 1, the FTA reduced manufacturing employment by 5 percent. This impact is statistically significant and quite similar across all the OLS specifications. It stands in sharp contrast to Gaston and Trefler (1997) who found economically small and statistically insignificant effects of the FTA. The difference in conclusions reflects both the better data and the better methodology of the current study.

Employment losses of 5 percent translate into 100,000 lost jobs and strike me as large, not least because only a relatively small number of industries experienced deep tariff concessions. Indeed, most of these lost jobs were concentrated in the most impacted, import-competing industries. For this group, with its 12-percent job losses, one in eight jobs disappeared. *This number points to the very large transition costs of moving out of low-end, heavily protected industries. It reflects the most obvious of the costs associated with trade liberalization.*

It is difficult to be sure whether these transition costs were short-run in nature. However, two facts drawn from the most recent seasonally adjusted data suggest that they probably were short-run costs. First, the FTA had no long-run effect on the Canadian employment rate which was 62 percent both in April 1988 and April 2002. Second, Canadian manufacturing employment has been more robust than in most OECD countries. For example, between April 1988 and April 2002, manufacturing employment rose by 9.1 percent in Canada, but fell by 12.9 percent in the United States and by 9.7 percent in Japan. This suggests, albeit not conclusively, that the transition costs were short run in the sense that within ten years the lost employment was made up for by employment gains in other parts of manufacturing.

VI. Labor Productivity

It would be best to examine productivity using a total factor productivity (TFP) measure. Unfortunately, the Canadian ASM does not record capital stock or investment data. There is

TABLE 2—DETAILED RESULTS FOR LABOR PRODUCTIVITY

Construction of Δb	Canadian tariffs $\Delta\tau^{CA}$ β^{CA}	t	U.S. tariffs $\Delta\tau^{US}$ β^{US}	t	Business conditions Δb δ	t	U.S. control Δy^{US} γ	t	Adjusted R^2	Overld/ Hausman	Total FTA impact *TFI*	t
Industry level, OLS												
1 *gdp*, *rer* (2)	0.15	3.11	0.04	1.14	0.25	8.30	0.16	1.99	0.31		0.058	3.79
2 *gdp*, *rer* (0)	0.15	2.77	0.02	0.40	0.13	1.79	0.28	3.05	0.09		0.050	2.87
3 *gdp* (2)	0.17	3.21	0.04	1.17	0.25	5.19	0.21	2.43	0.18		0.065	3.87
4 —	0.16	2.85	0.01	0.34			0.29	3.23	0.08		0.051	2.89
5 *gdp*, *rer* (2)	0.14	2.79	0.05	1.36	0.26	8.77	0.05	0.31	0.29		0.058	2.46
6 *gdp*, *rer* (2)	0.14	2.96	0.05	1.44	0.27	8.82			0.30		0.059	3.89
7 —	0.15	2.58	0.03	0.76					0.04		0.053	2.98
8 *gdp*, *rer* (2)	0.17	2.97	0.04	0.98	0.26	8.34	0.16	1.95	0.30		0.061	3.76
9 *gdp*, *rer* (2)	0.16	3.27	0.02	0.49	0.26	8.61	0.18	2.24	0.33		0.051	3.36
Plant level, OLS												
10 *gdp*, *rer* (2)	0.08	1.70	0.14	3.97	0.12	3.95	0.11	1.51	0.06		0.074	4.92
11 *gdp*, *rer* (2)	0.09	1.92	0.11	3.02	0.10	3.18	0.14	1.79	0.01		0.066	4.39
Industry level, IV												
12 *gdp*, *rer* (2)	0.15	1.10	0.10	0.86	0.26	8.09	0.14	1.53	0.30	0.86/0.43	0.081	3.41
13 *gdp*, *rer* (2)	0.13	0.89	0.13	1.01	0.28	6.99	−0.08	−0.28	0.28	0.87/0.51	0.083	3.40
Plant level, IV												
14 *gdp*, *rer* (2)	0.22	1.67	0.05	0.49	0.11	3.20	0.17	1.80	0.06	0.06/0.77	0.082	2.53
15 *gdp*, *rer* (2)	0.79	2.58	−0.49	−1.73	−0.19	−1.29	2.07	2.29	0.05	0.76/0.52	0.050	0.39

Notes: The dependent variable is the log of labor productivity. The estimating equation is equation (6) for the industry-level regressions and equation (7) for the plant-level regressions. The number of observations is 211 for the industry-level regressions and 3,726 for the plant-level regressions. See the notes to Table 1 for additional details. In rows 4 and 7, the business conditions variable is omitted so that business conditions are controlled for implicitly by double-differencing $\Delta y_{i1} - \Delta y_{i0}$. In row 5 the U.S. control is replaced by the Japan-U.K. control discussed in the text. In row 8, the two "outlier" observations with the largest Canadian tariff cuts are omitted. In row 9, all nine observations associated with the automotive sector are omitted. In row 11, the plant controls are omitted. In rows 12 and 14, only the Canadian and U.S. tariff variables are instrumented. In rows 13 and 15, the two tariff variables and the U.S. control are instrumented.

thus little alternative but to work with labor productivity. I define labor productivity as value added in production activities per hour worked by production workers.[9] I deflate using 3-digit SIC output deflators.[10] Table 2 reports the labor productivity results. The table has the exact same format as the Table 1 employment results so that I can review it quickly. As in Table 1, endogeneity is always rejected[11] and all the industry-level OLS results are similar so that I can focus on the baseline row 1 specification.

From the industry-level OLS results, the Canadian tariff concessions raised labor productivity by 15 percent in the most impacted, import-competing group of industries (t = 3.11). *This translates into an enormous compound annual growth rate of 1.9 percent.* The fact that the effect is smaller and statistically insignificant at the plant level (row 10) suggests that much of the productivity gain is coming from market share shifts favoring high-productivity plants. Such share shifting would come about

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[9] Trefler (2001) extensively examined the sensitivity of results to alternative definitions of labor productivity. Appendix D of the current paper shows that the results are not sensitive to redefining labor productivity as total value added (in production plus nonproduction activities) per worker (production plus nonproduction workers). This definition does not correct for hours; however, it is useful in that it is directly comparable to the way in which I am forced to define U.S. labor productivity in Δy_{is}^{US}. (The U.S. ASM does not report value added in production activities.)

[10] Appendix D also shows that the results do not change when labor productivity is deflated by the available 2-digit SIC value-added deflators. I am indebted to Alwyn Young for encouraging me to carefully examine the issue of deflators.

[11] The Table 2 plant-level IV results are based on an instrument set without squares or cross-products because these are rejected by the overidentification tests.

from the growth of high-productivity plants and the demise and/or exit of low-productivity plants.

From the plant-level OLS results (row 10), the U.S. tariff concessions raised labor productivity by 14 percent or 1.9 percent annually in the most impacted, export-oriented group of industries ($t = 3.97$). This labor productivity gain does not appear at the industry level ($\hat{\beta}^{US} = 0.04$, $t = 1.14$) which is likely due to the fact that the U.S. tariff concessions encouraged entry of plants that are less productive by virtue of being young. (On the low productivity of young plants see John R. Baldwin, 1995, for Canada and Andrew B. Bernard and J. Bradford Jensen, 1995, for the United States.) The importance of controlling for plant age can be seen by comparing rows 10 and 11 since the latter excludes the plant age control and has a lower $\hat{\beta}^{US}$.[12]

The last column of Table 2 looks at the total FTA impact on all of manufacturing. The plant-level numbers of row 10 indicate that *the FTA raised labor productivity in manufacturing by 7.4 percent or by an annual compound growth rate of 0.93 percent* ($t = 4.92$). The industry-level numbers are about the same. These numbers, along with the 14–15 percent effects for the most impacted importers and exporters, are enormous. *The idea that an international trade policy could raise labor productivity so dramatically is, to my mind, remarkable.*

VII. Import Prices and Trade Creation/Diversion: Implications for Welfare

Preferential trade arrangements, including the FTA, need not be welfare improving. The literature identifies two conditions which, if satisfied, increase the likelihood of welfare gains for a representative domestic agent. These are that trade creation "dominates" trade diversion and that import prices do not rise (Panagariya, 2000; Krishna, 2003). This section explores these conditions.

A. *Trade Creation and Trade Diversion*

Krishna (2003) offers a precise expression for welfare gains in terms of the relative sizes of trade creation and diversion. Let $\Delta \ln m_{isj}$ be the log change in Canadian imports of industry i in period s from region $j = US$ or $j = ROW$ (rest of the world). Let $\Delta\tau_{isj}$ be the corresponding change in the Canadian tariff. Krishna shows that a sufficient condition for welfare gains is

$$(9)\qquad -0.8\frac{\Delta \ln m_{i1US}}{\Delta\tau_{i1US}} - 0.2\frac{\Delta \ln m_{i1ROW}}{\Delta\tau_{i1US}} > 0$$

where 0.8 is the share of Canadian imports originating from the United States.[13] The first term is proportional to a utility-relevant measure of trade creation and is positive because $\Delta \ln m_{i1US}/\Delta\tau_{i1US} < 0$. The second term is proportional to a utility-relevant measure of trade diversion and is likely negative because $\Delta \ln m_{i1ROW}/\Delta\tau_{i1US}$ is likely positive.

I examine equation (9) empirically as follows. The first row in Table 3 reports estimates of my standard equation (6) using Canadian imports from the United States as the dependent variable. Note that there is no U.S. control in this regression because it makes no sense in an

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[12] Another contributing factor to the difference between the $\hat{\beta}^{US}$ at the industry and plant levels is that the U.S. tariff concessions encouraged Canadian plants to enter the U.S. market. This must reduce average productivity because new Canadian exporters are less productive than old Canadian exporters (Baldwin and Wulong Gu, 2003). Expansion into the U.S. market therefore increases the market share of lower productivity new exporters, thus reducing the industry-level productivity effect.

[13] To derive equation (9), start with equation (10) in Krishna: $\tau_{iUS}\partial m_{iUS}/\partial\tau_{iUS} + \tau_{iROW}\partial m_{iROW}/\partial\tau_{iUS}$ where all variables relate to 1988. Since $\tau_{iUS} = \tau_{iROW}$ in 1988, this expression can be rewritten as

$$\frac{\tau_{iUS}}{m_{iUS} + m_{iROW}}[\theta_{iUS}\partial \ln m_{iUS}/\partial\tau_{iUS} + (1 - \theta_{iUS})\partial \ln m_{iROW}/\partial\tau_{iUS}]$$

where $\theta_{iUS} \equiv m_{iUS}/(m_{iUS} + m_{iROW}) = 0.8$ is the U.S. import share. Krishna's analysis looks at a representative consumer in an economy with a single final good. The generalization to many goods is trivial as long as expenditure shares for each good are independent of the tariff, e.g., Cobb-Douglas preferences. In examining equation (9) empirically, I ignore the fact that Krishna's m_{iUS} and m_{iROW} are compensated demands for imports.

TABLE 3—TRADE DIVERSION/CREATION AND IMPORT PRICES

	Canadian tariffs		U.S. tariffs		Total FTA impact		Business conditions			
Variable	β^{CA}	t	β^{US}	t	TFI	t	δ	Adjusted R^2	OverId/ Hausman	Observations
Canadian imports from the United States										
OLS Industry	0.54	−4.67	0.16	−2.16	0.01	0.83	0.22*	0.24		211
IV Industry	2.32	0.80	−0.86	−0.40	−0.15	−0.48	0.30	0.15	NA/0.28	211
Canadian imports from the rest of the world										
OLS Industry	−0.40	2.67	0.08	−0.17	0.03	0.12	0.11*	0.05		211
IV Industry	−1.60	−0.54	1.24	0.48	0.22	0.47	0.08	0.04	NA/0.75	211
Canadian import prices										
OLS Product	−0.004	0.20						0.00		4,700
IV Product	−0.073	2.26						0.00	0.51/0.03	4,700
Canadian import quantities										
OLS Product	0.70	15.12						0.05		4,700
IV Product	1.02	12.68						0.04	0.87/0.00	4,700

Notes: The dependent variable is indicated in bold font at the start of each block of results, e.g., "Canadian imports from the United States." All dependent variables are in log changes. The estimating equation is equation (6) for the industry-level Canadian imports regressions and equation (10) for the product-level import price and quantity regressions. The business conditions variable is the same as in the Table 1, row 1 baseline specification. The U.S. control is not included because it makes no sense in a bilateral import context. β^{CA} and β^{US} are scaled as described in the notes to Table 1. An asterisk indicates statistical significance at the 1-percent level. The "OverId/Hausman" column reports p-values for the overidentification and Hausman tests. Rejection of the instrument set or exogeneity are indicated by p-values of less than 0.01. Blank entries indicate OLS estimation. The product-level import results use wages, employment, squares, and cross-products as instruments. Based on the overidentification test, the industry-level import results drop the squares and cross-products from the instrument set. It is thus just identified (NA).

import context. The Canadian tariff concessions raised Canadian imports from the United States by 54 log points. I therefore set $\Delta \ln m_{i1US}/\Delta\tau_{i1US}$ equal to −0.54. The third row in Table 3 reports my OLS estimates of equation (6) using Canadian imports from the rest of the world as the dependent variable. The Canadian tariff concessions lowered Canadian imports from the rest of the world by 40 log points. I therefore set $\Delta \ln m_{i1ROW}/\Delta\tau_{i1US}$ equal to +0.40.[14]

Plugging −0.54 and +0.40 into equation (9) yields $-0.8 \times (-0.54) - 0.2 \times (0.40) = 0.35$ ($t = 3.62$). Since this number is statistically greater than zero, Krishna's (2003) welfare condition is satisfied. This conclusion is robust to the many alternative specifications described in Tables 1–2. Thus, FTA trade creation dominated FTA trade diversion enough to ensure that the FTA improved the welfare of the "representative" Canadian.

B. *Prices*

A preferential trading agreement will not likely be welfare improving if it raises prices (Panagariya, 2000). Clearly the FTA is unlikely to have raised import prices—this would require either some unusual change in the strategic interactions between firms or a rise in tariffs against non-FTA trading partners. More likely the FTA reduced import prices by allowing U.S. producers to send larger quantities per shipment, thus spreading fixed shipping costs over a larger number of units. Fixed costs of shipping are sufficiently large that reducing them has been a key focus of Canadian public policy.[15] Surprisingly, there exists very little econometric work on the effects of trade liberalization on import prices. J. Richard Huber (1971) is a rare exception.

To investigate, I examine the relationship

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[14] Using U.S. rather than Canadian imports, Romalis (2004) finds large impacts of both the FTA and NAFTA on U.S. trade creation and diversion.

[15] See the C. D. Howe *Border Papers* series for reviews of the public policy discussions, e.g., Wendy Dobson (2002).

between tariff cuts and changes in import unit values. Both these variables are available at the 10-digit Harmonized System (HS10) level. While unit values are difficult to interpret as prices, the hope is that at this detailed level of disaggregation, *changes* in unit values over the FTA period reflect *changes* in prices. Note that I am looking only at unit-value changes *within* an HS10 item. This is very different from and less problematic than the typical use made of unit values. Typically, researchers draw conclusions from the fact that one HS10 item has a higher unit value *level* than another. Since unit values are based on actual payments net of import duties, freight, insurance, and other charges, I will interpret changes in unit values as changes in producer prices.

Canadian trade data was first collected in the HS system in 1988.[16] Let $\Delta\tau_{i1j}$ be the FTA period change in Canada's tariff against country j for HS10 product i. Let $\Delta \ln p_{i1j}$ be the corresponding log import price change. Since I do not have pre-FTA data on import price changes at the HS10 level ($\Delta \ln p_{i0j}$), I cannot estimate my standard equation (6) with $\Delta \ln p_{i1US} - \Delta \ln p_{i0US}$ as the dependent variable. However, if the FTA had never been implemented one expects $\Delta \ln p_{i1US}$ to have evolved in the same way that Canada's import prices from other advanced economies evolved. I thus estimate

$$(10)\quad \Delta \ln p_{i1US} - \Delta \ln p_{i1OECD} = \alpha + \beta^{CA}(\Delta\tau_{i1US} - \Delta\tau_{i1OECD}) + \varepsilon_i$$

where $\Delta \ln p_{i1OECD}$ is the simple average of the $\Delta \ln p_{i1j}$ for the United Kingdom, Germany, France, and Japan. Likewise for $\Delta\tau_{i1OECD}$.

The third block of results in Table 3, labeled "Canadian import prices," reports the estimates. The OLS estimate indicates that the FTA did not raise import prices ($\hat{\beta}^{CA} = -0.004$). There is modest evidence of endogeneity at the 3-percent level and the IV estimates indicate that the FTA reduced import prices by 7 percent for the most impacted, import-competing products.

One wonders if the HS10 import price changes are so noisy that these results are meaningless. Import prices are defined as import values divided by import quantities so that any noisiness in prices must come from noisiness in quantities. To investigate the role of noise, I reestimated equation (10) using log import *quantity* changes as the dependent variable. The fourth block of results in Table 3 reports the results. The FTA raised import quantities by 70 percent and the t-statistic is huge (15.12). Further, for the first time in this paper I obtain the expected strong rejection of the exogeneity of tariffs. Thus, noise does not appear to be a problem.

To summarize, two conditions increase the likelihood that a preferential trade arrangement is welfare improving: trade creation must dominate trade diversion and import prices must not rise. Both of these condition are met in the FTA context.

VIII. Employment of Production and Nonproduction Workers

I am now in a position to quickly review the results for other outcomes. The data distinguish between workers employed in manufacturing activities and nonmanufacturing activities. I will refer to these as production and nonproduction workers since the distinction broadly follows that used in the U.S. ASM. In particular, nonproduction workers are more educated and better paid. The top block of results in Table 4 reports a limited number of specifications for the employment of production workers. My baseline industry- and plant-level specifications appear in rows 1 and 10, respectively. (Row numbers match those of Table 1 so that the reader can always remind herself of the specification details of any row by referring back to the detailed discussion surrounding Table 1.) The results indicate that the Canadian tariff concessions reduced employment by a large amount, 14 percent using industry-level estimates ($t = -2.44$), and 9 percent using

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[16] In matching 1988 data with 1996 data I lose 33 percent of the 1988 HS10 items. There is some evidence that the loss is nonrandom in that the average tariff on the unmatched commodities is 0.5 percentage points lower than on the matched commodities. This reflects the fact that many of the unmatched commodities are in high-tech industries. For example, Intel's introduction of the 486 CPU in 1989 quickly led to the demise of the 386 CPU. (Don't date yourself by admitting you remember this!)

TABLE 4—EMPLOYMENT AND SKILL UPGRADING

	Canadian tariffs		U.S. tariffs		Total FTA impact		Business conditions	U.S. control		
Variable	β^{CA}	t	β^{US}	t	TFI	t	δ	γ	Adjusted R^2	OverId/ Hausman
Employment—Production workers										
1 Industry	−0.14	−2.44	−0.07	−1.56	−0.08	−3.44	0.37*	0.16	0.33	
4 Industry	−0.13	−1.99	−0.07	−1.36	−0.08	−2.89		0.21	0.07	
6 Industry	−0.16	−2.93	−0.08	−1.71	−0.09	−4.08	0.37*		0.32	
12 Industry	−0.20	−1.28	0.03	0.17	−0.06	−1.60	0.37*	0.16	0.32	0.59/0.70
10 Plant	−0.09	−2.58	−0.03	−0.87	−0.04	−3.01	0.17*	0.29*	0.04	
Employment—Nonproduction workers										
1 Industry	−0.06	−0.71	0.05	0.79	0.00	0.02	0.36*	0.07	0.26	
4 Industry	−0.07	−0.77	0.05	0.73	−0.00	−0.09		0.14	0.00	
6 Industry	−0.06	−0.79	0.04	0.71	−0.00	−0.12	0.36*		0.26	
12 Industry	0.01	0.06	0.11	0.52	0.05	1.22	0.36*	0.11	0.25	0.18/0.36
10 Plant	−0.14	−3.02	0.04	1.19	−0.03	−1.72	0.02	0.15	0.01	
Skill upgrading										
1 Industry	0.11	1.41	0.10	1.67	0.08	2.72	0.47*	0.24	0.48	
4 Industry	0.08	0.79	0.11	1.26	0.07	1.81		0.24	0.01	
6 Industry	0.12	1.63	0.10	1.56	0.08	2.82	0.47*		0.48	
12 Industry	0.11	0.50	0.15	0.74	0.10	2.21	0.47*	0.25	0.48	0.11/0.83
10 Plant	−0.01	−0.30	0.04	1.48	0.01	0.96	0.05*	0.17	0.01	

Notes: The dependent variable is indicated in bold font at the start of each block of results, e.g., "Employment—Production workers." The estimating equation is equation (6) for the industry-level regressions and equation (7) for the plant-level regressions. Row numbers correspond to those in Table 1 so that the reader can refer to Table 1 for details of the specification. Rows 1 and 10 are my baseline specifications. See notes to Table 1 for further details, including the scaling of the β^{CA} and β^{US}. An asterisk indicates statistical significance at the 1-percent level. Skill upgrading is the log of the ratio of nonproduction workers to production workers. All dependent variables are in logs. The number of observations in the industry-level (plant-level) regressions is 211 (3,742) for production workers, 212 (3,539) for nonproduction workers, and 211 (3,489) for skill upgrading.

plant-level estimates ($t = -2.58$). The effects of the U.S. tariff concessions are less clear. They reduced employment by 7 percent using industry-level estimates, but this is not statistically significant and virtually disappears in the plant-level estimates. The total FTA impact of 8 percent (industry level) and 4 percent (plant level) are both economically large and statistically significant.

Rows 4, 6, and 12 present alternative specifications. In rows 4 and 6 the business conditions control and the U.S. control are excluded, respectively. This does not affect the $\hat{\beta}^{CA}$ or $\hat{\beta}^{US}$. In row 12, the industry-level IV results are reported. Endogeneity is strongly rejected ($p = 0.99$). I do not report the plant-level IV results because endogeneity is always strongly rejected at the plant level.

In contrast to the results for production workers, nonproduction worker employment is estimated to have been unaffected by the U.S. tariff concessions.

Finally, the "Skill upgrading" block of results in Table 4 show that there has been FTA-induced skill upgrading, i.e., an increase in the ratio of nonproduction workers to production workers. This happened at the industry level much more than at the plant level which means that market shares have shifted in favor of nonproduction-worker-intensive plants. Possibly these workers are a fixed cost that is needed to penetrate U.S. markets.

IX. Earnings

Most commentators expected Canadian wages to fall in response to competition from less unionized, less educated workers in the southern United States. Table 5 revisits this question using payroll statistics. Since the

TABLE 5—EARNINGS, WAGES, HOURS, INEQUALITY, AND OUTPUT

	Canadian tariffs		U.S. tariffs		Total FTA impact		Business conditions	U.S. control	
Variable	β^{CA}	t	β^{US}	t	TFI	t	δ	γ	Adjusted R^2
Earnings—All workers									
1 Industry	0.05	2.43	0.03	1.92	0.03	3.80	0.34*	0.25*	0.20
10 Plant	0.04	2.92	0.04	3.60	0.03	5.64	0.17*	0.19*	0.03
Earnings—Production workers									
1 Industry	0.04	2.12	0.00	−0.02	0.02	3.61	0.16*	0.11	0.07
10 Plant	0.05	3.25	0.03	2.57	0.03	4.74	0.12	0.21	0.02
Earnings—Nonproduction workers									
1 Industry	0.01	0.30	−0.01	−0.29	0.00	0.02	0.18*	0.12	0.08
10 Plant	0.04	1.48	0.06	2.87	0.03	3.67	0.11	0.11	0.01
Hourly wages of production workers									
1 Industry	0.05	3.15	0.03	1.84	0.03	4.37	0.60*	0.13	0.33
10 Plant	0.06	3.23	0.02	1.40	0.03	4.04	0.20	0.16*	0.01
Annual hours of production workers									
1 Industry	−0.01	−0.48	−0.02	−1.75	−0.01	−1.94	0.02	0.14	0.01
10 Plant	−0.02	−0.90	0.01	0.80	0.00	−0.12	0.03	0.07	0.00
Earnings inequality									
1 Industry	−0.04	−1.32	−0.01	−0.55	−0.02	−1.66	0.42*	0.05	0.21
10 Plant	−0.01	−0.46	0.02	0.97	0.00	0.41	0.13*	0.08	0.00
Gross output per plant in production activities									
1 Industry	−0.05	−0.65	0.03	0.54	0.00	−0.05	0.30*		0.18
10 Plant	−0.05	−1.36	0.06	2.01	0.01	0.72	0.16*		0.05

Notes: The dependent variable is indicated in bold font at the start of each block of results, e.g., "Earnings—All workers." The estimating equation is equation (6) for the industry-level regressions and equation (7) for the plant-level regressions. Row numbers correspond to those in Table 1 so that the reader can refer to Table 1 for details of the specification. Rows 1 and 10 are my baseline specifications. See notes to Table 1 for further details, including the scaling of the β^{CA} and β^{US}. An asterisk indicates statistical significance at the 1-percent level. Earnings inequality is the ratio of nonproduction-worker earnings to production-workers earnings. The U.S. control is not included in the output equations because the published data on the number of U.S. plants are only available at five-year intervals. All dependent variables are in logs. The number of observations in the industry-level (plant-level) regressions is 213 (3,801) for the earnings of all workers, 211 (3,742) for the earnings of production workers, 212 (3,526) for the earnings of nonproduction workers, 211 (3,738) for wages, 211 (3,738) for hours, 211 (3,489) for earnings inequality, and 211 (3,751) for output.

industry-level results are robust and since endogeneity is strongly rejected, I do not report the specifications that appeared as rows 4, 6, and 12 of Table 4. For all workers, the tariff concessions raised annual earnings. For example, the total FTA impact is a rise of 3 percent at both the industry level (t = 3.80) and the plant level (t = 5.64). At the plant level, earnings rose for both production and nonproduction workers. At the industry level, earnings gains were concentrated among production workers.[17] I have refined this observation by looking at hourly wages and hours worked by production workers. As shown in Table 5, there are wage effects and no hours effects. These earnings and wage effects are large in a statistical sense, but small in an economic sense. For example, a 3-percent rise in earnings spread over eight years will buy you more than a cup of coffee, but not at Starbucks. The important finding is not that earnings went up, but that earnings did not go down

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[17] My earnings results contrast sharply with those of Gaston and Trefler (1997) and Beaulieu (2000). Gaston and Trefler found no statistically significant effect of the tariff concessions on earnings. The only effect Beaulieu finds is the positive effect of U.S. tariff concessions on nonproduction worker earnings (an effect I find only in the plant-level data, *not* the industry-level data). Once again, my improved data and methodology means that my results supersede older results.

in response to competitive pressures from the U.S. South.

There are a number of reasons why earnings may have risen slightly at a time when employment was falling. First, there may have been end-game bargaining on the part of unions seeking to extract rents from nearly bankrupt firms as in Colin Lawrence and Robert Z. Lawrence (1985). To investigate, I use the Canadian *Labour Force Survey* which reports unionization rates in 1996 for a classification in which manufacturing is divided up into 16 industries. The correlation of Canadian tariff concessions with union membership rates and union coverage rates is 0.016 and 0.002, respectively. Thus, unionization does not offer an explanation of modestly rising earnings.

Another possibility is that workers in the most impacted industries upgraded their skills, possibly through the attrition of less-skilled workers. The *Labour Force Survey* is the most detailed source of data on education by industry. It reports education on a consistent basis back to 1988 (but not 1980). The correlation of Canadian tariff concessions $\Delta\tau_{i1}^{CA}$ with 1988–1996 log changes in average years of schooling is -0.28 which supports the view that the tariff cuts were associated with educational upgrading. However, this correlation is almost completely driven by the Clothing industry. The correlation falls to -0.06 when Clothing is omitted. Note of course that the Clothing industry is too important for an analysis of the FTA to simply be dismissed as an outlier. Thus, while there is some evidence that the earnings effect is driven in part by educational upgrading, this conclusion must be tentative.

The explanation of modestly rising earnings best supported by the data is seniority-based worker attrition. The *Labour Force Survey* reports current job tenure over the 1980–1996 period. Let $\Delta \ln Tenure_{is}$ be the average annual log change in tenure in the pre-FTA period ($s = 0$) or FTA period ($s = 1$). Figure 3 plots $\Delta \ln Tenure_{i1} - \Delta \ln Tenure_{i0}$ against $\Delta\tau_{i1}^{CA} - \Delta\tau_{i0}^{CA}$. That is, it has the form of my usual difference-of-differences estimator. As is apparent, industries that experienced the deepest tariff cuts (and hence the deepest employment losses) also experienced the largest increases in current job tenure. The correlation is -0.45.

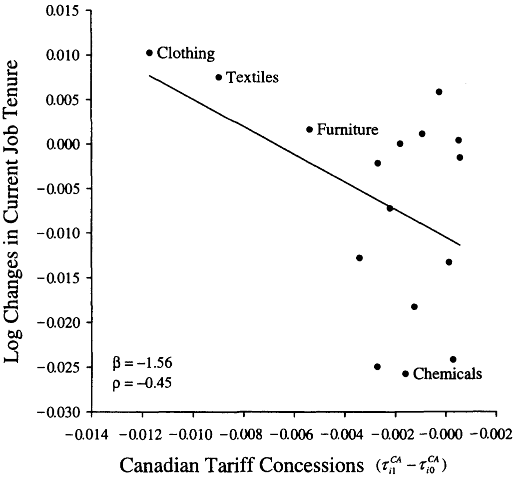

FIGURE 3. CURRENT JOB TENURE CHANGES [(1996–1988) LESS (1986–1980)] VS. CANADIAN TARIFF CONCESSIONS

The wage results point to a potential caveat for the labor productivity results. The 5-percent earnings rise associated with the Canadian tariff concessions may in part reflect a rise in labor quality. At one extreme, if the earnings rise was *entirely* due to increased labor quality then labor productivity rose not by 15 percent, but by $15 - 5 = 10$ percent. This translates into a compound annual growth rate of 1.2 percent, still an enormous number. At the other extreme, if productivity increases drove wage increases (i.e., if there was no labor quality increase), then no correction to the productivity numbers is needed.

There is a presumption in the popular press that anything to do with globalization will worsen income inequality. It is thus reassuring that there is absolutely no evidence that the FTA worsened income inequality. In the last block of results in Table 5, where inequality is measured as the earnings of nonproduction workers relative to production workers, $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ are effectively 0.

X. What Underlies Rising Labor Productivity?

To the extent that the labor productivity benefits of the FTA reflect gains in technical efficiency (as opposed to allocative efficiency), it is of interest to know how this came about. This section examines three possibilities.

First, plants may have moved down their average cost curves. To examine this I estimated my industry-level equation (6) for average output per plant and my plant-level equation (7) for plant output. The results appear at the bottom of Table 5. The industry-level $\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$ are comparable in magnitude to those estimated by Head and Ries (1999b) though my significance level is much lower.[18] Their finding of statistical significance may reflect their decision to work with annual changes without correcting for serial correlation. The more interesting results are at the plant level since these are more readily interpretable as moving along an average cost curve. The results indicate that the Canadian tariff concessions led the most impacted, import-competing plants to contract by 5 percent ($t = 1.36$) while the U.S. tariff concessions led the most impacted, export-oriented plants to expand by 6 percent ($t = 2.01$). These are not statistically significant results. Thus, this is not strong evidence in support of a simple scale-effects explanation of labor productivity gains.

Second, the popular press reports that U.S.-owned multinationals have been reorganizing their Canadian plants in order to produce fewer product lines, each with a global mandate. This is consistent with Baldwin et al. (2002) who find that for foreign-owned plants operating in Canada, increases in exports are associated with reductions in the number of commodities produced. Thus, plant rationalization may have contributed to rising productivity.

Third, it is possible that my FTA-induced labor productivity gains do not extend to TFP gains. However, this seems unlikely since there is little evidence of capital deepening, more intensive use of intermediate inputs, or rising markups. Specifically, using my difference-of-differences methodology, Trefler (2001) finds (1) no evidence of capital deepening at the 3-digit SIC level (capital stock is not available at the 4-digit level), (2) evidence of only very modest increases in the usage of intermediate inputs at the 4-digit SIC level, and (3) no evidence of increased markups (not a surprise given that the most impacted import-competing industries are low-end manufacturing industries with low markups to begin with). Thus, the Robert E. Hall (1988) TFP calculation shows that TFP must have risen substantially. More exactly, Trefler (2001) argues that the FTA-induced TFP changes are roughly half of the labor productivity changes. That is, the TFP changes are huge.

XI. Conclusions

There are many ways in which the Canada-U.S. Free Trade Agreement provides a unique window onto the effects of freer trade. The FTA was a relatively clean policy experiment, untainted by macro shocks or financial crises. It was an agreement between two industrialized countries. It was a reciprocal agreement, which means it affected exporters, not just importers. In contrast, most previous studies of trade liberalization have dealt with the unilateral trade actions of a developing country. Several strong conclusions emerged from the analysis. First, the FTA was associated with substantial employment losses: 12 percent for the most impacted, import-competing group of industries and 5 percent for manufacturing as a whole. These effects appear in both the industry- and plant-level analyses. Second, the FTA led to large labor productivity gains. For the most impacted, export-oriented group of industries, labor productivity rose by 14 percent at the plant level. For the most impacted, import-competing group of industries, labor productivity rose by 15 percent with at least half of this coming from the exit and/or contraction of low-productivity plants. For manufacturing as a whole, labor productivity rose by about 6 percent which is remarkable given that much of manufacturing was duty-free before implementation of the FTA. Third, the FTA created more trade than it diverted and possibly lowered import prices. Thus, the FTA likely raised aggregate welfare.

The FTA is the wellspring of one of the most heated political debates in Canada. This heat is

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[18] Head and Ries (1999b) find $\hat{\beta}^{CA} = -0.11$ with $t = 3.08$ and $\hat{\beta}^{US} = 0.06$ with $t = 2.74$. (For comparability, I have scaled their estimates.)

generated by the conflict between those who bore the *short-run adjustment costs* (displaced workers and stakeholders of closed plants) and those who are garnering the *long-run gains* (stakeholders of efficient plants, consumers, and purchasers of intermediate inputs). One cannot understand current debates about freer trade without understanding this conflict. Unfortunately, much of the academic debate has been fragmented: one set of researchers has focused on the short-run adjustment costs of worker displacement while another has focused on the long-run productivity gains. While this paper does not provide the silver bullet that makes the case either for or against free trade, I believe that it has considerably refined the question. My hope is that the results here take us one step closer to understanding how freer trade can be implemented in an industrialized economy in a way that recognizes both the long-run gains and the short-run adjustment costs borne by workers and others.

APPENDIX A: TARIFF DETAILS

The Canadian tariff data were supplied by Statistics Canada at the 4-digit SIC level. The U.S. tariff data were constructed as follows. The 1980–1988 data were converted from the TSUSA classification system (approximately 10,000 products) to SITC (revision 2) (approximately 800 products) using Feenstra's (1996) converter. It was then converted to Canadian SIC (213 industries) using a converter supplied by Statistics Canada. This converter was largely unique but, where not, weights for prorating data across SIC industries were supplied by Statistics Canada. For 1989–1994 tariff rates, the same procedure was followed, but starting from HS10 rather than TSUSA. For 1996 data, I converted the Census Bureau's "U.S. Imports of Merchandise: December 1996" (CD-96-12) data from HS10 to SITC (revision 3) using the supplied converter. I then converted the data to SITC (revision 2) using an almost 1:1 converter supplied by Feenstra (1996) and proceeded as with the 1980–1988 data.

Of Canada's 225 4-digit SIC industries, four were excluded from the analysis because of incomplete data and another 16 were aggregated into eight categories in order to ensure consistency of the trade and tariff data over time. The aggregated industries are: 1094 and 1099; 1511 and 1599; 1995 and 1999; 2911 and 2919; 2951 and 2959; 3051 and 3059; 3351 and 3359; 3362 and 3369.

The tariff data are defined as duties divided by imports. These data are collected at the tariff-line level (e.g., HS10 after 1988). I have compared a large number of the tariff rates so derived with published statutory tariff rates. The two tariff rate series are the same. A key issue is how to aggregate the tariff-line data up to the 4-digit SIC level. Since imports are the only data reported at a comparable level of disaggregation, I must follow what all empirical trade researchers do and aggregate using import weights. This is accomplished in the usual way as follows. Consider a single 4-digit SIC industry, let i be an HS10 item feeding into the industry, let I be the set of HS10 items feeding into the industry, let τ_{it} be the tariff rate, and let m_{it} be the *share* of the industry's imports accounted for by product i. My tariff rate changes have the form $\Delta\tau \equiv \sum_{i\in I} \tau_{it}m_{it} - \sum_{i\in I} \tau_{i,t-1}m_{i,t-1}$. For later reference, $\Delta\tau = \sum_{i\in I} (\tau_{it} - \tau_{i,t-1})m_{it} + \sum_{i\in I} (m_{it} - m_{i,t-1})\tau_{i,t-1}$.

Ideally I would prefer to use fixed-weight tariffs $\Delta\tau^{fixed} = \sum_{i\in I} (\tau_{it} - \tau_{i,t-1})m_{i,t-1}$. However this cannot be calculated because about one-third of all 1988 HS10 items disappeared by 1996. (Companies often hire lawyers to have their HS10 product reallocated to a higher tariff HS10.) To get a handle on the difference between $\Delta\tau^{fixed}$ and $\Delta\tau$, I manipulated the estimates of $\Delta\tau^{fixed}$ that were used by the Government of Canada in its pre-FTA assessment of the likely impacts of the agreement (S. Magun et al., 1988). To understand what I did, note that most industries had their tariffs reduced to zero linearly either over five years or ten years. Using Magun et al. (1988) I classified 4-digit SIC industries into either the five- or ten-year category. (The Magun et al. study reported estimates of $\Delta\tau^{fixed}$ using an input-output table classification that breaks manufacturing into about 60 industries.) In the formula $\Delta\tau^{fixed} = \sum_{i\in I} (\tau_{i,1996} - \tau_{i,1988})m_{i,1988}$ I set $\tau_{i,1996} = 0$ for five-year industries and $\tau_{i,1996} = 0.20\tau_{i,1988}$ for ten-year industries. This allows me to compute $\Delta\tau^{fixed}$.

The outcome of this procedure is estimates of $\Delta\tau_{i1}^{CA,fixed}$ and $\Delta\tau_{i1}^{US,fixed}$ where I am using the notation of equation (2). Across 4-digit SIC industries the correlation of $\Delta\tau_{i1}^{CA,fixed}$ with $\Delta\tau_{i1}^{CA}$ is 0.98 and the correlation of $\Delta\tau_{i1}^{US,fixed}$ with $\Delta\tau_{i1}^{US}$ is 0.97. That is, my tariff rate changes are very similar to a best estimate of fixed-weight tariff changes. Not surprisingly, the two tariff-change series yield almost identical results for estimates of β^{CA} and β^{US}. Trefler (2001, Appendix 2) discusses further aspects of aggregation.

Table A1 reports $\Delta\tau_{i1}^{CA}$ and $\Delta\tau_{i1}^{US}$ for the most impacted, import-competing industries.

APPENDIX B: SCALING β^{CA} AND β^{US} AND DEFINING "TOTAL FTA IMPACT"

Recall that $Y_{i,1988}$ is the level of, say, employment in industry i in 1988. The industry i change in employment over the FTA period is approximately $8(\Delta y_{i1})Y_{i,1988}$, i.e., the log change times the initial level. Multiplying by eight converts the average annual changes for the eight FTA years into a total FTA period change. The change in employment among industries in any set I is approximately $8\ \Sigma_{i\in I}\,(\Delta y_{i1})Y_{i,1988}$. As a proportion of total employment it is $8\ \Sigma_{i\in I}\,\Delta y_{i1}\omega_i$ where $\omega_i \equiv Y_{i,1988}/\Sigma_{j\in I}\,Y_{j,1988}$.[19] Using the fact that $8\widehat{\Delta y_{i1}} = 8\hat{\beta}^k\Delta\tau_{i1}^k$ ($k = CA, US$) is the predicted impact of country k's tariff concessions in industry i, the predicted tariff-induced log change in employment is $8\ \Sigma_{i\in I}\,\hat{\beta}^k\Delta\tau_{i1}^k\omega_i$ where I is the set of industries in the most impacted, import-competing industries ($k = CA$) or export-oriented industries ($k = US$). Defining $\overline{\Delta\tau^k}_{\cdot 1} \equiv 8\ \Sigma_{i\in I}\,\Delta\tau_{i1}^k\omega_i$, the predicted impact reduces to $\hat{\beta}^k\overline{\Delta\tau_{\cdot 1}^k}$ which is what is reported in the tables.

APPENDIX C: ESTIMATION OF Δb_{is}

As noted in Section IV, construction of Δb_{is} requires the preliminary step of estimating

$$\Delta_1 y_{it} = \theta_i + \sum_{j=0}^{J} \theta_{ij}\Delta_1 z_{t-j} + \eta_{it}.$$

I use OLS since my only criterion is to minimize in-sample prediction error. This regression was estimated separately for each industry using 1983–1996 data. (I do not have data for 1982.) This leaves only 13 observations for estimating seven parameters. (θ_{i0}, θ_{i1}, and θ_{i2} are each tuples.) To modestly increase the degrees of freedom, I estimated the regression at the 3-digit SIC industry level rather than at the 4-digit SIC industry level. There is not much difference between the 3- and 4-digit Δb_{is} as can be seen from the fact that on average there are only 2.03 4-digit industries per 3-digit industry.

Since Δb_{is} is a generated regressor, I reestimated all my results for the case where $\Delta b_{i1} - \Delta b_{i0}$ is an endogenous regressor in equations (6) and (7). This had no impact on the results. Further tests of misspecification due to a generated regressor led to rejection of misspecification.

Table A2 reports results for different choices of years. As is apparent, the results do not change substantially as long as the FTA baseline year is 1988. A referee has suggested that I also report results for the periods 1981–1988 and 1989–1996. Since the worst of the FTA adjustment happened immediately, the use of 1989 as the FTA baseline period means that I miss at least some of the adjustment. Indeed, the estimated coefficients are somewhat smaller.

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[19] There are some exceptions to this definition of ω_i. For the cases of production worker earnings and wages, ω_i is based on total hours worked by production workers. For the cases of skill upgrading and inequality ω_i is based on total employment. For intraindustry trade, ω_i is based on Canadian imports from the United States. Otherwise, if $Y_{i,1988}$ is a ratio then ω_i is based on the numerator of the ratio, i.e., if $Y_{i,1988} = a_{i,1988}/b_{i,1988}$ then $\omega_i \equiv a_{i,1988}/\Sigma_{j\in I}\,a_{j,1988}$.

APPENDIX D: MEASURING LABOR PRODUCTIVITY

Table A3 reports the results for labor productivity using three alternative measures of labor productivity. The most commonly used measure of labor productivity at the industry level is value added per worker deflated by an output deflator. This is the third measure reported in Table A3. There are several defects with this measure, two of which are easily addressed.

The first deals with the measurement of labor input. In Canada, but not in the United States, there has been a strong trend towards part-time employment. By not correcting for Canadian hours, measure 3 has a downward trend. Since this trend will be spuriously correlated with the downward trend in tariffs, the estimated effect of the FTA on productivity ($\hat{\beta}^{CA}$ and $\hat{\beta}^{US}$) will be downward biased. The Canadian data allow for an hours correction. Unlike the U.S. data, value added is reported for production activities alone and thus can be directly compared with the data reported for hours worked. Measure 1 of Table A3 reports the estimates using Canadian real value added in production activities per hour worked and U.S. real value added in all activities per employee. This is the same measure used in Table 2. As expected, the estimates tend to be larger for measure 1 than for measure 3 (though both are large). Clearly, measure 1 is preferred.

The second data issue deals with deflators. In Table A3, measures 1 and 3 use output deflators while measure 2 uses value-added deflators. Value-added deflators would have been preferable had the U.S. deflator not been seriously flawed for present purposes. It is at the 2-digit level (20 industries) and even at this highly aggregated level there are imputations for instruments (SIC 38) and electric and electronic equipment (SIC 36). Measure 2 of Table A3, the value-added deflated measure, thus has serious problems. This said, the ($\hat{\beta}^{CA}$, $\hat{\beta}^{US}$) based on value-added deflators are very similar to the ($\hat{\beta}^{CA}$, $\hat{\beta}^{US}$) based on output deflators. This can be seen by comparing measures 1 and 2 in Table A3. See Trefler (2001, Appendix 4) for a detailed discussion of deflators.

APPENDIX E: PLANT SELECTION ISSUES

As noted in Section II, subsection E, my results apply to long-form plants that were in existence in 1980, 1986, 1988, and 1996. These tend to be large plants. For example, in 1988 the average long-form plant was 2.2 times larger than the all-plant average. Note that the average long-form continuing plant was only 2.1 times larger than the all-continuing-plant average so that the large size of my plants is due to the fact that they are long-form rather than continuing per se.

The available evidence suggests that long-form selection issues are of secondary importance in the current context. To see this, I begin by noting that almost every plant in Canada receives either a long-form or short-form survey so that almost the entire universe of Canadian plants is surveyed. Next, for the few industry outcomes available in the short-form survey (employment, earnings, output, and a measure of labor productivity), the estimates of β^{CA} and β^{US} based on long-form and on long-form plus short-form plants are very similar. The exception is the estimate of β^{US} for employment. It implies employment losses of -4 percent using the long-form plants and -6.7 percent using long-form plus short-form plants. Thus, the conclusions from the long-form continuing plants appear to be broadly representative of all continuing plants.

TABLE A1—THE 71 MOST IMPACTED, IMPORT-COMPETING INDUSTRIES

SIC	Industry description	$\Delta\tau_{i1}^{CA}$	$\Delta\tau_{i1}^{US}$
1131	Brewery Products Industry	−0.331	−0.012
3271	Shipbuilding and Repair Industry	−0.241	−0.012
1931	Canvas and Related Products Industry	−0.183	−0.008
2433	Men's and Boys' Pants Industry	−0.170	−0.053*
2443	Women's Dress Industry	−0.162	−0.076*
2491	Sweater Industry	−0.159	−0.125*
2451	Children's Clothing Industry	−0.159	−0.031*
2441	Women's Coat and Jacket Industry	−0.157	−0.049*
1993	Household Products of Textile Materials	−0.156	−0.017
2442	Women's Sportswear Industry	−0.154	−0.053*
2494	Hosiery Industry	−0.152	−0.040*
1911	Natural Fibers and Felt Processing	−0.150	−0.041*
2434	Men's and Boys' Shirts and Underwear	−0.147	−0.072*
2432	Men's and Boys' Suits and Jackets	−0.147	−0.065*
2431	Men's and Boys' Coat Industry	−0.143	−0.079*
2493	Glove Industry	−0.140	−0.020
2496	Foundation Garment Industry	−0.137	−0.029*
1712	Footwear Industry	−0.127	−0.082*
2612	Upholstered Household Furniture Industry	−0.112	−0.001
1998	Tire Cord Fabric and Other Textiles Products	−0.108	−0.047*
2611	Wooden Household Furniture Industry	−0.106	−0.002
2499	Other Clothing and Apparel Industries	−0.103	−0.040*
2581	Coffin and Casket Industry	−0.101	−0.004
2495	Fur Goods Industry	−0.097	−0.053*
2444	Women's Blouse and Shirt Industry	−0.094	−0.104*
2649	Other Office Furniture Industries	−0.090	−0.002
1041	Fluid Milk Industry	−0.089	−0.006
1991	Narrow Fabric Industry	−0.089	−0.002
2619	Other Household Furniture Industries	−0.089	−0.012
3761	Soap and Cleaning Compounds Industry	−0.088	−0.032*
1829	Other Spun Yarn and Woven Cloth	−0.088	−0.081*
3242	Commercial Trailer Industry	−0.087	−0.004
3792	Adhesives Industry	−0.084	−0.025*
1713	Luggage, Purse and Handbag Industry	−0.082	−0.073*
2543	Wooden Door and Window Industry	−0.079	−0.039*
1691	Plastic Bag Industry	−0.079	−0.023
3612	Lubricating Oil and Grease Industry	−0.079	−0.004
2641	Metal Office Furniture Industry	−0.079	−0.001
2811	Business Forms Printing Industry	−0.078	−0.016
1921	Carpet, Mat and Rug Industry	−0.078	−0.021
1083	Sugar and Chocolate Confectionery	−0.077	−0.024
3751	Paint and Varnish Industry	−0.073	−0.036*
2542	Wooden Kitchen Cabinets, Vanities	−0.073	−0.002
1141	Wine Industry	−0.071	−0.030*
3771	Toilet Preparations Industry	−0.070	−0.024
3993	Floor Tile, Linoleum and Coated Fabrics	−0.070	−0.045*
2721	Asphalt Roofing Industry	−0.069	−0.044*
3791	Printing Ink Industry	−0.069	−0.017
2492	Occupational Clothing Industry	−0.066	−0.031*
3542	Structural Concrete Products Industry	−0.066	−0.015
3021	Metal Tanks (Heavy Gauge) Industry	−0.066	−0.011
3029	Other Fabricated Structural Metal Products	−0.065	−0.033*
3931	Sporting Goods Industry	−0.065	−0.010
1821	Wool Yarn and Woven Cloth Industry	−0.061	0.004
2733	Paper Bag Industry	−0.061	−0.042*
3243	Non-Commercial Trailer Industry	−0.060	0.009
1621	Plastic Pipe and Pipe Fittings Industry	−0.058	−0.031*
3311	Small Electrical Appliance Industry	−0.058	−0.024

TABLE A1—*Continued.*

SIC	Industry description	$\Delta\tau_{i1}^{CA}$	$\Delta\tau_{i1}^{US}$
1051	Cereal Grain Flour Industry	−0.057	−0.008
3032	Prefabricated Portable Metal Buildings	−0.057	0.000
2941	Iron Foundries	−0.057	−0.002
1093	Potato Chips, Pretzels and Popcorn	−0.056	0.017
3991	Broom, Brush and Mop Industry	−0.055	−0.040*
2792	Stationery Paper Products Industry	−0.054	−0.013
1052	Prepared Flour Mixes and Cereals	−0.054	−0.021
2819	Other Commercial Printing Industries	−0.052	−0.003
2799	Other Converted Paper Products	−0.051	−0.013
3031	Metal Door and Window Industry	−0.051	−0.032*
2821	Platemaking Typesetting and Bindery	−0.051	−0.012
1012	Poultry Products Industry	−0.051	−0.017
3594	Non-Metallic Mineral Insulation	−0.049	−0.058*

Notes: This table reports 1988–1996 changes in tariff concessions for those industries in the most impacted, import-competing group. An asterisk indicates that the industry is also in the most impacted, export-oriented group of industries.

TABLE A2—DIFFERENT CHOICES OF PRE-FTA AND FTA PERIODS

	Canadian tariffs $\Delta\tau^{CA}$		U.S. tariffs $\Delta\tau^{US}$	
Variable	β^{CA}	t	β^{US}	t
Employment, OLS				
1980–1986, 1988–1996	−0.12	−2.35	−0.03	−0.67
1980–1988, 1988–1996	−0.09	−2.03	0.00	0.04
1980–1986, 1988–1994	−0.13	−2.35	0.00	0.02
1981–1988, 1989–1996	−0.10	−2.05	0.01	0.14
Productivity, OLS				
1980–1986, 1988–1996	0.15	3.11	0.04	1.14
1980–1988, 1988–1996	0.15	3.35	0.00	0.04
1980–1986, 1988–1994	0.17	2.74	0.01	0.20
1981–1988, 1989–1996	0.12	2.64	−0.04	−1.03

Notes: The dependent variable is given in bold font. The estimating equation is equation (6). All rows correspond to the Table 1, row 1 baseline specification except in the choice of years used for the difference of differences.

TABLE A3—SENSITIVITY TO DIFFERENT DEFINITIONS OF LABOR PRODUCTIVITY

	Canadian tariffs		U.S. tariffs		Total FTA impact		Business conditions	U.S. control	
	β^{CA}	t	β^{US}	t	TFI	t	δ	γ	Adjusted R^2
1. Labor productivity—Production activities—Hours adjusted—Output deflators									
1 Industry	0.15	3.11	0.04	1.14	0.06	3.79	0.25*	0.16	0.31
10 Plant	0.08	1.70	0.14	3.97	0.07	4.92	0.12*	0.00	0.06
2. Labor productivity—Production activities—Hours adjusted—Value-added deflators									
1 Industry	0.17	2.96	0.03	0.67	0.06	3.26	0.19*	0.13	0.16
10 Plant	0.10	2.06	0.16	4.58	0.09	5.69	0.07	0.20*	0.07
3. Labor productivity—All activities—Not hours adjusted—Output deflators									
1 Industry	0.11	2.27	−0.03	−0.93	0.02	1.29	0.20*	0.24*	0.19
10 Plant	0.09	2.19	0.13	4.07	0.07	5.54	0.11*	0.13	0.09

Notes: The dependent variable is indicated in bold font at the start of each block of results. The estimating equation is equation (6) for the industry-level regressions and equation (7) for the plant-level regressions. Rows 1 and 10 are my baseline specifications as in Table 1. See the notes to Table 1 for further details, including the scaling of the β^{CA} and β^{US}. All estimates are OLS. An asterisk indicates statistical significance at the 1-percent level. All dependent variables are in logs. The number of observations in the industry-level (plant-level) regressions is 211 (3,726) for measures 1 and 2 and 213 (3,801) for measure 3.

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