Replication of “The Long and Short of the Canadian-U.S. Free Trade Agreement” by Trefler D.

Project 1

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1. Introduction

The Canada-United States Free Trade Agreement (FTA) is a bilateral agreement between Canada and United States, intending to remove trading barriers between the two countries. The United States has always been Canada's biggest trading country, and FTA eventually led to a bigger global market access for Canada. The agreement, superseded by NAFTA, was entered into force in 1989, and spurred trades of products and services between Canada and the United States, which many believed that it was the major contributor to substantial increases of labour productivity in both countries. The benefits that arose from the FTA include a wider range of goods and services, spurring trade volumes, and an increase in employment opportunities in both countries. The FTA laid the foundation for economic integration and eliminated existing trade restrictions for major industries in both countries. While the actual effects of the FTA are hard to measure, this agreement positively impacted both countries' economies as the FTA and the NAFTA ensured fair competition and encouraged investment within the free-trade area, and opened up entrepreneurial opportunities and motivated innovation, which contributed to the long-term economic growth in the NA region.

While existing literature established that the impacts of the FTA on U.S. and Canada would depend on the value difference between their currencies, some authors such as Trefler (1994) and Harrison (1994) have divided the short-run transition costs and the long-run productivity gains into distinctive categories. Therefore, the replication of "The Long and Short of the Canadian-U.S. Free Trade Agreement" by Trefler (1994) can help us to study the economic impacts of the FTA on both Canada and the United States empirically, by observing how employment is affected by conducting several statistical analyses. Below are the conclusions

reached by us which are in line with the author's findings: 1. Higher tariff cuts cause firms to reduce their number of employees, leading to a significant decrease in total employment in Canada; 2. Tariff cuts impacts on production employment and total employment differ significantly. 3. A cut in Canadian tariffs decreases production employment in Canada, while a cut in U.S. tariffs increases the total number of production employees in Canada; 4. Tariff cuts reduce the hiring of non-production workers in Canada, leading to a reduction in Canadian non-production employment.

2. Methodology/ Economic Strategy

The main objective of this paper is to examine the effects of tariff cuts on employment in manufacturing industries. Set Y_{it} as the dependent variable, which is employment. We denote *i* as industry and *t* as year. $\Delta\ Y_{i,s}$ approximates the annual changes in the growth rate (compounded) of employment.

Pre-FTA: $\Delta Y_{i0} = (\ln Y_{i,1986} - \ln Y_{i,1980}) / (1986 - 1980)$ **(1)**

After-FTA: $\Delta Y_{i1} = (\ln Y_{i,1996} - \ln Y_{i,1988}) / (1996 - 1988)$ **(2)**

where is the pre-FTA period is from the year 1980 to 1988, denoted as s=0, while the post-FTA period is from the year 1989 to 1996, denoted as s=1. Therefore, the denominators of both equations (1) and (2) represent changes in the pre-FTA period between the years 1980-1986 and 1988-1996 respectively.

In equations (3) and (4) below, $\Delta\tau^{country}{}_{i,s}$ approximates the annual changes in tariff cuts. $\tau^{country}{}_{i,s}$ should not be simply assumed as Canadian Tariffs against the US under FTA, the estimate results would be biased because it will include the impact that other global trends had

on the tariff rates. It would be prudent to calculate the FTA tariff concession to the US as a difference between τ_{it}^{US}(Canadian tariff against the US) and τ_{it}^{ROW} (Canadian tariff against the rest of the world):

Pre-FTA: $\Delta\tau^{country}{}_{i,0} = (\tau^{country}{}_{i,1986} - \tau^{ca}{}_{i,1980}) / (1986 - 1980)$ **(3)**

After-FTA: $\Delta\tau^{country}{}_{i,1} = (\tau^{country}{}_{i,1996} - \tau^{ca}{}_{i,1988}) / (1996 - 1988)$ **(4)**

As FTA was enforced at the start of the year 1989, we set $\Delta\tau^{country}{}_{i,0} = \Delta\tau^{ca}{}_{i,0} = \Delta\tau^{US}{}_{i,0} = 0$, as we expect the pre-FTA tariff rates to coincide (when i is not an automotive industry).

Based on what Trefler (1994) established in his paper, we know that Canadian employment is affected by the tariff cuts in both countries, industry-specific economic growth, industry-specific shock, and business cycle controls:

Pre-FTA: $\Delta Y_{i,0} = \theta_{i,0} + \alpha_i + \beta^{ca}\,\Delta\tau^{ca}{}_{i,0} + \beta^{us}\,\Delta\tau^{us}{}_{i,0} + \gamma\Delta y^{US}{}_{i,0} + \delta_i\Delta z_s + \epsilon_{i,s}$ **(5)**

After-FTA: $\Delta Y_{i,1} = \theta_{i,1} + \alpha_i + \beta^{ca}\,\Delta\tau^{ca}{}_{i,1} + \beta^{us}\,\Delta\tau^{us}{}_{i,1} + \gamma\Delta y^{US}{}_{i,1} + \delta_i\Delta z_s + \epsilon_{i,s}$ **(6)**

The formal estimation of the regression model uses the double differencing method (DD). Assuming industries are at similar points on the business cycle, this method eliminates 2 x 213 observations and nullifies the impact of α_i and δ_i. In equations (5) and (6), α_i denotes industry-specific economic growth while $\beta^{country}$ denotes country-specific coefficients for annual changes in tariff cuts. $\delta_i\Delta z_s$ denotes the joint effects of business cycle and industry-specific growth. The author assumed assuming industries were subjected to the same time of the business cycle and economic growth within the same country.

Also, there is no evidence showing the pre-FTA and after-FTA business and industry fluctuation changes due to tariff changes.

To capture significant value discrepancies in employment outcome across the treatment "U.S. tariff" we constructed a "Differencing-in Difference model", hereinafter referred to as "DinD". This model is formed by double differencing using the equation (3) and equation (4) as the base equations, with an intercept value of $(\theta_{i,1} - \theta_{i,0})$, which is then simplified into a single θ in equation (8).

$$(\Delta Y_{i,1} - \Delta Y_{i,0}) = (\theta_{i,1} - \theta_{i,0}) + \beta^{ca} (\Delta\tau^{ca}_{i,1} - \Delta\tau^{ca}_{i,0}) + \beta^{us} (\Delta\tau^{us}_{i,1} - \Delta\tau^{us}_{i,0}) + \gamma (\Delta y^{US}_{i,1} - \Delta y^{US}_{i,0}) + \varepsilon_{is} \quad \textbf{(7)}$$

$$(\Delta Y_{i,1} - \Delta Y_{i,0}) = \theta_{i} + \beta^{ca} (\Delta\tau^{ca}_{i,1} - \Delta\tau^{ca}_{i,0}) + \beta^{us} (\Delta\tau^{us}_{i,1} - \Delta\tau^{us}_{i,0}) + \gamma (\Delta y^{US}_{i,1} - \Delta y^{US}_{i,0}) + \varepsilon_{is} \quad \textbf{(8)}$$

We will use this DinD model to look at the effect of FTA by taking into consideration the presence of the U.S. tariff cut.

3. Data

To analyze the impact of liberalizing FTA policies, we use the data from the years 1980-1996. As the agreement was put into effect on January 1st, 1988; the years considered include the pre-FTA and post-FTA years to provide the comparative statistics. However, it is important to note, Canadian data is at the 4-digit SIC level (n= 213 manufacturing industries). The 3-digit SIC level (n=104 manufacturing industries) did not have any industry with 1988 tariff more than 10 percent. Therefore, using the 4-digit SIC level provides a more varied sample. The author utilized a database published by Statistics Canada. The database spans the years 1980-96 and is at the 4-digit SIC level (213 manufacturing industries). (Trefler, 1994) The variables used are divided into the following groups: (i) Imports, exports, and tariff duties from special tabulations of the International Trade Division. (ii) Gross output, value added, number of plants, employment, annual earnings, wages, and hours from special tabulations by the Canadian Annual Survey of

Manufactures (ASM) Section. (iii) The above ASM data by plant size, again by special tabulation. (iv) Output and value-added deflators from the Input-Output Division and the Prices Division. (v) Concordances from U.S. SIC (1987) and Canadian SIC (1970) to Canadian SIC (1980) from the Standards Division. For our empirical study, we formed the following variables: (i) Change in Canadian Total Employment. (ii) Change in U.S. Total Employment. (iii) Change in Canadian Non-Production Employment. (iv) Change in U.S. Non-Production Employment. (v) Change in Canadian Production Employment. (vi) Change in U.S. Production Employment. (vii) Change in Canadian Skill Upgrading Employment. (viii) Change in U.S. Skill Upgrading Employment. (ix) Change in Canadian Tariff due to FTA. (x) Change in U.S. Tariff due to FTA.

We can observe the overtime value fluctuations in the variables constructed by us by looking at (Appendix A) Table 1: Sample Statistics -- Double-differencing Statistical Output. By deploying the 'SUM' option of MEANS procedure in SAS data tool, we can observe the total value of change in Canadian Total Employment by looking at the "Sum" Column. Both -3.6188403 in Row 1 and -4.2783850 indicated that the tariff cuts led to decrease of values in Canadian Total Employment and Canadian Production Employment respectively, i.e. tariff cuts have a negative impact on Canada's employment. We can also study the maximum and minimum of value changes of variables constructed by using the 'MAX', 'MIN' option for MEANS procedure. The number of observations means, and standard deviations of each variable constructed in this project are displayed in the same Table 1 as well.

4. Empirical Results

4.1. (Part A) Main Regressions

Difference-in-Difference model ---- Our base model

The objective of forming a base model using the Difference-in-difference method is to calculate the treatment effects of tariff cut on Canadian employment, since randomization on the individual level is not available in the database used by both author and us. While we constructed a single differencing model in our SAS program (submitted), it was simply to show that implementation of double differencing method is superior to a single differencing method and that is indeed the case. Results have been summarized in (Appendix B) Table 2: Regression Outputs based on Canadian employment. The 'Regression's Model Specification' columns state that equation (8) is the model being estimated and how the pre-FTA and FTA period columns state how time period are defined. Our preferred specification appears at the top; estimating equation $(\Delta Y_{i,1} - \Delta Y_{i,0}) = \theta_i + \beta^{ca} (\Delta\tau^{ca}{}_{i,1} - \Delta\tau^{ca}{}_{i,0}) + \beta^{us} (\Delta\tau^{us}{}_{i,1} - \Delta\tau^{us}{}_{i,0}) + \gamma (\Delta y^{US}{}_{i,1} - \Delta y^{US}{}_{i,0}) + \varepsilon_{is}$ with pre-FTA and post-FTA periods defined as 1980-86 and 1988-96 respectively. The β shows tariff concessions and γ is the coefficient for the US control; their t values are reported respectively. The results for Employment (all, production workers, non-production workers, and skill upgrading) follow the same pattern as described above.

For employment (all workers), under our preferred specification, β=1.65733 indicates that tariff concessions reduced employment. The US control coefficient is reported as γ=0.17543. As for skill upgrading, the ratio of non-production workers to production workers in an industry, we do not see statistically significant results as β=1.47368 and t=1.30. Hence, tariff concessions did not contribute to skill upgrading in any of our defined periods as shown in Table 2.

To summarize, the low regression coefficients and associated low t-values indicate that tariff cuts have insignificant impacts on Canadian total employment, production or non-

production employment and skill-upgrading employment. The low R^2 values, for example R^2 = 0.044 for Canadian Total Employment implies that the constructed model explains only approximately 4.4% of variation in changes in Canadian Total Employment around its mean. Based on this DinD model, by measuring the treatment and post-treatment effects on the changes in Canadian Employment (considering all four employment variables in each model), we can summarize that the changes in tariffs, and the U.S. tariffs had insignificant impacts on changes in Canadian Employment.

4.2. (Part B) Modifications

Modification I *– Switching from Double-differencing to Single Differencing* : Explanation as R^2 s are extremely low and regression outputs imply that double differencing method is superior to this method, specifically in this paper.

Modification II*– Modifying time periods implemented*

Please refer to (Appendix C) Table 3: Regression Outputs based on Canadian employment for empirical results produced based on the modified models.

(i) *Time periods (1996-1988)-(1988-1980)*

(ii) *Time periods (1994-1988)-(1986-1980)*

(iii) *Time periods (1994-1988)-(1984-1980)*

Based on the regression outputs in Table 3, we can immediately observe that the modifications of time periods using our base model (DinD), all βs stand statistically significant at a 10% level indicating the sensitivity to time modifications and the implicit choice of business-cycle control. All regression models suffered from extremely low R^2 values, which means that all models failed to explain more than 10% of the variation Canadian employment. However, this

would further supplement our empirical findings above -- FTA had insignificant impact on the changes in Canadian employment, and labour productivity growth.

4.3. (Part C) Ranking

Ranking industries into 3 groups based on the sizes of the Canadian tariff cut

(Appendix D) Table 4: Regression Outputs based on Canadian employment shows our third modification of the author's empirical model. We ranked all observations by their size of Canadian tariff cut, which is $(\Delta\tau^{ca}_{i,1} - \Delta\tau^{ca}_{i,0})$. The observations are then divided into three group, which are group 0, group 1 and group 2. Group 0 is 1/3 portion of observations with lowest size of Canadian tariff cut while group 2 is the 1/3 portion of observations with highest size of Canadian tariff cut. Then, we regressed each group of observations based on our base model (DinD) to determine whether sizes of the Canadian tariff cut have impact on employment.

R^2 of all ranks for each regression model are all significantly low as demonstrated in Table 4. None of the R^2 exceeds 0.1, which means that all regression models in this section do not explain more than 10% of the variation in the dependent variable.

5. Conclusion

While the overall worker's productivity in Canada has risen substantially since the establishment of the Free Trade Agreement, the existence of the FTA is not the key factor to this phenomenon. We argue that the impacts of FTA, is not as significant as everyone predicted. In terms of short-term transition costs and long-term productivity gains, particularly in terms of employment which we studied extensively, large tariff cut leads to decrease in total employment.

For production employment, reducing Canadian tariff leads to reduction in production employment in Canada, while reducing U.S. tariff leads to increase in production employment in Canada. In addition, for non-production employment, cutting tariff will reduce non-production employment in Canada. To conclude, the enforcement of FTA had insignificant contributions to the spurring labour productivity growth in specified time periods in Canada.

References

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Appendix

(Appendix A) Table 1: Sample Statistics -- Double-differencing Statistical Output

Variable	N	Mean	Std. dev.	Sum	Minimum	Maximum
Change in Canadian Total Employment ($\Delta Y_{i,1}^{CA} - \Delta Y_{i,0}^{CA}$)	213	-0.0169899	0.0690946	-3.6188403	-0.2071348	0.1809317
Change in U.S. Total Employment $\Delta Y_{i,1}^{US} - \Delta Y_{i,0}^{US}$)	213	0.0183357	0.0455576	3.9054942	-0.2597835	0.1760331
Change in Canadian Non-Production employment $\Delta Y_{i,1}^{CA} - \Delta Y_{i,0}^{CA}$)	209	0.0092473	0.1020088	1.9326949	-0.3786787	0.3329827
Change in U.S. Non-Production Workers $\Delta Y_{i,1}^{US} - \Delta Y_{i,0}^{US}$)	213	0.0071593	0.0456368	1.5249372	-0.2704109	0.2021679
Change in Canadian Production Employment $\Delta Y_{i,1}^{CA} - \Delta Y_{i,0}^{CA}$)	211	-0.0202767	0.0738058	-4.2783850	-0.2363327	0.1823851
Change in U.S. Production workers $\Delta Y_{i,1}^{US} - \Delta Y_{i,0}^{US}$)	213	0.0231973	0.0469322	4.9410304	-0.2581860	0.2026869
Change in Canadian Skill Upgrading ($\Delta Y_{i,1}^{CA} - \Delta Y_{i,0}^{CA}$)	207	-0.0298234	0.1050113	-6.1734427	-0.3920903	0.2829736
Change in U.S. Skill Upgrading ($\Delta Y_{i,1}^{CA} - \Delta Y_{i,0}^{CA}$)	213	0.0160380	0.0271332	3.4160932	-0.0703178	0.0937561
Change in Canadian Tariff $\Delta\tau^{ca}_{i,1} - \Delta\tau^{ca}_{i,0}$)	213	-0.0051175	0.0064464	-1.0900332	-0.0413567	0.0059593
Change in U.S. Tariff $\Delta\tau^{us}_{i,1} - \Delta\tau^{us}_{i,0}$)	213	-0.0024620	0.0030108	-0.5244158	-0.0156590	0.0035419

(Appendix B) Table 2: Regression Outputs based on Canadian employment

[Difference-in-Difference]

Regression's Model Specification	Period		Canadian Tariff		U.S. Tariff		U.S. Control			
Equation	Pre-FTA	FTA	β^{CA}	t	β^{US}	t	γ	t	R^2	Adj R^2
Employment: All Workers										
8	1980-1986	1988-1996	1.60343	2.02	0.31634	0.19	0.17436	1.67	0.0444	0.0307
8	1980-1986	1988-1996	1.65733	2.25	-	-	0.17543	1.68	0.0443	0.0352
Employment: Non-Production Workers										
8	1980-1986	1988-1996	1.02730	0.86	-1.72983	-0.66	0.03854	0.24	0.0046	-0.0100
8	1980-1986	1988-1996	0.72809	0.66	-	-	0.02693	0.17	0.0025	-0.0072
Employment: Production Workers										
8	1980-1986	1988-1996	1.50287	1.78	1.62606	0.91	0.23225	2.14	0.0619	0.0483
8	1980-1986	1988-1996	1.77288	2.24	-	-	0.23889	2.21	0.0581	0.0491
Employment: Skill Upgrading Workers										
8	1980-1986	1988-1996	0.88207	0.72	3.24598	1.22	0.08302	0.30	0.0159	0.0014
8	1980-1986	1988-1996	1.47368	1.30	-	-	0.05489	0.20	0.0087	-0.0010

(Appendix C) Table 3: Regression Outputs based on Canadian employment

[Modification II - Modifications on Time Periods Considered]
Periods:

i. Time periods (1996-1988)-(1988-1980)
ii. Time periods (1994-1988)-(1986-1980)
iii. Time periods (1994-1988)-(1984-1980)

Regression's Model Specification	Period		CA Tariff		U.S. Tariff		U.S. control			
Period	Pre-FTA	FTA	β^{CA}	t	β^{US}	t	γ	t	R^2	Adj R^2
Employment: All workers										
i.	1980-1988	1988-1996	1.40719	2.11	-0.39094	-0.27	0.13287	1.52	0.0400	0.0262
	(Without	U.S.tariff)	1.34538	2.15	-	-	0.12875	1.50	0.0397	0.0305
ii.	1980-1986	1988-1994	1.52733	2.16	0.15916	0.11	0.23897	2.26	0.0541	0.0405
	(Without	U.S.tariff)	1.54690	2.27	-	-	0.23888	2.27	0.0541	0.0451
iii.	1980-1984	1988-1996	1.87523	1.89	0.21143	0.10	0.20250	1.61	0.0358	0.0220
	(Without	U.S.tariff)	1.90112	1.99	-	-	0.20250	1.62	0.0358	0.0266
Employment: Non-Production Workers										
i.	1980-1988	1988-1996	1.31257	1.25	-2.61341	-1.16	0.04859	0.39	0.0111	-0.0032
	(Without	U.S.tariff)	0.90576	0.92	-	-	0.01857	0.15	0.0047	-0.0048
ii.	1980-1986	1988-1994	0.35216	0.33	-0.67378	-0.30	-0.06525	-0.40	0.0015	-0.0131
	(Without	U.S.tariff)	0.26742	0.26	-	-	-0.06678	0.16113	0.0010	-0.0087
iii.	1980-1984	1988-1996	1.12057	0.86	-0.83229	-0.31	-0.01980	-0.13	0.0036	-0.0108
	(Without	U.S.tariff)	1.01611	0.81	-	-	-0.02084	-0.14	0.0031	-0.0064
Employment: Production Workers										
i.	1980-1988	1988-1996	1.43326	2.01	0.21640	0.14	0.18217	1.95	0.0524	0.0386
	(Without	U.S.tariff)	1.46664	2.18	-	-	0.18456	2.02	0.0523	0.0432
ii.	1980-1986	1988-1994	1.67524	2.20	1.20752	0.76	0.32786	3.00	0.0824	0.0691
	(Without	U.S.tariff)	1.81767	2.47	-	-	0.32856	3.01	0.0798	0.0710
iii.	1980-1984	1988-1996	2.26193	2.24	0.61806	0.29	0.31682	2.54	0.0656	0.0520
	(Without	U.S.tariff)	2.33492	2.39	-	-	0.31707	2.55	0.0652	0.0562
Employment: Skill Upgrading Workers										
i.	1980-1988	1988-1996	0.35512	0.34	2.97973	1.31	0.12380	0.54	0.0127	-0.0017
	(Without	U.S.tariff)	0.87149	0.89	-	-	0.09770	0.43	0.0044	-0.0052
ii.	1980-1986	1988-1994	1.76093	1.51	1.85866	0.74	-0.09568	-0.32	0.0182	0.0037
	(Without	U.S.tariff)	1.99346	1.78	-	-	-0.10651	-0.36	0.0156	0.0059
iii.	1980-1984	1988-1996	1.55965	1.40	1.19266	0.51	0.08363	0.40	0.0134	-0.0009
	(Without	U.S.tariff)	1.70538	1.58	-	-	0.08001	0.38	0.0122	0.0026

(Appendix D) Table 4: Regression Outputs based on Canadian employment

[Modification III - Ranked based on the sizes of the Canadian tariff cut]

Regression's Model Specification										
	Period		CA Tariff		U.S. Tariff		U.S. control			
Rank	Pre-FTA	FTA	β^{CA}	t	β^{US}	t	γ	t	R^2	Adj R^2
Employment: All workers										
0	1980-1986	1988-1996	0.17331	0.16	3.15890	1.52	-0.0753	-0.52	0.0384	-0.0046
1	1980-1986	1988-1996	6.05770	0.93	-0.39414	-0.11	0.25336	0.99	0.0315	-0.0118
2	1980-1986	1988-1996	0.95661	0.14	-1.04986	-0.27	0.26642	1.39	0.0332	-0.0101
Employment: Non-Production Workers										
0	1980-1986	1988-1996	-0.063477	-0.42	1.51387	0.50	-0.26744	-1.31	0.0268	-0.0174
1	1980-1986	1988-1996	1.159296	0.16	-0.81234	-0.14	0.95983	2.35	0.0828	0.0411
2	1980-1986	1988-1996	7.744710	0.72	-1.81110	-0.30	-0.15838	-0.57	0.0156	-0.0298
Employment: Production Workers										
0	1980-1986	1988-1996	0.10386	0.09	4.28405	1.89	-0.03129	-0.21	0.0578	0.0156
1	1980-1986	1988-1996	7.78058	1.13	1.56046	0.41	0.08946	0.36	0.0303	-0.0131
2	1980-1986	1988-1996	-3.00351	-0.43	-0.73036	-0.18	0.45183	2.26	0.0832	0.0409
Employment: Skill Upgrading Workers										
0	1980-1986	1988-1996	0.33519	0.19	4.95353	1.54	0.24697	0.61	0.0420	-0.0016
1	1980-1986	1988-1996	2.70657	0.26	4.41892	0.73	0.68559	0.73	0.0339	-0.0100
2	1980-1986	1988-1996	-12.22297	-0.52	-4.97732	-0.84	-0.43141	-0.99	0.0424	-0.0032