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Regional industrial trade with Canada and Mexico

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Abstract. Using trade exposure and production exposure data for both exports and imports of the U.S. with Canada and Mexico as components of exports and imports indexes, the paper ranks the states. The impact of exports and imports on regions are deduced. We find that the Great Lakes, Plains, Rocky Mountain, and New England regions are biased toward trade with Canada, while the Southwest region is biased toward trade with Mexico.

1. Introduction

The North American Free Trade Agreement (NAFTA), which was envisioned as creating a $6 trillion market with more than 360 million consumers, was approved by the United States, Canada, and Mexico in 1993 and went into effect on January 1, 1994 (Carbaugh 2000). Many issues concerning international trade in general and NAFTA in particular are continually being debated and assessed. Karemera and Ojah (1998) estimate trade creation and trade diversion effects upon removal of all tariff barriers among the three countries. They conclude that the United States initially will benefit the most, while Mexico will benefit the least. Many studies have been done concerning the role of nontariff barriers (Roland-Holst, Reinert, and Shiells 1994), and the potential impact on employment and wages (Maskus, Blyde, and Van Stone 1994).

A related area of research is the general economic impact of international trade on regions of the United States (Riefler 1990), which also includes the importance of foreign direct investment (FDI) especially on regional exports, as indicated by Kahley (1990); Giese, Kahley, and Riefler (1990); and Leichenko and Erickson (1997). The regional extent and growth of exports due to inward FDI are viewed as being detrimental because of importation of intermediate goods; as being beneficial because of enhanced productivity and increased

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international competitiveness; or as being of little overall impact. Added to the proponents' side of the argument are such factors as the transfer of technology, the stimulation of investment, and the creation of jobs. Domestic overcapacity and unfair competition are additional arguments on the side of detractors.

An essential research follow-up is an assessment of exports of manufactured products at the state level, exemplified by Smith (1989, 1990). Smith identifies the industrial mix by grouping states into nine multistate regions, taking into account similarity of manufacturing and proximity to major ports. Along these lines, Hayward and Erickson (1995) investigate manufacturing trade export and import flows between the United States and its neighbors Canada and Mexico for the period 1983 to 1991.

Canada, with a population in 1993 of 29 million, and Mexico, with a population of 90 million (World Bank 1995), are the United States' first and third trading partners. Corresponding exports in 1993 are \$100 billion and \$42 billion, and imports are \$110 billion and \$40 billion (Bureau of the Census 1994).

Among the data provided by Hayward and Erickson on the 48 contiguous states are (1) trade exposure, which is the proportion of a state's total trade accounted for by Canada and Mexico, computed for both exports and imports, and (2) production exposure, which is trade with Canada and Mexico as a proportion of a state's total manufacturing shipments, computed for both exports and imports. Hayward and Erickson use shift-share analysis, incorporating each state's trade with Canada and Mexico. This shift-share analysis enables us to estimate the growth in trade of each state with the two countries.

This paper extends the work of Hayward and Erickson by constructing indexes to rank individual states for their orientation to trade with Canada and Mexico and to compare regional levels. The extension also undertakes an assessment of the relationship between the potential of trade and its growth at the state level. The next section provides a brief outline of Hayward and Erickson's approach, followed by a description of the index section. Empirical results and concluding remarks constitute the remainder.

2. Shift-share with international trade effect

A shift-share model explains regional differentials in output or employment in three components. The first component is the national economic change component, the second is the structural component (industry mix) of the region, and the third component is the competitive advantages or disadvantages of the region. Various extensions to shift-share have been made over the years. An important one by Markusen, Noponen, and Driessen (1991) disaggregates the national and the industrial mix components to reflect changes in exports, imports, domestic demand, and labor productivity. Hayward (1995) introduces a further extension to the model.

Hayward's extension, which was used by Hayward and Erickson (1995) in their study of U.S. state trade with Canada and Mexico, results in a model with seven national shifts, seven industrial shifts, and four regional shifts: a total of 18 shifts. For the 1983 to 1991 time period, the shifts are calculated using the dynamic shift-share, whereby the yearly data between the two time periods are employed as suggested by Barff and Knight (1988).

When highlighting patterns of total export and total import shifts of the Canadian and Mexican trade contribution across the states, an estimate is obtained for the growth of exports and imports. The final product of Hayward and Erickson is an estimate of total shifts or of growth in exports to and imports from Canada and Mexico as related to each of the 48 states.

3. An index for exports and imports

While Hayward and Erickson provide estimates of growth in trade with Canada and Mexico across the 48 states, this research entails an estimation of the flow of their trade using data on trade exposure and production exposure for both exports and imports. A state's trade exposure, expressed as a proportion, reflects its trade orientation. Production exposure represents the trade as a proportion of its total manufacturing output. It reflects, according to Hayward (1995), the relative dependence of a state on industrial production.

As Bauer and Eberts (1990) indicate, exports lead to increases in domestic production through the expansion of demand for domestic products. Imports, because they compete with domestic suppliers by displacing their output, may decrease domestic output. There are some beneficial consequences to imports as pointed out by Brown (1992), however—firms with limited previous competition for their output are forced to reduce their price cost margins and improve the efficiency of their operations.

Data for 1991 provided by Hayward and Erickson for trade and production exposures are used to construct indexes by which the states are ranked on a single scale for their flow of trade orientation. The index provides a universal measure by which data on trade exposure and production exposure are combined, resulting in four indexes: two for Canada (exports and imports) and two for Mexico.

The index is constructed by a modification of a procedure developed by the United Nations Development Program (UNDP 1995) for a human development index (HDI). For the purpose of this paper, let

X_1 = Trade exposure, and,

X_2 = Production exposure.

Identify for each variable the maximum and minimum values. An indicator

$$I_{ij} = \frac{\max\limits_{j} X_{ij} - X_{ij}}{\max\limits_{j} X_{ij} - \min\limits_{j} X_{ij}} \quad 0 \le I_{ij} \le 1, \tag{1}$$

where max X_{ij} and min X_{ij} are the maximum (highest) and minimum (lowest) achievements statewide, places state j in a range for variable i, I = 1, 2. An index I_j for state j is constructed as

$$I_j = \tfrac{1}{2} \sum_{i=1}^{2} I_{ij} \tag{2}$$

The values of the index range between 0, indicating that a state had the best performance, to 1.0, indicating that a state had the least performance. Therefore, the lower the value of the index, the better is the performance. The index as constructed differs a bit from the way it is usually constructed [e.g., by Perrons (1995)], in that I_j in equation (2) is not subtracted from 1.00.

4. Comparisons by states

Table 1 displays the export indexes for Canada and Mexico by state arranged in alphabetical order. The smaller the magnitudes are, the closer is the individual state to the anchor. In other words, the numbers define how far a given individual state falls short of the anchor defined as the maximum of trade exposure and the maximum of production exposure.

Michigan has a score of zero for exports to Canada and thus ranks first, as shown in columns 2 and 3, which implies that Michigan has the highest scores on both variables and, therefore, the distance to itself is zero. Vermont, North Dakota, and Delaware follow Michigan with ranks 2, 3, and 4, respectively. New Mexico ranks last with a score of 0.9800.

For exports to Mexico, Texas serves as an anchor for both variables and, thus, has a score of zero and ranked first (columns 4 and 5). Arizona with a score 0.4409 is ranked second. Mississippi and California with scores of 0.6617 and 0.6649 are ranked third and fourth, respectively. Wyoming ranks 48 with a score of 1.00, implying that it is the farthest from the maximum for both variables (trade exposure and production exposure).

The appeal of the industrial mix and/or geographic proximity of the high-ranking states in exports provide some explanations, as does Smith (1989, 1990). The top four among the 20 major industrial sectors to Canada in 1991 are transport equipment ($20.21 billion), machinery ($11.76 billion), electric and electronic equipment ($8.94 billion), and chemicals ($5.40 billion). For exports to Mexico, the four largest export sectors are electric and electronic equipment, transport equipment, machinery, and chemicals with totals of $5.30 billion, $4.25 billion, $4.04 billion, and $2.17 billion, echoing the key export industries

Table 1. States' index of exports to Canada and Mexico

State	Canada		Mexico	
	Index	Rank	Index	Rank
Alabama	0.7854	35	0.8438	15
Arizona	0.9102	43	0.4409	2
Arkansas	0.6270	17	0.7746	7
California	0.9084	42	0.6649	4
Colorado	0.7971	40	0.8791	27
Connecticut	0.6417	18	0.8326	14
Delaware	0.1850	4	0.7588	5
Florida	0.9755	46	0.8689	21
Georgia	0.7809	34	0.8555	18
Idaho	0.7858	36	0.8982	33
Illinois	0.5625	10	0.7969	9
Indiana	0.4258	8	0.8736	24
Iowa	0.6949	23	0.8708	23
Kansas	0.7936	38	0.7974	10
Kentucky	0.6060	14	0.8080	11
Louisiana	0.9774	47	0.8736	24
Maine	0.5671	11	0.9702	47
Maryland	0.7908	37	0.9530	45
Massachusetts	0.6265	16	0.9228	38
Michigan	0.0000	1	0.7713	6
Minnesota	0.7129	24	0.8963	32
Mississippi	0.7944	39	0.6617	3
Missouri	0.2793	5	0.8541	17
Montana	0.5075	9	0.9479	44
Nebraska	0.7510	29	0.8852	28
Nevada	0.7628	31	0.8936	31
New Hampshire	0.5804	12	0.8903	30
New Jersey	0.7466	27	0.8741	26
New Mexico	0.9800	48	0.8503	16
New York	0.6938	22	0.9005	34
North Carolina	0.7791	32	0.8880	29
North Dakota	0.0617	3	0.9475	43
Ohio	0.3059	6	0.9033	35
Oklahoma	0.6659	21	0.8610	19
Oregon	0.7625	30	0.9600	46
Pennsylvania	0.6541	19	0.8099	12
Rhode Island	0.7209	25	0.8661	20
South Carolina	0.7808	33	0.9316	41
South Dakota	0.6252	15	0.7946	8
Tennessee	0.6559	20	0.8113	13
Texas	0.9710	45	0.0000	1
Utah	0.7490	28	0.9275	39
Vermont	0.0090	2	0.9289	40
Virginia	0.9194	44	0.9447	42
Washington	0.8727	41	0.9135	37
West Virginia	0.7382	26	0.9089	36
Wisconsin	0.5862	13	0.8694	22
Wyoming	0.4054	7	1.0000	48

Source: Hayward and Erikson (1995). Computations by equation (2) to Canada. In both cases, either the industrial mix or the geographic proximity plays an important role for the high or low rankings observed.

Table 2 displays the import indexes from Canada and Mexico by states arranged in alphabetical order. Alabama is ranked 12 for imports from Canada and 21.5 for imports from Mexico. Illinois has an identical score as Alabama for Mexican imports and is ranked similarly, 21.5. Washington, with a score of 0.1008, is ranked first for imports from Canada while Vermont ranks first for imports from Mexico. Rhode Island ranks last for imports from Canada while Wyoming ranks last for imports from Mexico. The ranking may be attributed, as Hayward (1995, p. 50) explains, to "sectoral variations filtered through the regions' industrial mix."

At this juncture, we relate our results of the exports and imports indexes to those of Hayward and Erickson. Because the shift-share methodology they employ reflects changes (growth) in exports and imports at the state level while the indexes correspondingly reflect their levels, we would like to determine whether a state placing high on the index for exports and imports also exhibits high growth performance. Of course, the directions of the two need not coincide. For example, as pointed out by Smith (1990), the Great Lakes region predominates in exports to Canada while the West and Mid-Atlantic regions account for a much larger share of the growth.

To test for mutual relationships, the rank correlation is obtained between the exports and imports indexes to Canada and Mexico (Tables 1 and 2) and total Canadian and Mexican export and import shifts (Hayward and Erickson, Table 7, pp. 25-26). Here, the shift-share results are ranked and are used opposite the ranks provided in Tables 1 and 2 using the Spearman rank correlation (Conover 1980) estimated by

$$r_s = 1 - \frac{6\Sigma d_i^2}{n(n^2 - 1)}$$

where:

d_i = The difference between the two ranks for the ith state; and

n = 48, the number of states.

According to Hawkins and Weber (1980), the rank correlation r_s is asymptotically normal for large samples, and the normal approximation

$$Z = \frac{r_s\sqrt{n-1}}{\sqrt{1-r_s^2}}$$

is therefore appropriate for testing the significance of r_s.

The results of r_s between the ranks of the indexes and the ranks of the shift-share are as follows:

Table 2. States' index of imports from Canada and Mexico

State	Canada		Mexico	
	Index	Rank	Index	Rank
Alabama	0.5501	12	0.5227	21.5
Arizona	0.5719	15	0.2205	2
Arkansas	0.5932	20	0.5496	24
California	0.6553	26	0.4587	8
Colorado	0.9403	47	0.5968	29
Connecticut	0.5298	10	0.4957	15
Delaware	0.2362	4	0.6515	39
Florida	0.7291	33	0.4309	5
Georgia	0.5909	19	0.6052	31
Idaho	0.6306	23	0.6506	37.5
Illinois	0.7121	31	0.5227	21.5
Indiana	0.5071	9	0.3484	3.5
Iowa	0.8262	40	0.6506	37.5
Kansas	0.5885	17	0.7247	45
Kentucky	0.5303	11	0.4494	7
Louisiana	0.5984	21	0.8804	47
Maine	0.3991	7	0.6893	41
Maryland	0.6429	25	0.5134	19
Massachusetts	0.8381	41	0.4318	6
Michigan	0.1571	2	0.5143	20
Minnesota	0.7353	34	0.6330	34
Mississippi	0.5733	16	0.4764	11
Missouri	0.3371	6	0.4957	15
Montana	0.2343	3	0.8064	46
Nebraska	0.8693	44	0.6043	30
Nevada	0.8759	45	0.5959	28
New Hampshire	0.7727	38	0.5875	27
New Jersey	0.7987	39	0.6237	32.5
New Mexico	0.7035	29	0.3484	3.5
New York	0.8555	43	0.4772	12
North Carolina	0.8371	42	0.5867	26
North Dakota	0.7102	30	0.7062	43.5
Ohio	0.4147	8	0.4680	9.5
Oklahoma	0.5667	14	0.4957	15
Oregon	0.3285	5	0.6414	35.5
Pennsylvania	0.6946	27	0.5042	17
Rhode Island	0.9531	48	0.5336	23
South Carolina	0.7428	35	0.7062	43.5
South Dakota	0.9223	46	0.6969	42
Tennessee	0.7017	28	0.4865	13
Texas	0.7220	32	0.6599	40
Utah	0.5516	13	0.4680	9.5
Vermont	0.7552	37	0.0000	1
Virginia	0.6415	24	0.6414	35.5
Washington	0.1008	1	0.5690	25
West Virginia	0.6302	22	0.5126	18
Wisconsin	0.5904	18	0.6237	32.5
Wyoming	0.7547	36	1.0000	48

Source: Hayward and Erikson (1995). Computations by equation (2)

Exports Index and Total Export Shifts

Canada: $r_s = -0.4006$, $Z = -2.80$

Mexico: $r_s = -0.5804$, $Z = -4.06$

Imports Index and Total Import Shifts

Canada: $r_s = 0.1248$, $Z = 0.85$

Mexico: $r_s = -0.3868$, $Z = -2.71$

On comparing the |Z| values with the 5 percent level of significance, where $|Z| > 1.96$, all the rank correlations are statistically significant with the exception of Canada's imports.

With the exception of imports from Canada, where the correlation coefficient is not statistically significant, there is an inverse correspondence between the potentials of states' trade and the growth of such trade, reinforcing Smith's (1990) observation that the potential of trade needs not coincide with the growth of trade. The results indicate that many states that are placed low in the flow of trade as depicted by the indexes are placed high in the growth of trade as depicted by the shifts in shift-share or vice versa. A plausible explanation for the imports from Canada's aberration (nonstatistical significance) is that the growth in imports is less localized than imports from Mexico.

The inverse relationships between the potential of trade and its growth at the state level as depicted by the negative rank correlations above are important when pondering the questions of convergence of states' trade. For convergence to occur, the growth rates of states lagging in their orientation to trade must be higher than the growth rates of the states in a better orientation position. If the trends continue into the future, there is the possibility of a catch-up by some of the lagging states.

5. Comparisons by regions

Table 3 provides summary information by region for exports and imports trade exposure, production exposure, and the composite indexes of trade for Canada and Mexico as transformed by equations (1) and (2). The mean and the standard deviation of each are shown. The table indicates that both the means and the standard deviations differ among regions, more so for exports than for imports. For this reason, analysis of variance, which tests for significant variation among regions, is performed for exports and imports along with their corresponding indexes for both Canada and Mexico.

The results are shown in Table 4. For exports to Canada and Mexico, the F-values are highly significant for trade exposure, production exposure, and the index, with P-values ranging between 0.003 and 0.014. This indicates that a null hypothesis of no significant regional variation of both variables as well as the index is rejected, implying that regions on average differ substantially in their

Table 3. Canada and Mexico exports and imports, 1991 (transformed data and index)

		Trade Exposure (%)		Production Exposure (%)		Index	
	n	X	S	X	S	X	S
Panel A: Canada							
Exports							
New England	6	.564	.289	.485	.240	.524	.258
Mideast	5	.570	.261	.658	.233	.614	.245
Great Lakes	5	.363	.221	.389	.262	.376	.239
Plains	7	.504	.281	.616	.277	.560	.278
Southeast	12	.758	.133	.812	.117	.785	.123
Southwest	4	.868	.177	.896	.120	.882	.147
Rocky Mountain	5	.520	.404	.778	.071	.649	.180
Far West	4	.862	.124	.791	.074	.827	.075
Imports							
New England	6	.770	.162	.646	.255	.708	.205
Mideast	5	.629	.232	.663	.258	.646	.244
Great Lakes	5	.515	.137	.438	.282	.476	.209
Plains	7	.671	.135	.755	.266	.713	.199
Southeast	12	.602	.104	.685	.104	.643	.092
Southwest	4	.657	.049	.625	.133	.641	.083
Rocky Mountain	5	.520	.337	.725	.220	.622	.262
Far West	4	.473	.325	.508	.379	.490	.343
Panel B: Mexico							
Exports							
New England	6	.912	.037	.892	.064	.902	.049
Mideast	5	.837	.089	.879	.065	.859	.076
Great Lakes	5	.830	.062	.856	.050	.843	.056
Plains	7	.840	.068	.887	.041	.864	.055
Southeast	12	.835	.084	.861	.073	.848	.077
Southwest	4	.553	.402	.523	.418	.538	.409
Rocky Mountain	5	.931	.045	.930	.059	.931	.047
Far West	4	.879	.125	.837	.145	.858	.133
Imports							
New England	6	.534	.288	.379	.203	.456	.240
Mideast	5	.544	.089	.564	.076	.554	.278
Great Lakes	5	.500	.107	.491	.104	.496	.100
Plains	7	.614	.086	.675	.103	.645	.078
Southeast	12	.528	.133	.614	.135	.571	.127
Southwest	4	.431	.160	.432	.227	.431	.190
Rocky Mountain	5	.682	.197	.727	.232	.704	.205
Far West	4	.542	.055	.591	.117	.566	.078

Source: Hayward and Erikson (1995). Note: Trade exposure and production exposure are the component values of the index by equation (1), while the index is computed by equation (2). X and S are the respective regional means and the standard deviations. n the number of states in a region as classified by the Bureau of Economic Analysis as follows: New England (ME, NH, VT, MA, CT, RI), Mideast (NY, PA, NJ, DE, MD), Great Lakes (OH, MI, IN, WI, IL), Plains (MN, IA, MO, ND, SD, NE, KS), Southeast (VA, WV, NC, SC, GA, FL, KY, TN, AL, MS, AR, LA), Southwest (OK, TX, AZ, NM), Rocky Mountain (CO, WY, MT, ID, UT), Far West (NV, CA, OR, WA) exports. Some regions are considerably more active in exports to Canada and Mexico than are others.

On calculating the 95 percent confidence intervals, it is possible to separate the regions for significant differences in their means in Table 3. Ordering the means from smallest to largest (remembering that the smaller values correspond to larger roles in regional exports) shows that the regions with the least export activity to Canada are the Southeast, the Southwest, and the Far West. The regions with the most export activities are the Great Lakes, New England, the Plains, and the Mideast. These findings coincide with the findings of Smith (1989). For exports to Mexico, it is evident that the Southwest region occupies a unique position among the eight regions. The least significant regions are consistently New England and the Rocky Mountain, again substantiating Smith's (1989) findings.

Table 4 shows that the only significant difference among the regions for imports is Mexico for both the production exposure (p-value = .007) and the index (p-value = 0.073), indicating that at least one region differs significantly from the others in import activities. Table 3 shows that the qualified regions are the Southwest and the Southeast. The nonsignificance of differences in regional means for imports, especially from Canada, indicates the absence of regional bias. In other words, the regional orientations toward imports from Canada are on average of comparable magnitude. Sectoral variation seems to be filtered equally through regional industrial mix.

6. Concluding remarks

An important area of research is the differential impact of exports on the individual states, attributed by Smith (1989, 1990) to the regional industrial mix and the destination of the exports. The destination may entail a regional bias because of geographic proximity of a region to final destination of exports. In particular, NAFTA, a free trade agreement for promoting freedom of movement for goods, services, and investment among the United States, Canada, and Mexico, will create opportunities for localized areas.

This paper implements the work of Hayward and Erickson (1995) concerning the growth patterns of trade between the United States, Canada, and Mexico. The results of constructing indexes for trade orientation reveal that, on a regional basis, the Great Lakes, Plains, Rocky Mountain, and New England regions are biased in their trade relationships toward Canada, while the Southwest region is biased toward trade with Mexico. The findings of inverse relationships between orientation of trade and its growth with Canada and Mexico at the state level signal larger future potential of trade by some of the states with current low participation.

Table 4. Analysis of variance for Canada and Mexico by region for exports and imports, 1991 (transformed data and index)

Exports	F	P-value
Trade exposure		
Canada	2.95	0.014
Mexico	3.33	0.007
Production exposure		
Canada	4.56	0.001
Mexico	3.86	0.003
Index		
Canada	3.78	0.003
Mexico	3.60	0.004
Imports	**F**	**P-value**
Trade exposure		
Canada	1.41	0.230
Mexico	1.13	0.362
Production exposure		
Canada	1.15	0.353
Mexico	3.34	0.007
Index		
Canada	1.01	0.436
Mexico	2.04	0.073

Source: Hayward and Erikson (1995). Trade exposure and production exposure are from equation (1) and the index is from equation (2)

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