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TRADE AND THE INDUSTRIAL SPECIALIZATION OF CANADIAN MANUFACTURING REGIONS, 1974 TO 1999

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Using a longitudinal micro data file of manufacturing plants (1974 to 1999), this study tests the relationship between trade and industrial specialization experienced by regional manufacturing economies. Consistent with trade driven by comparative advantage, the analysis demonstrates that export intensity (exports as a share of output) is positively associated with industrial specialization. This association is strongest in cross-section but remains, albeit weaker, when the data are differenced throughout time. The association between trade and specialization is strongest outside of urban areas and Ontario and Quebec, regions where trade is most likely driven by access to resource endowments. The association between trade and specialization weakens significantly after 1990, a period that corresponds with the rapid integration of the Canadian economy into the U.S. market resulting from trade liberalization.

Keywords: *international trade; comparative advantage; regional industrial specialization; manufacturing*

1. INTRODUCTION

Throughout the past three decades, the Canadian economy has become increasingly integrated into world markets. This is the result of successive rounds of tariff cuts under the General Agreement on Tariffs and Trade (GATT), and the implementation of the Canada-U.S. Free Trade Agreement (FTA) and its successor, the North American Free Trade Agreement (NAFTA). With this growing integration, questions are inevitably raised regarding how it has affected the Canadian economy.

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Focusing on the impacts of the FTA and NAFTA, most studies have emphasized the national impact of trade liberalization.[1] This belies the fact that Canada is composed of a distinct set of regional economies, whose ties to North American and global markets are often quantitatively and qualitatively different. The purpose of this article is to begin to fill the gap in our knowledge of how trade liberalization affects regional economies.

The effect of trade on regional economies can be measured across many dimensions. This article focuses on how trade has influenced the level of and change in industrial specialization experienced by regional manufacturing economies. A companion paper asks how trade has differentially affected how production is organized within plants across regions (see Baldwin and Brown 2007).

There is, of course, a close theoretical link between trade liberalization and industrial specialization at the national scale. Trade liberalization should increase the size of those industries that have a comparative advantage in world markets and decrease the size of those that have a comparative disadvantage. In short, increased trade should lead to greater industrial specialization.

Industrial specialization creates both benefits and risks. On one hand, trade driven by comparative advantage should result in a more efficient allocation of resources across industries, increasing productivity. On the other hand, greater specialization increases the risk of a significant downturn in the local economy with the loss of one or two key industries.[2]

Theory regarding the effects of trade liberalization on industrial specialization at the regional scale is less well developed than at the national scale, but it is still instructive. Transposing expectations regarding the effect of trade liberalization from the national to the regional scale, one would expect those regions that specialized in industries with a comparative advantage in world markets to become even more specialized. Given that most Canadian regions, be they large or small, export part of their manufactured output, high levels of trade would be expected to be associated with higher levels of industrial specialization.

Trade liberalization can also affect industrial specialization indirectly. Fujita, Krugman, and Venables (1999) argued that falling trade barriers diminish centripetal forces—driven by access to consumers and intermediate inputs—that underlie the concentration of population and industries in large and industrially diversified regions. The resulting dispersion of industry may lead to increased industrial specialization.

The economic forces unleashed by trade liberalization that push regions toward greater industrial specialization can be lessened if trade is driven not by specialization across industries but by specialization across individual products. A significant proportion of Canada's trade with its NAFTA partners is in varieties of goods produced by the same industries (see Brülhart and Thorpe 2001). This intra-industry form of trade is consistent with specialization in particular varieties of goods (e.g., different types of auto parts) but not with industry-level specialization.[3] The greater the intra-industry share of a region's trade, the lower the effect higher

levels of trade will have on its level of industrial specialization. Because the intra-industry share of Canada's trade rose through the 1980s, the effect of trade on specialization is expected to decline throughout time.

As the importance of intra-industry trade may vary throughout time, it may also vary across regions. There is strong empirical evidence that the degree of intra-industry trade with the United States varies considerably from province to province. Intra-industry trade is highest in Ontario and Quebec, and lowest in the Atlantic and Western provinces (Brown and Anderson 1999). Therefore, higher levels of trade are expected to be more strongly associated with industrial specialization in the Atlantic Provinces and Western Canada than in Ontario and Quebec.

The article's broad objective is to explore empirically the relationship between trade and specialization. To do so, it approaches the analysis in two ways. The first is to ask whether regions that export a larger share of their manufacturing output are more industrially specialized than regions that export a smaller share. If the degree of specialization observed is the result of long-term historical processes, then the first approach serves to test the relationship between trade and long-run levels of specialization.

The second approach to the analysis is to ask whether regions that increased their export intensity experienced an increase in their level of industrial specialization. It serves to test whether the growing integration of Canada's manufacturing sector into the world markets is associated with rising levels of industrial specialization, especially during the free trade era of the 1990s. It also serves as a more rigorous test of the association between trade and specialization than in the cross-sectional analysis, which may be biased due to unobserved fixed effects.

The remainder of the article is organized as follows. In section 2, the data source and econometric strategy are described. Section 3 provides a description of trends in export intensity and industrial specialization across Canadian regions. Section 4 uses a multivariate analysis to examine the cross-sectional relationship between export intensity and industry specialization. Section 5 analyzes the effect of changes in export intensity on specialization. Section 6 concludes.

2. DATA AND ECONOMETRIC STRATEGY

The data used for this project are derived from a longitudinal data file that covers the universe of manufacturing plants in Canada from 1973 to 1999. The longitudinal data file is built from both administrative and survey sources, with the primary sources being the Annual Census of Manufactures in earlier years and the Annual Survey of Manufactures (ASM; Statistics Canada various years) in later years. The survey data are derived from the more detailed long-form questionnaires that are primarily sent to larger plants and the less detailed short-form questionnaires that are mainly sent to smaller plants.

It is only long-form questionnaires that provide information on plant exports. As a result, data set is restricted to plants that respond to it (i.e., long-form plants). In 1999, long-form plants accounted for 82 percent of plant-based employment and 93 percent of manufacturing shipments.[4] Therefore, there is little loss of generality by focusing the analysis only on long-form plants. Long-form plants were asked to report their exports in a selection of years: 1974, 1979, 1984, 1990, 1993, and 1996 to 1999.

The objective of the article is to examine the links between trade and industrial specialization at the regional scale. Census divisions form the fundamental geographic unit of analysis in this article. These are geographic units that correspond in most provinces to counties or regional municipalities. To ensure that changes in the boundaries of census divisions throughout time do not influence my results, a constant 1976 census-division geography is used.[5] Using this geography, there are approximately 250 census divisions. I limit my set of census divisions to those that had manufacturing employment throughout the study period, which results in a balanced panel of 210 census divisions.

In the analysis, census divisions are classified across two dimensions, with respect to the region in which they belong—Atlantic Canada (Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and New Brunswick), Quebec, Ontario, and Western Canada (Manitoba, Saskatchewan, Alberta, and British Columbia)—and whether they are rural or urban. Urban census divisions are those that fall partially or fully within the boundaries of a metropolitan area[6] that has a population of 50,000 or more persons.[7] All other census divisions are classified as rural.

The *export intensity* of a census division is defined as the proportion of the value of its total shipments that are exported abroad. Census divisions that have higher export intensities are those with greater integration into world markets. In other research, the height of tariff barriers and their decline throughout time have been used to measure the extent to which an industry was exposed to decreases in trade barriers throughout time (see Baldwin and Gu 2006). Here, export intensity is used to provide a more comprehensive measure of trade exposure—because the purpose of this article is to expand our understanding of how integration into world markets is related to the industrial characteristics of regions.

Throughout, the analysis investigates the effect of export intensity on industrial specialization. *Industrial specialization* is defined as the degree to which a region relies on a small number of industries. It is measured using a Herfindahl index:

$$IS_j = \sum_{i=1}^{n} s_{ij}^2, \tag{1}$$

where s_{ij} is the share of employment in region j accounted for by industry i. A higher value of the Herfindahl index indicates that the region specializes in fewer industries. The index obtains a maximum value of 1 when employment is

concentrated in one industry and a minimum value of $1/n$ when employment is evenly distributed across all n industries, where n is taken to be the total number of four-digit Standard Industrial Classification (SIC) 1980 industries. There are a total of 236 manufacturing industries at the four-digit level.[8]

The data used for this analysis are derived from a panel of census divisions covering selected years. Panel data present a challenge because they combine both cross-sectional and time series effects, whose influence on the dependent variable may not be the same. To capture cross-sectional variation, the following model is estimated using the *between* estimator,

$$\overline{IS}_j = \alpha + \bar{\mathbf{x}}_j\boldsymbol{\beta} + \nu_j + \varepsilon_j, \tag{2}$$

where x_j and β are vectors of variables and parameters, respectively; ν_j is an unobserved census division–specific fixed effect; and ε_j is an error term. A bar over a variable indicates it has been averaged across time. By averaging each variable across time, any time series variation is eliminated from the analysis while capturing the average long-run characteristics of census divisions.

To capture variation in the dependent and independent variables through time, the variables are first-differenced:

$$IS_{jt} - IS_{jt-\tau} = \alpha_t - \alpha_{t-\tau} + (\mathbf{x}_{jt} - \mathbf{x}_{jt-\tau})\boldsymbol{\beta} + \varepsilon_{jt} - \varepsilon_{jt-\tau}, \tag{3}$$

where t indexes time and τ is the length of time between the beginning and end points. The first-differencing framework allows one to estimate the effect of change alone. Note that first differencing also eliminates any bias potentially introduced by the fixed effect ν_j present in equation 2.

3. DATA DESCRIPTION

As noted above, integration into world markets can result in higher levels of industrial specialization experienced by regional economies. A descriptive analysis of the trends in export intensity and specialization across Canadian regions is presented here that will serve as a point of departure for the multivariate statistical analysis developed in sections 4 and 5.

Before delving into the analysis of trends in the data, see table 1, which presents simple descriptive statistics for the specialization index and export intensity. These statistics are calculated for each census division using the mean level of the variables during the study period. Across census divisions, the mean level of export intensity is 0.36, or 36 percent, of total output exported abroad, whereas the median export intensity is 0.30, which suggests a slight positive skew to the distribution. This positive skew also applies to the specialization index, with a mean of 0.25 and a median of 0.18.

TABLE 1. Descriptive Statistics

Variable	*Mean*	*Standard Deviation*	*Median*	*Minimum*	*Maximum*	*Observations*
Specialization index	0.25	0.20	0.18	0.01	0.97	210
Export intensity	0.36	0.20	0.30	0.05	0.80	210

Source: Statistics Canada, Annual Survey of Manufactures (Ottawa: Statistics Canada, various years), special tabulation.

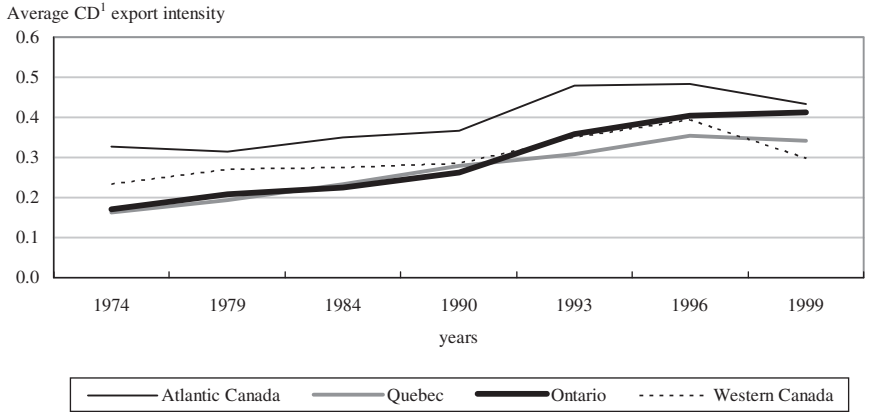

FIGURE 1. Average Export Intensity across Census Divisions, by Region, 1974 to 1999
1. Census division.
Source: Statistics Canada, Annual Survey of Manufactures (Ottawa: Statistics Canada, various years), special tabulation.

During the past quarter century, Canadian manufacturing plants have become increasingly integrated into world markets. The export intensity (exports divided by sales) of the manufacturing sector as a whole more than doubled during a twenty-five-year period—increasing from 0.18 in 1974 to 0.43 in 1999.[9]

Across regions, the average export intensity of census divisions followed this broad pattern, but with some regional differences. Census divisions in Atlantic Canada and Western Canada started the period with average export intensities that were higher than those of census divisions in Ontario and Quebec (see figure 1). Throughout time, however, the export intensity of census divisions in Ontario and Quebec increased at a faster pace than those in Atlantic Canada or Western Canada. The overall picture that emerges is of a manufacturing sector that has become increasingly integrated into world markets, especially Canada's industrial heartland of Ontario and Quebec.

It is noteworthy that Western Canada's export intensity declined significantly between 1996 and 1999. This was likely due to the Asian financial crisis in

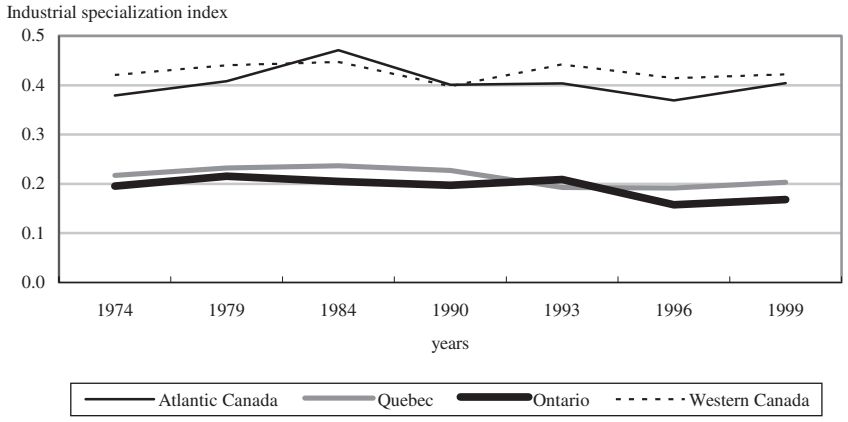

FIGURE 2. Average Census Division Industrial Specialization Index, by Region, 1974 to 1999
Source: Statistics Canada, Annual Survey of Manufactures (Ottawa: Statistics Canada, various years), special tabulation.

1997, which led to declining demand for Western Canada's resource-based exports.

Figure 2 presents the industrial specialization index averaged across the census divisions for the same four regions presented in figure 1. During the study period, the manufacturing economies of census divisions in Atlantic Canada and Western Canada were about twice as specialized as those in Ontario and Quebec. The figure also illustrates that although there was some variability in the degree of specialization found in Atlantic Canada and Western Canada throughout time, there was no apparent upward or downward trend in their levels. In contrast, a general but weak decline in the degree of specialization (i.e., an increase in diversification) of census divisions in both Quebec and Ontario is observed, with both having lower levels of industrial specialization at the end of the period than at the beginning.

Taken as a whole, there are two curious aspects of figures 1 and 2. First, the positive association between export intensity and specialization apparent at the beginning of the study period disappeared by the end. In 1974, those regions whose census divisions were, on average, the most export intensive were also the most industrially specialized. Yet, by 1999 this pattern no longer held—Ontario was the second most export intensive but the least specialized, whereas Western Canada was the least export intensive but the most specialized. Second, even though the export intensity of census divisions across all regions increased during the study period, there was no discernable increase in specialization. As noted above, for some regions the average specialization of their census divisions actually fell.

It might be tempting to stop here and conclude that there is no relationship between trade and industrial specialization, either across regions or throughout time. But, as the more detailed multivariate analysis that follows will show, there is a relationship between trade and specialization, although the apparent strength of this relationship depends on the period and the econometric strategy used.

4. CROSS-SECTIONAL ANALYSIS

Trade in all of its forms is driven by the benefits of specialization. Specialization can occur at the level of industries, and it can also occur at the level of plants and firms. Industry-level specialization is often associated with comparative advantage driven by differences in factor endowments (land, labor, and capital) across countries,[10] whereas plant-level specialization is often attributed to the exploitation of scale economies.[11] Increases in trade do not necessarily lead to increases in industrial specialization.

As was noted in the introduction, the pattern of trade between Canadian and U.S. regions suggests there may be considerable variation in the type of specialization across regions. Intra-industry trade—which is consistent with specialization at the plant level—is more prevalent in some regions than others. Upward of 30 to 40 percent of Ontario and Quebec's trade with U.S. regions is of the intra-industry type, whereas typically less than 15 percent of trade between Atlantic Canada, Manitoba-Saskatchewan, and Alberta–British Columbia and U.S. regions is intra-industry trade (Brown and Anderson 1999). Hence, a larger share of Ontario and Quebec's trade, compared with that of Atlantic and Western Canada, is consistent with plant-level specialization (rather than industry-level specialization).

Krugman's (1991a, 1991b) core-periphery model can help to explain why we observe variation in the kind of specialization experienced by regions. Krugman's model is driven by two centripetal forces and one centrifugal force. The centripetal forces relate to the savings on transportation costs that consumers and firms gain from locating in the core. The centrifugal force relates to the higher costs of servicing peripheral markets from the core. In this model, as transportation costs fall, industries whose firms experience economies of scale and that do not rely on a factor of production that is fixed in space will tend to concentrate in the core. In effect, Krugman identified a "sorting" mechanism whereby industries that rely on increasing returns to scale become geographically concentrated in the core, whereas industries that rely on factor advantages that are fixed in space locate in the periphery.

Although Krugman's core-periphery model is highly stylized, it is a useful starting point to explain Canada's economic geography and the pattern of trade-induced specialization it implies. As the Canadian economy industrialized and transportation costs fell, the manufacturing sector increasingly concentrated in cities, in particular the cities of Central Canada (Ontario and Quebec). Industries that relied on being close to their raw material inputs remained in rural regions,

whereas industries oriented toward consumer markets migrated to or developed in the cities.

The pattern of location implied by the Krugman model suggests that trade liberalization would have been expected to affect Canadian regional economies in different ways. That is, falling barriers to trade would have facilitated increases in trade in products that relied on resource endowments in the peripheral regions, possibly resulting in greater specialization. It would also have permitted the attainment of greater scale economies in Central Canada. The latter may not have led to as much industrial specialization as for peripheral regions.

The industries that concentrated in Central Canada may have been amenable to the exploitation of scale economies that resulted from specialization in the production of particular varieties of goods. For instance, as a result of the Canada–United States Automotive Agreement of 1965 (also known as the Auto Pact), Canadian car plants reduced the number of models built in their plants. Trade increased as different varieties of cars crossed the border (intra-industry trade), and there was no concomitant increase in the level of industrial specialization. The fact that we observe higher levels of intra-industry trade for Ontario and Quebec is consistent with this explanation. This is not, however, the only explanation for why we might see less specialization in Central Canada resulting from increased trade.

Central Canada was a region whose factor endowment might have led some industries to decline after trade liberalization. But it also possessed industries whose cost disadvantage in world markets was driven by the inability to exploit economies of scale. It is important to keep in mind that although Canada, and especially Central Canada, developed in a similar way to the United States, its industries did not obtain the scale that was obtained in the United States. Canadian plants during much of the postwar period were smaller than in the United States with shorter production-run lengths (Daly, Keys, and Spence 1968; Spence 1977; Caves et al. 1980). Increased integration with world markets was predicted to reduce this disadvantage. If the capability to take advantage of scale economies were inversely correlated with factor endowment disadvantages across industries, these two forces would have operated in opposite directions. That is, if cost disadvantages owing to factor endowments were offset by cost economies resulting from increasing plant size, there may have been less of an effect of integration on industrial specialization.

4.1 Definition of Independent Variables

The primary objective of this article is to model the effect of variation in export intensity on the level of industrial specialization of regional economies, be they census divisions or larger regions that span provinces. To do so, the model incorporates other variables that will help to provide a more complete understanding of the factors that influence industrial specialization at the regional scale.

The descriptive analysis indicated that the level of industrial specialization of the average census division varied across provincial regions. To control for and measure these regional effects, regional binary variables are included in the model (Atlantic Canada, Quebec, and Western Canada), with Ontario excluded to avoid perfect multicollinearity.

The size of a local manufacturing economy is likely to influence its degree of specialization. This is because larger manufacturing economies generate demand for intermediate inputs across a wide variety of upstream industries, which results in greater industrial diversity (i.e., less specialization). Furthermore, the size of the local manufacturing economy reflects, in part, the size of the local market for finished products (Christaller [1933] 1966; Fujita, Krugman, and Venables 1999). As markets become larger, they are able to support a wider variety of locally manufactured products.

Included in the model are three variables that explicitly control for the size of the local economy. First, these include the level of manufacturing employment (*employment*). In addition to the level of manufacturing employment, size is controlled for by adding a binary variable for whether a census division is urban (*urban*), that is, it is associated with a census agglomeration or census metropolitan area of greater than 50,000 persons.[12] This variable is meant to capture the effect of local consumer demand on the industrial diversity of the census division. *Urban* is interacted with *employment* (Employment × Urban) to account for any nonlinear effect of employment on specialization that might be associated with the size of the local market as captured by the *urban* variable. Finally, included in the model is the *market potential* of each census division industry *i* in census division *j*, which is defined as

$$MP_{ij} = \sum_{k} Y_{ik} d_{jk}^{\beta} \exp^{\alpha CANUS} \tag{4}$$

where Y_{ik} is the final demand[13] for the output of (two-digit) industry *i* in region (census division or U.S. county) *j*, d_{jk} is the distance between regions *j* and *k*, and *CANUS* is a dummy variable for whether the region pair includes a U.S. county. The parameter estimates for β and α are derived from the industry-level gravity models estimated in Brown and Anderson (2002). To obtain the overall market potential for each census division, the market potential of industries is added together.

Included in the model are a set of variables that account for export intensity. The first variable measures the level of export intensity of census divisions (*export intensity*). The remaining variables are a set of interaction terms that allow the effect of export intensity on specialization to vary across rural and urban areas (Export Intensity × Urban) and regions (Export Intensity × Atlantic Canada, Export Intensity × Quebec, and Export Intensity × Western Canada). As outlined above, export intensity may have a differential effect on the level of industrial specialization of regions.

The effect of trade may be felt on plant structure in addition to inter-industry specialization (Baldwin and Gu 2006; Baldwin and Brown 2007). And the two may be related. Increases in plant size allow the exploitation of scale economies. In turn, these may enhance the move to greater industrial specialization, particularly in smaller manufacturing regions. To control for this, the average plant size of exporters (*exporter size*) is included in the model. This allows better isolation of the effect of trade on industry specialization driven by industry-based comparative advantage, rather than specialization driven by larger plant sizes resulting from scale economies.

Finally, several controls for industry are included in the model. Industry controls take the form of employment shares of five sectors—labor-intensive, natural resource–based, scale-based, product-differentiated, and science-based industries. Labor-intensive industries are those with low capital-labor ratios, low wages, and considerable import competition. Natural resource–based industries are those that have relatively low value added relative to their inputs—industries like food processing that depend on agricultural materials. Scale-based industries have large plants, high capital-labor ratios, and economies of scale. Product-differentiated industries have high ratios of advertising to sales, and they produce a larger number of products per plant. Science-based industries have a relatively large white-collar workforce, and focus on research and development.[14]

4.2 Model Results

The results of the between estimator models are presented in table 2. In the first model, only region binary variables are included. They confirm what we observed in the descriptive analysis. Census divisions in Atlantic Canada and Western Canada have higher levels of industrial specialization than Ontario, whereas census divisions in Quebec are not significantly different.

Of course, the variation that we observe in specialization across regions may be due to differences in the size of their local economies. Size is controlled for by including in the model measures of the level of manufacturing employment, whether the census division is urban or rural, and the market potential of each census division (see model 2). The coefficients on *employment* and *urban* are negative and statistically significant, whereas the coefficient on Employment × Urban is positive and significant. Because the sum of the coefficients on *employment* and Employment × Urban is effectively zero, the effect of higher levels of manufacturing employment in urban areas is negligible. The effect of *market potential* is negative and significant, which suggests that location relative to markets—be they in Canada or the United States—negatively influences the level of specialization experienced by a census division. Including the size-related variables in model 2 substantially reduces the effect of the regional differences in specialization (as measured by the regional binary variables). Atlantic Canada and Western Canada's coefficients are no longer significantly different from zero.

TABLE 2. Industrial Specialization Models, between Estimator

	Model 1		*Model 2*		*Model 3*		*Model 4*	
	Coefficient	p *Values*	*Coefficient*	p *Values*	*Coefficient*	p *Values*	*Coefficient*	p *Values*
Intercept	0.1526	< 0.001	0.4638	< 0.001	0.2301	< 0.001	0.2179	< 0.001
Atlantic Canada	0.2197	< 0.001	0.0565	0.161	0.0592	0.062	−0.1392	0.009
Quebec	0.0434	0.086	−0.0555	0.024	0.0073	0.683	0.0205	0.541
Western Canada	0.1653	< 0.001	−0.0074	0.839	0.0017	0.91	−0.1294	0.001
Urban			−0.1977	< 0.001	−0.1849	< 0.001	−0.0934	0.002
Employment			−0.0233	< 0.001	−0.029	< 0.001	−0.0273	< 0.001
Employment × Urban			0.0231	< 0.001	0.0287	< 0.001	0.0269	< 0.001
Market potential			−0.0175	< 0.001	−0.0115	0.001	−0.0077	0.015
Exporter size					0.0008	0.005	0.0011	0.001
Export intensity					0.4357	< 0.001	0.284	0.001
Export Intensity × Urban							−0.2215	0.002
Export Intensity × Atlantic Canada							0.4155	0.001
Export Intensity × Quebec							−0.0994	0.266
Export Intensity × Western Canada							0.3321	0.001
Resource-based share							0.1496	0.029
Labor-intensive share							−0.1366	0.072
Product-differentiated share							−0.0582	0.635
Science-based share							−0.0461	0.584
R^2	0.17		0.40		0.64		0.70	
F (Prob > F)	13.8	< 0.001	18.9	< 0.001	30.1	< 0.001	26.0	< 0.001
N	210		209		209		209	

Note: The dependent variable is *industry specialization* (IS). *P* values are derived from heteroscedasticity-consistent standard errors. The number of observations dropped by one from model 1 to 2 because one census division did not have a market potential estimate. Estimating model 1 without this observation resulted in no qualitative change in the estimates.

In total, model 2 confirms the expectation that the size of local economies—as measured by manufacturing employment, location in an urban area, and market potential—is negatively associated with the level of specialization. Moreover, it is market size that accounts for the variation in the relatively high level of specialization experienced by census divisions in Atlantic and Western Canada. Still to be determined is the effect of export intensity on specialization.

In model 3, export intensity is introduced. Also included is exporter plant size (*exporter size*) to account for the indirect effect of higher export levels on specialization through larger average plant sizes. There is a strong positive effect of export intensity on specialization, after controlling for exporter plant size, which also has a strong positive effect. Therefore, census divisions that are more export intensive are more industrially specialized, which is consistent with my theoretical expectations regarding the relationship between trade and specialization. Including these two variables had relatively little impact on the level of effects of the Atlantic Canada and Western Canada binary variables, but did move the coefficient on Quebec closer to Ontario's level of specialization.[15,16]

It was hypothesized above that the effect of export intensity on regional specialization may differ across regions and urban and rural areas if the underlying causes of trade also vary across them. Specifically, the effect of trade on specialization might be stronger in Atlantic and Western Canada, as well as in rural areas, because exports from these regions are more likely to be driven by comparative advantage related to their resource endowments. To test this expectation, in model 4, *export intensity* is interacted with regional and *urban* binary variables. Consistent with expectations, for urban census divisions the effect of higher levels of export intensity on specialization is significantly weaker than in rural census divisions. The model also indicates that the effect of higher levels of export intensity on census divisions is stronger in Atlantic Canada and Western Canada than in Ontario. For Quebec, there is no significant difference from Ontario. In short, the effect of trade on specialization was felt most in more resource-reliant rural areas and in Atlantic Canada and Western Canada. This is in contrast to urban areas and census divisions in Ontario and Quebec, whose trade is more likely to be driven by increasing returns to scale and, therefore, is less likely to result in greater industrial specialization.

Also included in model 4 are the sector shares, with scale-based industries excluded, to account for the effect of industry differences across census divisions. Areas with a larger proportion of resource industries tend to be the most specialized, as one would expect from the theory of comparative advantage.

It is noteworthy that because the variables used in the analysis were calculated across spatial units, parameter estimates and their standard errors may be biased because of spatial dependence in the data. Tests of spatial dependence of the errors for model 1 (using rook contiguity) indicated spatial dependence was an issue. The addition of export intensity to the model (model 3), however, eliminated any statistically significant spatial dependence across the errors. This would be consistent with high (and low) levels of export intensity stretching

across adjacent census divisions, possibly because resource inputs cross census division boundaries (e.g., access to fishing grounds) or because of shared proximity to international markets (e.g., census divisions that are close to the U.S. border). These high (low) levels of exports would, in turn, be associated with high (low) levels of specialization across adjacent census divisions, leading to spatially dependent errors when export intensity is not included in the model.[17] The remaining models presented in the article include export intensity, and their parameter estimates and standard errors are expected to be similarly unaffected by spatial dependence.

The estimates in table 2 provide a picture of the influence of the average of each of the independent variables during the entire study period on the average level of specialization experienced by each census division. It is unclear, however, whether these relationships have shifted during the study period. To test whether changes have occurred, the panel was divided into two periods (see table 3). The first covers the 1970s and 1980s (1974 to 1984), and the second the 1990s (1990 to 1999), roughly the pre– and post–free trade eras.

Model 1 includes controls and the effect of export intensity on specialization, and is estimated for both periods. Note, first, that there was relatively little variation in the coefficients or significance levels for the controls regardless of the period in question. The exception was exporter size. During the 1974-1984 period, it had no significant effect, but during the 1990s, it had a positive and statistically significant influence on specialization. This suggests that in the 1990s, exporters may have become larger and therein contributed to higher levels of specialization.

The effect of export intensity on specialization consistent with industry-based comparative advantage has weakened by the 1990s. In part, this shift may be tied to the growing importance of intra-industry trade between the 1980s and 1990s. The proportion of Canada's trade in manufactured products of the intra-industry variety was 0.61 in 1980, but 0.71 in 1990 and 0.72 in 1999 (Brülhart and Thorpe 2001). Hence, during the 1974-1984 period, intra-industry trade was lower than in the post-1990 period; and this may account for part of the declining effect of export intensity on regional specialization.

The weakened importance of the *export intensity* variable should not be interpreted as implying that the overall impact of trade on specialization has declined throughout time. Rather, the avenue by which trade influences specialization may have changed from specialization driven by industry-based comparative advantage to industry specialization resulting from larger plant sizes. When model 1 is estimated with exporter size excluded, the coefficient on *export intensity* remains unchanged throughout time.[18]

Model 2 expands on model 1 by including a set of regional interaction terms. Comparing the results across the two time periods, and focusing on the *export intensity* interaction terms, the primary change is the declining influence of export intensity on specialization in Ontario and Quebec and in urban areas. Note that the effect of each of the regional interaction terms is measured relative

TABLE 3. Industrial Specialization Models, between Estimator: 1974 to 1984 and 1990 to 1999

	1974 to 1984				*1990 to 1999*			
	Model 1		*Model 2*		*Model 1*		*Model 2*	
	Coefficient	p *Values*	*Coefficient*	p *Values*	*Coefficient*	p *Values*	*Coefficient*	p *Values*
Intercept	0.293	< 0.001	0.286	< 0.001	0.224	< 0.001	0.237	< 0.001
Atlantic Canada	0.039	0.308	−0.075	0.120	0.069	0.030	−0.128	0.026
Quebec	−0.015	0.524	0.005	0.872	−0.008	0.688	0.019	0.619
Western Canada	−0.025	0.453	−0.103	0.008	0.004	0.885	−0.136	0.003
Urban	−0.186	< 0.001	−0.135	< 0.001	−0.184	< 0.001	−0.089	0.008
Employment	−0.030	< 0.001	−0.029	< 0.001	−0.029	< 0.001	−0.026	< 0.001
Employment × Urban	0.030	< 0.001	0.029	< 0.001	0.028	< 0.001	0.026	< 0.001
Market potential	−0.011	0.007	−0.008	0.062	−0.012	< 0.001	−0.008	0.023
Exporter size	0.0004	0.425	0.0006	0.183	0.001	0.002	0.0012	< 0.001
Export intensity	0.494	< 0.001	0.364	< 0.001	0.368	< 0.001	0.198	0.023
Export Intensity × Urban			−0.174	0.045			−0.199	0.005
Export Intensity × Atlantic Canada			0.255	0.025			0.412	0.002
Export Intensity × Quebec			−0.083	0.41			−0.07	0.439
Export Intensity × Western Canada			0.236	0.018			0.357	0.002
Resource-based share			0.126	0.115			0.104	0.116
Labor-intensive share			−0.152	0.075			−0.153	0.036
Product-differentiated share			−0.091	0.450			−0.064	0.572
Science-based share			−0.007	0.95			−0.08	0.305
R^2	0.63		0.67		0.60		0.66	
F (Prob > F)	330	< 0.001	24.1	< 0.001	24.9	< 0.001	22.3	< 0.001
N	209		209		209		209	

Note: The dependent variable is *industry specialization* (IS). *P* values are derived from heteroscedasticity-consistent standard errors.

to the excluded category, which is rural Ontario. The effect of export intensity on rural areas in Ontario declines between the two periods, such that by the 1990-1999 period, it is only significant at the 12 percent level. The parameter estimates on the interaction terms for *urban* and Quebec remain constant, and hence their effect has declined between the two periods. In contrast, although the parameter estimates for Atlantic Canada and Western Canada increase, there is little change in their influence because the declining coefficient on *export intensity* effectively mitigates their increase.

5. First-difference Analysis

The identification of the effect of export intensity on specialization in the models presented to this point has relied on cross-sectional variation. This obviously provides information on how export intensity is associated with the level of specialization experienced by a region, but the cross-sectional analysis does not provide information on how changing levels of export intensity have influenced changes in specialization during the study period. Moreover, the cross-sectional estimates may be influenced by unobserved fixed effects whose influence is eliminated when the data are differenced.

Table 3 reports the results of a model that estimates the effect of a change in export intensity on the change in the level of specialization from 1974 to 1990 (panel A) and from 1990 to 1999 (panel B). The model corresponds to model 3 from table 2, except that variables that are invariant throughout time are by necessity dropped from the model. The model includes, in addition to export intensity, controls for changes in exporter size, total employment, and total employment interacted with a binary variable for whether the census division is urban.

Turning first to the controls, the effect of exporter size is insignificant in the first period but highly significant in the second, suggesting that the role of exporter size as a driver of specialization increased during the period. During the first period, there is a weakly significant negative relationship between increases in employment in rural areas and changes in specialization. This suggests that in this period, there was a tendency for rural regions to increase employment in sectors in which they were not specialized, resulting in less specialization. In the second period, however, we see a complete reversal in the relationship. During this time, rural areas appear to be increasing their employment in sectors in which they were already specialized. In urban areas in both periods, there is no significant influence of changes in manufacturing employment on their change in specialization.

Paralleling the cross-sectional results, there is a positive relationship between export intensity and specialization, and the effect of export intensity tends to fall throughout time (see tables 2 and 3). The coefficients on *export intensity* derived from the first-difference model are, however, much smaller than the coefficients derived from the cross-sectional model and are only weakly significant. This is

consistent with the descriptive analysis, in which there was no apparent relationship between increases in export intensity and specialization.

To explore the association between changes in export intensity and changes in specialization further, the sample was divided into those census divisions that experienced an increase in export intensity and those that experienced a decrease (see table 4). There are two reasons to divide the data in this manner. First, the period under study is one when barriers to trade consistently fell, and therefore there is particular interest in the response of census divisions increases in their integration into world markets. Second, it is unclear how to interpret the effect of a decline in export intensity on specialization because a falling level of export intensity may not necessarily lead to lower levels of specialization. Falling export intensity may result from the exhaustion of a resource endowment (e.g., a fish stock) that causes the loss of large parts of the local economy, leading to an increase in specialization. Alternatively, a rapid increase in domestic demand for the output of a region may lead to a decline in export intensity and an increase in specialization.

For those census divisions that experienced an increase in export intensity, the effect of export intensity on specialization is more positive than in the full sample of census divisions. In both periods, the coefficient on *export intensity* is about twice that of the full sample. Alternatively, for those census divisions with declining export intensity, the coefficient on *export intensity* tended to be negative, and for 1974-1990 it was marginally significant. When export intensity is decreasing, we observe a very different association between trade and specialization.

Although these results suggest that an increase in export intensity is associated with higher levels of industrial specialization, the core results remain. That is, there is a weaker association between trade and specialization in the first difference than in the cross-section. This weaker association may relate to unobserved fixed effects that bias upward the coefficient on *export intensity* when using the between estimator.[19] Alternatively, this result is also consistent with a world where comparative advantage is shifting from more to less important industries, as measured by employment, which would tend to undermine the effect of rising export intensity on specialization. There is some evidence that this has been occurring across Canada's manufacturing regions (see Brown 2007). Regardless, these results show that there is a positive association between trade and the industrial specialization of regional economies, but that this association has weakened significantly throughout time.

6. CONCLUSION

One of the most basic predictions of comparative advantage, whether it is driven by Ricardian technological differences or by differences in factor endowments, is that trade should lead to more industrially specialized economies. This brings the benefit of higher levels of productivity resulting from the more

TABLE 4. Industrial Specialization Models, First Difference Estimator

	Panel A: 1974 to 1990					
	Full Sample		Δ *Export Intensity* > *0*		Δ *Export Intensity* ≤ *0*	
	Coefficient	p *Values*	*Coefficient*	p *Values*	*Coefficient*	p *Values*
Constant	−0.014	0.265	−0.045	0.024	−0.076	0.058
Δ Exporter size	0.0004	0.412	−0.0002	0.717	0.0013	0.031
Δ Export intensity	0.179	0.078	0.382	0.011	−0.475	0.063
Δ Total employment	−0.011	0.115	−0.017	0.019	−0.037	0.418
Δ Total Employment × Urban	0.011	0.112	−0.017	0.018	0.087	0.107
R^2	0.06		0.15		0.14	
F (Prob > F)	1.24	0.294	1.79	0.133	3.07	0.026
N	210		162		48	
	Panel B: 1990 to 1999					
	Full Sample		Δ *Export Intensity* > *0*		Δ *Export Intensity* ≤ *0*	
	Coefficient	p *Values*	*Coefficient*	p *Values*	*Coefficient*	p *Values*
Constant	−0.032	< .001	−0.039	.012	−0.057	.007
Δ Exporter size	0.0006	< .001	0.0005	.051	0.0007	.026
Δ Export intensity	0.057	.163	0.139	.075	−0.070	.296
Δ Total employment	0.01	.043	0.009	.081	0.018	.534
Δ Total Employment × Urban	−0.01	.068	−0.008	.125	−0.015	.608
R^2	0.10		0.09		0.09	
F (Prob > F)	5.66	< .001	2.76	.030	2.59	.045
N	210		146		64	

Note: The dependent variable is the change in *industrial specialization* (IS) between periods. *P* values are derived from heteroscedasticity-consistent standard errors.

efficient allocation of resources across industries. But it may also result in economies that are more vulnerable to economic shocks.

This article tests the association between trade and specialization at the regional scale using a panel of geographic regions that allows for the estimation of the effect of variation across regions and across time. The analysis has demonstrated that higher levels of export intensity are positively associated with higher levels of industrial specialization. It also shows that these effects are strongest in regions outside of urban areas and Canada's industrial heartland of Ontario and Quebec. These are regions where trade is most likely to be driven by factor (resource) endowments rather than increasing returns to scale.

As the effects of trade vary across regions, they also vary across time. During the 1990s, the impact of trade on specialization was much weaker. This was also an era when Canada's trade was increasingly in the same types of goods flowing back and forth across the border, rather than in the products of different industries that would be consistent with specialization in particular industries.

Finally, the analysis shows that the association between trade and specialization so evident in the cross-sectional analysis is weaker when we begin to look at the effect of changes in export intensity on specialization. Nevertheless, the association persists.

This leaves at least two avenues for future study. The first is to explore in more depth why we observe such a larger difference between the cross-sectional and first-difference results. Are these differences completely attributable to unobserved fixed effects, or have the dynamics of the economy changed throughout time? Why has the influence of export intensity on industrial specialization declined throughout time? This may be due to the rising importance of intra-industry trade, but this apparent association requires more formal testing.

NOTES

1. See Schwanen (1997), Head and Ries (1999a, 1999b, 2001), McCallum (1999), Trefler (2004), and Baldwin and Gu (2006).

2. See Baldwin and Brown (2004) for an analysis of the link among trade, specialization, and the volatility of employment growth.

3. Theoretically, intra-industry trade is driven by plant-level economies of scale (Krugman 1980) and/or technological differences that vary from plant to plant (Davis 1995).

4. These data are derived from a special tabulation of the Annual Survey of Manufactures (Statistics Canada various years).

5. See Brown and Baldwin (2003) for another application of this constant geography, whose construction is described in Baldwin and Brown (2001, app. A).

6. I define *metropolitan areas* (Census Metropolitan Areas and Census Agglomerations) using the 1976 geographic boundaries provided by the census.

7. This is based on the 1976 population of these metropolitan areas.

8. Because industry output may be more sensitive to increases in export intensity if exporters are more productive than nonexporters, the Herfindahl index was also calculated using industry shares of output (sales). This alternative measure of specialization was highly correlated ($r = 0.9$), with the employment-based measure making it unlikely that additional insight would be gained by using this alternative metric.

9. These data are derived from a special tabulation of the Annual Survey of Manufactures (Statistics Canada various years).

10. Industry-based comparative advantage may also result from Ricardian technological differences and/or localization economies. The discussion focuses on factor-based comparative advantage because this is the most likely underlying cause of Canadian trade in natural resource–based products, which continue to account for a significant proportion of Canadian manufactured exports (e.g., paper products).

11. Plant-level specialization can also be attributed to (Hicks neutral) technological differences (Davis 1995).

12. This classification of census divisions is based on the Beale rural-urban classification system, which is described in detail in Baldwin and Brown (2001).

13. The final demand for each 1987 U.S. Standard Industrial Classification (SIC) two-digit manufacturing sector is estimated using the U.S. 1987 benchmark input-output accounts applied to both Canadian Census divisions and U.S. counties.

14. For a fuller description of these sectors, see Baldwin and Rafiquzzaman (1995).

15. A modified version of model 3 was also estimated with the regional binary variables (Atlantic Canada, Quebec, and Western Canada) excluded. This model—which now includes only the structural variables related to the size of local economies, exporter size, and export intensity—provided estimates for these variables that were not qualitatively different from model 3.

16. Model 3 was also estimated using quintile regressions to test the effect of export intensity on different parts of the distribution (the tenth, twenty-fifth, fiftieth, seventy-fifth, and ninetieth percentiles). The results are qualitatively similar to those presented in table 2, with point estimates generally increasing with the quintile but remaining largely within the 95 percent confidence interval of the point estimate provided by the between estimator. The results of these regressions are available from the author on request.

17. This is confirmed by the high degree of spatial dependence observed between the specialization index (dependent variable) and spatially adjacent values for export intensity.

18. For the 1974-1984 period, the coefficient on *export intensity* was 0.52 (robust standard error = 0.05, $t = 11.3$), whereas for the 1990-1999 period, the coefficient was 0.47 (robust standard error = 0.05, $t = 9.3$).

19. The difference between the cross-sectional and first-difference estimates may also be due to errors-in-variables bias that is exacerbated by the differencing of the data. Because, however, the data used here are based on means across a usually larger number of plants in each census division and the difference is across long periods of time (ten years), the effect of this form of bias should be relatively small.

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