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Impact of the 1992 Cod Moratorium on Educational Attainment in the Province of Newfoundland and Labrador, Canada

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Abstract

The 1992 cod moratorium led to the largest mass layoff in Canadian history, displacing approximately 30,000 individuals in Newfoundland and Labrador. This study investigates whether the fishing ban affected post-secondary education in the province and examines how economic shocks influence resource-dependent communities. Using Statistics Canada census data from 1981 to 2006, a difference-in-differences approach is applied to compare coastal subdivisions in Newfoundland with a synthetic control group composed of coastal subdivisions from New Brunswick, Prince Edward Island, and British Columbia. The findings indicate that, following the moratorium, the trade certificates rate increased in Newfoundland's fishing communities, whereas the rates of university and non-university diplomas declined. The moratorium did not have a significant effect on overall post-secondary education. However, these latter results should be interpreted with caution, as robustness checks using alternative control groups revealed certain limitations of the model. This research suggests that, in response to economic disruption in the fishing sector, affected residents shifted toward skill-based training as a means of transitioning to other industries.

Keywords: cod moratorium, Newfoundland and Labrador, public policy evaluation, difference-in-differences, R

Résumé

Le moratoire sur la pêche à la morue de 1992 a engendré le plus important licenciement collectif de l'histoire canadienne, déplaçant approximativement 30 000 individus à Terre-Neuve-et-Labrador. Cette étude examine si l'interdiction de pêche a influencé l'éducation postsecondaire dans la province et analyse la manière dont les chocs économiques affectent les communautés dépendantes des ressources naturelles. En utilisant les données de recensement de Statistique Canada de 1981 à 2006, une approche de doubles différences est appliquée pour comparer les subdivisions côtières de Terre-Neuve avec un groupe de contrôle synthétique composé de subdivisions côtières du Nouveau-Brunswick, de l'Île-du-Prince-Édouard et de la Colombie-Britannique. Les résultats indiquent qu'à la suite du moratoire, le taux de certificats de métiers a augmenté dans les communautés de pêcheurs de Terre-Neuve, tandis que les taux de diplômes universitaires et non universitaires ont diminué. Le moratoire n'a pas eu d'effet significatif sur l'éducation postsecondaire globale. Cependant, ces derniers résultats doivent être interprétés avec prudence, car les tests de robustesse utilisant des groupes de contrôle alternatifs ont révélé certaines limites du modèle. Cette recherche suggère qu'en réponse à la perturbation économique du secteur de la pêche, les résidents affectés se sont orientés vers la formation axée sur les compétences comme moyen de transition vers d'autres industries.

Mots-clés : moratoire sur la pêche à la morue, Terre-Neuve-et-Labrador, évaluation de poltiques publiques, doubles différences, R

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Introduction

For more than 500 years, fishermen exploited northern cod on the coasts of Newfoundland and Labrador, Canada's easternmost province. The abundance of northern cod contributed to the economic development of the region, as 250,000 tonnes were caught every year for the century preceding the 1950s (Emery, 1992). This high figure demonstrates the extent to which Newfoundlanders relied on this ecosystem and how it shaped the social and cultural identities of fishing-dependent communities for generations. The exploitation of northern cod grew rapidly at the start of the 1950s due to new equipment and technologies that allowed fishers to catch it in high volumes, notably with the use of trawlers (commercial fishing vessels), which increased the area and the depth of fishing zones in the province's waters. As technological progress facilitated fishing techniques and as the data used to assess cod stocks became more and more blurry due, in part, to environmental miscalculations (Hamilton et al., 2004), cod levels in the Atlantic region began to fall drastically. The depletion of northern cod attributed to overfishing was such that by 1992, its biomass fell to 1% of its historical level (Hamilton and Butler, 2001). To face this ecological crisis, the Canadian government imposed a moratorium on the northern cod fishery on 2 July 1992, in hopes that the species would rebuild, going back to its original level. This ban on fishing led to the closure of fish plants, the docking of boats and, more generally, to the termination of all fishing activities related to cod (Higgins, 2008). In concrete terms, more than 30,000 workers whose lives depended on the fishing of northern cod lost their jobs overnight, resulting in the most important mass layoffs in the history of Canada.

The 1992 cod moratorium in Newfoundland and Labrador offers a unique and well-suited setting to examine the effects of a sudden, industry-specific policy change on post-secondary education. This policy, which effectively ended cod fishery in the province, which was a critical economic pillar for many coastal communities, disrupted the traditional livelihood of thousands, particularly in areas that were heavily reliant on fishing. The resulting economic shock provides an opportunity to study how such disruptions may prompt shifts in educational aspirations and outcomes. By focusing on municipalities where the fishing industry was central to the economy, this study can isolate the

impact of the moratorium in areas where individuals had fewer alternatives for employment. As suggested by scholars like Valero (2021), economic shocks can push individuals towards education as a means of diversifying their career opportunities, making education a tool for adaptation. This aligns with findings in other resource-dependent economies, where economic disruptions often lead to changes in labor force dynamics and educational pathways (Jackson et al., 2015).

The aim of this dissertation is to investigate whether the 1992 cod moratorium led to significant changes in post-secondary educational attainment in Newfoundland's fishing communities, compared to fishing communities that were not affected by this policy. Specifically, the study assesses whether these disruptions in traditional employment pathways prompted a shift toward higher levels of post-secondary education within selected areas.

To conduct this research, coastal Newfoundland subdivisions, as well as coastal subdivisions from other provinces across the country, were selected as the units of observation. These subdivisions are drawn from Statistics Canada Census profiles, spanning the years 1981 to 2006. In census terminology, *subdivisions* refers to municipalities (as determined by provincial legislation) or areas treated as municipal equivalents for statistical purposes, including Indian reserves, settlements, and unorganized territories. This framework enables an assessment of subdivisions directly affected by the moratorium, as well as those that were not, thus providing the setting to explore the potential impacts of industry-specific changes on education. Difference-in-difference regressions are applied to examine the impact of the moratorium on four types of higher education outcomes: university diplomas, non-university diplomas, trade certificates, and total post-secondary education. This quasi-experimental method compares changes in post-secondary outcomes between the designated treatment and control groups, and across the periods before and after the moratorium. The treatment group consists of coastal Newfoundland subdivisions, while the control group is selected based on comparable characteristics drawn from the dataset. The statistical programming language R is used to compute the estimates in the difference-in-differences framework and to perform supporting robustness checks.

The structure of this dissertation is as follows. Chapter 1 reviews the relevant literature, focusing on the relationship between economic shocks and human capital, the evolution of education and employment perceptions in Newfoundland, and the limitations of post-moratorium government responses. Chapter 2 presents the research methodology, including a description of the data, the difference-in-differences approach, variable definitions, and validity checks. Chapter 3 reports the main results followed by robustness tests. The conclusion summarizes the key findings and their broader implications.

1. Literature Review

1.1 Human Capital Development and Economic Disruptions

Upskilling and the development of human capital often emerge as a response to economic disruptions, more specifically after significant policy changes. Brown (1999) argues that the relationship between economic revitalization and human capital development is complex and that education and training initiatives are only effective when paired with targeted strategic interventions. With his human capital theory, Becker (1975) further explored this relationship by stating that investments in education and training can improve individuals' income and skills. This theory allows for a better understanding of the way educational attainment may respond to economic shocks.

Furthermore, in their study of South Wales' twentieth century coal mining collapse, Merrill and Kitson (2022) suggest that while education acts as a response to economic disruptions, it is also a key mechanism for long-term adaptation. In Newfoundland, young people traditionally entered the fishing industry through informal apprenticeships and familial ties. Boys, in particular, learned the craft of fishing from their fathers or uncles, usually while working in processing factories during the summer (Power et al., 2014). The author observes a notable transformation in the way young people viewed their future careers after the implementation of the cod moratorium. Although fishing was once considered a respected and reliable profession in the province, it became seen as physically demanding, unsustainable, and a mere seasonal career path. Many young people turned away from the fishing industry, instead pursuing opportunities in sectors such as Alberta's (western Canadian province) oil industry or urban professional jobs, where higher education was viewed as a key to success. This shift reflects a broader, intergenerational change in attitudes, stemming from the narrative that leaving small communities for urban areas and pursuing higher education is necessary to achieve upward mobility.

1.2 Shifting Attitudes Toward Education and Employment in Newfoundland

In response to the economic upheaval caused by the moratorium, the Newfoundland government created two relief programs : the Northern Cod Adjustment and Rehabilitation Program (NCARP) and The Atlantic Groundfish Strategy (TAGS) (Higgins, 2009). Although these initiatives were intended to provide financial stability to displaced workers, they faced significant limitations. NCARP and TAGS offered temporary relief; however, they did not adequately prepare people for employment in alternative industries or significantly reduce dependence on the fishing sector. As Higgins (2009) highlighted, the program primarily focused on short-term financial aid rather than fostering long-term economic diversification or skill development. Moreover, Woodrow (1998) found that only 10% of fishing licenses were renounced, instead of the intended 50%. This suggests that the programs did little to reduce reliance on the fishing industry, leaving many workers without concrete alternatives. Without sufficient government involvement, opportunities for individuals to pursue further education or transition to other sectors may have been limited.

1.3 Limitations of Government Interventions Post-Moratorium

As the moratorium led to the largest mass layoff in Canadian history, government intervention became essential. Brown (1999) and Merrill and Kitson (2022) stress the need for strategic interventions that go beyond financial support. Without extensive retraining and targeted education programs, they state that efforts to revitalize resource-dependent economies are unlikely to succeed. The suspension of cod fishing in the province thus highlighted the crucial role of education in supporting economic adaptation and resilience. Bavington (2011) argues that effective management of fisheries is less about controlling the resource itself and more about managing the people who rely on it. He suggests that co-management systems, established through educational initiatives, can address issues of overexploitation and promote sustainable practices. Similarly, Davis and Hulett (1999) advocates for the retraining and reeducation of fishers as a key solution to overfishing. They point to efforts made by organizations such as the Canadian Council of Professional Fish Harvesters, which provides retraining programs through colleges and universities. In parallel, the National Seafood Sector Council (NSSC) was established to address skill gaps by delivering diplomas and specialized training in collaboration with institutions such as

the Memorial University of Newfoundland. These initiatives underscore the importance of integrating education and skill development into broader economic recovery strategies.

Furthermore, Mason (2002) challenges the characterization of the collapse of Newfoundland's cod stock as a "tragedy of the commons", redefining it as a "tragedy of state management" instead. He attributes the collapse to a combination of overfishing driven by technological advancements, scientific errors, foreign exploitation, and political denial. This perspective underscores the way systemic social and institutional factors led to the crisis, as opposed to individual behaviors. Mason's analysis also highlights the profound socioeconomic consequences of the moratorium, which forced many individuals to seek alternatives such as migration or retraining programs. Although relief programs like the NCARP and TAGS provided short-term stability, Mason's critique suggests that these measures were insufficient in addressing the underlying structural challenges faced by affected communities in Newfoundland.

1.4 Education as a Tool for Long-Term Resilience and Adaptation

Lastly, the collapse of the Newfoundland cod industry highlighted the growing importance of education in building long-term resilience. Communities that traditionally depend on resource exploitation, such as the fishing industry, face an urgent need to adapt to new economic realities. Education thus becomes a key tool for such adaptation, allowing individuals to transition from declining sectors to occupations that require formal skills. Using a log-linear relationship model, Valero (2021) shows that higher levels of education increase firm-level productivity and foster societal benefits through knowledge spillovers. This perspective suggests that disruption in primary industries, such as the cod moratorium, can encourage individuals to pursue higher education as a means to adapt to new economic conditions. In this context, Valero (2021) provides a useful lens for understanding how younger generations in Newfoundland's fishing communities can look beyond fisheries for broader career opportunities.

2. Research Methodology

2.1 Data Description

The data used for this dissertation is pulled from the census profile for Canada, Pro Provinces and Territories, Census Divisions, and Census Subdivisions published by Statistics Canada, the country's national statistical office. These censuses cover a wide variety of topics, including population and dwelling counts, education, labor, families, households, and marital status. The datasets have then been filtered and assembled prior to the analysis to contain only subdivisions from relevant provinces, which constitute the units of observation. Given that the moratorium takes place in 1992, and that census data is collected every five years, six time periods have been selected:

1981 (Statistics Canada, 1981)
1986 (Statistics Canada, 1986)
1991 (Statistics Canada, 1991)
} Pre-moratorium

1996 (Statistics Canada, 1996)
2001 (Statistics Canada, 2001)
2006 (Statistics Canada, 2006)
} Post-moratorium

2.2 Overview of the Difference-in-Differences Approach

To determine the effects of the moratorium on educational attainment, simply comparing a group that has been affected by this policy (treatment group) and a group that has not (control group), using cross-sectional data and a classic Ordinary Least Square (OLS) technique may not be the most suitable option. This method does not take into account unobserved differences between groups that are correlated with the outcome variable (ed-

ucation), as changes in education between groups may stem from inherent differences between them rather than being caused by the moratorium. However, comparing the outcome variable only for individuals or subdivisions before and after the moratorium with a time-series estimate leads to a time-trend problem, as other factors, such as an economic recession, can alter the results, making it difficult to measure the causal effect of the policy on the outcome.

This issue can be solved with the Difference-in-Differences (DiD) approach which combines the difference between the control and treatment groups and the difference between the pre-moratorium and post-moratorium periods. With the use of panel data, this technique enables a more precise way of estimating the difference between the treatment and control groups, as well as the variation of the outcome variable over time. The corresponding DiD equation is as follows:

$$\text{PSE}_{it} = \alpha + \beta_1 \cdot \text{Cod}_i + \beta_2 \cdot \text{Mor}_t + \beta_3 \cdot (\text{Cod}_i \times \text{Mor}_t) + \beta_4 \cdot \text{X}_{it} + \varepsilon_{it} \tag{1}$$

- PSE_{it}: dependent variable which refers to post-secondary education for subdivision i in year t
- Cod_i: indicator variable equal to 1 if the subdivision i is part of the treatment group (i.e, if it is affected by the moratorium), 0 otherwise
- Mor_t: indicator variable equal to 1 for the years t following the 1992 moratorium, 0 otherwise
- $\text{Cod}_i \times \text{Mor}_t$: interaction term which captures the difference-in-differences effect, i.e., the estimated causal effect of the moratorium on the treated observations
- X_{it}: additional control variables included in the model to reduce unexplained variations
- ε_{it}: error term which captures other non observed factors that impact the dependent variable

2.3 Definition of Variables and Data Preparation

Due to the fact that this analysis deals with semi-aggregated data, scale issues might arise between subdivisions of different sizes if absolute values are used. For instance, it is likely that more university diplomas are earned in Quebec City than in St. John (capital of Newfoundland), but this figure is heavily influenced by each town's population size.

Consequently, the size effect of the subdivision might be measured instead of the effect of the moratorium. A solution to this problem is to convert these volumes into shares of the population allowing for a relative interpretation of a given variable. Thus, all outcome and control variables will be transformed into ratios (except median income).

2.3.1 Outcome Variables

All the following outcome variables are pulled from the number of highest certificates, diplomas, or degrees in each subdivision.

University Diplomas

University certificates or diplomas (below or above bachelor level) are non-degree programs of study completed through university. They are often connected with professional associations (which are a collaboration of individuals from the same occupation) in fields such as accounting, banking, insurance, or public administration. The ratio for this variable is calculated with this formula:

$$\text{University Diplomas Rate} = \frac{\text{Number of University Diplomas}}{\text{Population Aged 20 and Over}} \tag{2}$$

Non-University Education with Diploma

Non-university education with diploma refers to whether or not a person has received a certificate or a diploma (*degrees* excluded) from a community college, CEGEPs (general and professional college), private business college, technical institutes (polytechnic, institute of technology), school of nursing or vocational school. The ratio for this variable is calculated as follows:

$$\text{Non-University Diplomas Rate} = \frac{\text{Number of Non-University Diplomas}}{\text{Population Aged 20 and Over}} \tag{3}$$

Trade Certificates

Trade certificates or diplomas include pre-employment or vocational certificates and diplomas from short trade programs completed at colleges, institutes of technology, voca-

tional centers, or similar institutions. Overall, these certificates are designed to show that an individual has acquired a certain level of skill or knowledge (plumbing, electrical work, carpentry, etc.). The ratio for trade certificates can be found with the following equation:

$$\text{Trade Certificates Rate} = \frac{\text{Number of Trade Certificates}}{\text{Population Aged 20 and Over}} \tag{4}$$

Total Post-Secondary Education

Total post-secondary education refers to the sum of all education (certificates or diplomas) computed above, which translates to the following formula:

$$\begin{aligned}\text{Total Post-Secondary Education Rate} = {} & \text{Trade Certificates Rate} \\ & + \text{University Diplomas Rate} \\ & + \text{Non-University Diplomas Rate}\end{aligned} \tag{5}$$

2.3.2 Control Variables

Control variables are included to control for unobserved characteristics between subdivisions that are supposedly correlated to post-secondary education rates. In the context of a DiD model, adding them in the regression aims to justify a parallel assumption, in order to control for elements that are both related to treatment and to changes in the outcome. This topic is covered in the following section.

Median Income

The median income of a specified group of households is the amount which divides their income size distribution into two halves, i.e. the incomes of the first half of households are below the median, while those of the second half are above the median. No changes were made to this variable, which is measured in dollars ($).

Including median income of households in the models allows for a control of local wealth in each subdivision. It also captures the relationship between income and choices related to education: a higher income can encourage individuals to leave school early to aim for better paying jobs that do not require a diploma. Conversely, higher income indi-

viduals are likely to pursue post-secondary education, as tuition fees require a substantial investment. Lastly, the inclusion of median income partially takes into account the economic shock post-moratorium, as the ban on fishing may have affected local income in Newfoundland.

Female Population

The female population ratio refers to the share of females in a subdivision and is calculated as follows:

$$\text{Female Population Rate} = \frac{\text{Total Female Population}}{\text{Total Female Population} + \text{Total Male Population}} \tag{6}$$

Age

With age variables included, the model takes into account the direct correlation between education and different cohorts within a subdivision. For this reason, three age groups are considered. The first category covers all individuals under 14. This age group represents individuals who are not old enough to get a post-secondary diploma, and will be used as a reference, i.e., it will not be apart of the equation to avoid multicollinearity issues. The second group contains all individuals between 15 and 24 years of age, which is typically the age range to begin or pursue a higher education diploma. This age group is particularly relevant as the moratorium could drive young people, who otherwise would have gone directly into the fishing industry, to get an education after high school. The final category refers to all people older than 25 years and aims at including individuals who are already in the labor force but who may opt for a career change following the moratorium, that requires higher education. All age categories are converted into ratios, as such[1]:

$$\text{Age 0 to 14 Rate} = \frac{\text{Number of individuals from 0 to 14 years old}}{\text{Total Population}} \tag{7}$$

[1]The same formula applies for the "Age 15 to 24" and "Age 25 and older" categories.

Non-movers

The non-movers rate refers to the ratio of people who lived at the same address 5 years preceding the census year. This mobility status variable is used to control for individuals who may have anticipated the effect of the moratorium on themselves or on their family and have moved away from the subdivision or from Newfoundland to seek new or better career opportunities. If not controlled for, the effect on educational attainment may be biased due to the possible abnormal variations in diploma rate in regions affected by the moratorium and those who were not.

$$\text{Non-movers Rate} = \frac{\text{Number of individuals who lived at the same address 5 years ago}}{\text{Total Population}} \tag{8}$$

Primary Industry Workers

The primary industry ratio controls for a subdivision's exposure to agriculture, forestry, fishing and trapping, mines (including milling), quarries, and oil wells[2]. It measure the weight of the primary industry in the labor force as follows:

$$\text{Primary Industry Rate} = \frac{\text{Number of workers in the primary industry}}{\text{Total labor force 15 years and over}} \tag{9}$$

2.3.3 Descriptive Statistics

Table 2.1 provides descriptive statistics for the entire data set[3]. On average, 28% of the population holds a post-secondary diploma, with a mean of 6% holding trade certificates, 6% holding university diplomas, and 15% holding non-university diplomas. This suggests that the latter is the most common form of higher education in the sample.

Regarding control variables, the median income is approximately $26,000, but the high standard deviation ($15,000) and maximum value of $88,000 indicate substantial income disparities across subdivisions. Subdivisions in the sample include large towns as well as

[2]Only controlling for the rate of workers in the fishing industry rather than in the entire primary industry would have been more relevant. However, some census years regrouped primary industries into one indicator, making it impossible to only extract the fishing and trapping sector from the census.

[3]These statistics have been computed following an exploratory analysis involving the handling of outliers and missing data, and the examination of correlations between independent variables. Some of these tests are available in the appendix.

Table 2.1: Descriptive Statistics

Variable	Min.	Mean	St. Deviation	Max.	Obs.
Total Post Secondary Degrees ratio	0.00	0.28	0.14	0.83	3,044
Trade Certificates ratio	0.00	0.06	0.07	0.35	3,044
Non University Degrees ratio	0.00	0.15	0.07	0.46	3,044
University Degrees ratio	0.00	0.06	0.06	0.30	3,044
Median Income ($)	0	26,069	15,360	88,430	3,044
Female ratio	0.39	0.49	0.03	0.60	3,044
Age 0 to 14 ratio	0.00	0.23	0.07	0.53	3,044
Age 15 to 24 ratio	0.00	0.18	0.05	0.39	3,044
Age 25 and Over ratio	0.25	0.60	0.10	0.91	3,044
Non-movers ratio	0.11	0.72	0.15	0.99	3,044
Primary Industry ratio	0.00	0.13	0.13	0.68	3,044

Note: All variables in this table are ratios, except for median income which is in dollars ($).

small villages, which can explain this variation in median income. The female population ratio, balanced at around 49%, is consistent with national demographic trends. Age distribution shows that the population is relatively mature, with an average of 60% aged 25 and over, whereas younger age groups make up smaller proportions (23% for "0-14" and 18% for "15-24"). The mobility status variable shows that a high proportion of the population (72%) were non-movers over the last 5 years, although there is a noticeable variation (ranging from 11% to 99%), suggesting different levels of stability across subdivisions. Lastly, the average for the primary industry ratio is 13%, reflecting major differences in primary industry dependence between subdivisions. This discrepancy in local economies is useful to understand the heterogeneity in the impact of the cod moratorium on selected Canadian communities.

2.4 Parallel Trends Assumption and Counterfactual Analysis

To ensure the internal validity of the DiD estimator, the model must verify all traditional OLS assumptions[4], as well as the key identifying assumption of DiD, that is, the parallel trends assumption (Angrist and Pischke, 2008). This hypothesis stipulates that, in the absence of the moratorium, post-secondary education trends should be the same for the treated group and the control group. Since one of these events is unobserved (i.e., the treatment group is affected by the moratorium), this assumption cannot be empirically verified. However, an appropriate way to provide grounds that the treatment group would have followed a trend similar to the control group without the intervention is to compare

[4]Evidence of their verification can be found in the appendix.

the trends of both groups prior to the moratorium. This can be done by computing the time series averages of post-secondary education over time. Doing so adds evidence that the chosen control group is a good counterfactual to the treatment group.

Before testing for parallel trends, both the treatment and control groups must be defined. As the fishing of northern cod in coastal communities of Newfoundland was considered the economic foundation of the province (Emery, 1992), selecting its coastal subdivisions as the treatment group seems reasonable. These communities, highly dependent on fishing, were, in theory, more affected by the moratorium than inland counties. As a result, they were likely forced to seek alternative employment opportunities, thus increasing the demand for education. This aligns with studies such as Power et al. (2014), which suggest that economic shocks prompt workers to invest in education as a way to transition to new sectors.

For trends to be parallel pre-moratorium, the control group must have similar characteristics to the treatment group. Choosing coastal subdivisions from other provinces in Canada that are next to the ocean could be an effective selection method. The provinces of New Brunswick, Nova Scotia, Prince Edward Island, and Quebec are located in the Atlantic Ocean, as is Newfoundland. Conrad (2002) argues that, even though "Atlantic Canada" does not form a completely cohesive region, these provinces have common demographic, economic, political and social structures and share a similar history of belonging to the French, British and Canadian empires. However, fishermen and plant workers on the east coast of Nova Scotia also suffered from the moratorium, as northern cod represented 12% of groundfish in 1989, compared to less than 4% in 1991 (Emery, 1992). Nova Scotia being exposed, even partially, to the treatment represents a spillover risk, as educational attainment in the province may be correlated with the implementation of the moratorium. Consequently, it may not be the most suitable counterfactual for Newfoundland. On the other hand, the province of British Columbia on the western side of the country is bordered by the Pacific Ocean, where strong fishing communities are established. Coastal subdivisions in this province, as well as in New Brunswick, Prince Edward Island, and Quebec, supposedly make good candidates for a control group[5].

Another justification for the choice of a good counterfactual for Newfoundland is the percentage of primary industry workers in relation to the total labor force (15 years and older), for each province. Exploring these characteristics allows for a better understanding of the similarities and differences between Newfoundland and other provinces. This ratio encompasses fishing, trapping, logging, forestry, agriculture, and mining (including the milling, quarrying, and oil well industries).

[5]Northwest Territories, Nunavut, and Yukon were not considered for this analysis due to lack of sufficient data.

Table 2.2: Primary Industry Workers Rate by Province (%)

Province	**1981**	**1991**
Newfoundland and Labrador	9.89	8.08
British Columbia	7.17	6.29
New Brunswick	8.00	7.21
Prince Edward Island	16.23	14.59
Quebec	4.51	3.90

Note: Values are calculated based on the census data of selected provinces (Statistics Canada, 1981, 1991).

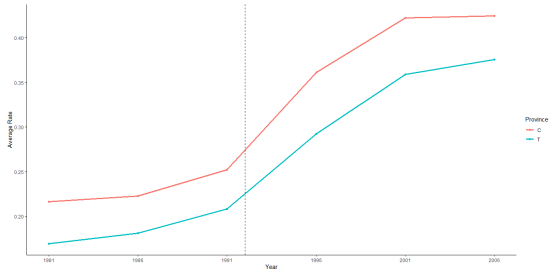
Table 2.2 shows that the primary industry workers rate in British Columbia and New Brunswick are very similar to Newfoundland's pre-moratorium. Although results are slightly higher for Prince Edward Island, its economy relies heavily on agriculture, fisheries and tourism (Government of Prince Edward Island, 2018), making it comparable to Newfoundland nonetheless. However, the ratios for Quebec are less than half of those for Newfoundland. As a consequence, the estimated effect of the moratorium might wrongly capture structural differences between groups. Furthermore, if subdivisions in Quebec are less dependent on fishing, significant results may be caused by inherent differences between subdivisions, instead of the causal effect of the moratorium, which would discredit the entire study. To avoid this bias, Quebec will not be considered for the rest of this analysis.

Therefore, the main counterfactual for this research will be a synthetic control group made up of the average of coastal subdivisions from New Brunswick, Prince Edward Island, and British Columbia. In addition, placebo tests will be performed individually for each province to assess the robustness of the models. The parallel trends assumption can now be examined for the four outcome variables.

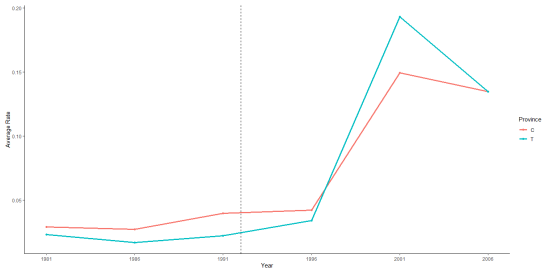
As shown in Figure 2.1, the parallel trends hypothesis pre-moratorium appears to hold for all indicators of post-secondary education. The DiD models can now be estimated. The next section focuses on interpreting the results obtained from these models[6].

[6]Additional parallel trend figures for New Brunswick (Figure A.6), Prince Edward Island (Figure A.7), and British Columbia (Figure A.8) are available in the appendix.

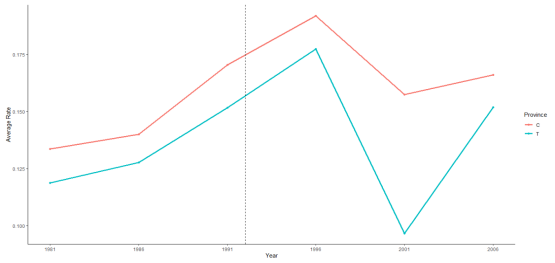
Figure 2.1: Parallel Trends for Post Secondary Education Rates: Newfoundland Against Synthetic Control Group



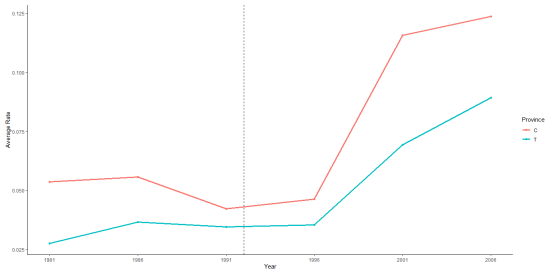
Y = Total Post Secondary Education Rate



Y = Trade Certificates Rate



Y = Non-University Diploma Rate



Y = University Diploma Rate

Note: The synthetic control group is represented by red lines, and Newfoundland by blue lines. The vertical dotted line marks the 1992 moratorium.

3. Results

3.1 Main Specification

Table 3.1: Difference-in-Differences Estimates for Post-Secondary Education Outcomes

	Outcome Variable							
	Without Covariates				**With Covariates**			
	TPS	TC	NUD	UD	TPS	TC	NUD	UD
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
cod	-0.046***	-0.011***	-0.017***	-0.018***	-0.006	-0.005	2.01×10^{-4}	-0.003
	(0.005)	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.002)
mor	0.170***	0.073***	0.025***	0.041***	0.126***	0.074***	0.003	0.023***
	(0.006)	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.003)
did	-0.018*	0.016***	-0.010	-0.013***	-0.01	0.03***	-0.011*	-0.010**
	(0.008)	(0.004)	(0.005)	(0.004)	(0.007)	(0.004)	(0.005)	(0.003)
Median Income					2.84×10^{-6}***	2.11×10^{-7}**	1.29×10^{-6}***	1.07×10^{-6}***
					(1.24×10^{-7})	(6.66×10^{-8})	(8.91×10^{-8})	(6.26×10^{-8})
Female Ratio					0.344***	-0.105**	0.243***	0.114**
					(0.069)	(0.037)	(0.049)	(0.035)
Age 15 to 24 Ratio					-0.359***	-0.630***	0.174***	-0.238***
					(0.042)	(0.022)	(0.030)	(0.021)
Age 25 and Over Ratio					0.011	-0.150***	0.083***	0.001
					(0.027)	(0.014)	(0.019)	(0.014)
Non-movers Ratio					-0.159***	0.010	-0.087***	-0.044***
					(0.013)	(0.007)	(0.009)	(0.006)
Primary Industry Ratio					-0.157***	-0.044***	-0.066***	-0.050***
					(0.014)	(0.008)	(0.010)	(0.007)
Observations	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044
R^2	0.37	0.34	0.04	0.15	0.59	0.50	0.21	0.36

Note 1: TPS = Total Post-Secondary, TC = Trade Certificates, NUD = Non-University Diplomas, UD = University Diplomas.
Note 2: `cod` indicates the treatment group (Newfoundland), `mor` is a post-treatment dummy (after the moratorium), and `did` is the interaction term capturing the difference-in-differences estimator, i.e., the key coefficient of interest.
Note 3: Coefficients are shown with standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.1 reports the difference-in-differences estimates for post-secondary education outcomes in coastal Newfoundland subdivisions, relative to coastal subdivisions of the synthetic control group. Without covariates, the moratorium is associated with a significant decrease of 1.8 percentage points in the total post-secondary education ratio and a significant increase of 1.6 percentage points in the trade certificates ratio. With covariates, the increase in trade certificates becomes even stronger (3 percentage points), and the initial negative effects on university diplomas persist, in addition to a significant decrease in non-university diplomas. The coefficient for the total post-secondary ratio becomes insignificant, suggesting that the initial negative effect of the moratorium may have been confounded by other factors that were not included in the simple regression.

The addition of covariates clearly demonstrates an improvement in the quality of the models, as R^2 increases when they are included. For instance, the model with control variables explains up to 50% of the variation in trade certificates. Although the coefficients are relatively small, household income is positively associated with all post-secondary outcomes. This result highlights the potential financial constraints tied to the choice to pursue higher education. A higher female ratio is positively associated with all types of diplomas, except for trade certificates. This aligns with studies such as Vaarmets (2018) that provide evidence that men are more inclined to choose a professional higher education, while women tend to opt for university diplomas in fields such as humanities or social sciences. In addition, the age 15-24 ratio is significant across models, whereas the age 25 and over ratio only significantly decreases the trade certificate ratio and increases the non-university diplomas one. Thus, post-secondary education applies more to younger generations, signifying that the rate of adults in the labor force deciding to obtain a diploma or a certificate as a means of changing career paths is perhaps less important than suggested in previous sections of this study. Non-movers and primary industry workers ratios are also associated with lower post-secondary attainment, particularly for total post-secondary education and non-university diplomas, highlighting potential structural or cultural barriers to higher education. Overall, these results show that demographic and economic variables help reduce omitted variable bias by partly explaining shifts in educational outcomes.

In regards to models with covariates, the main takeaway is that, following the moratorium, coastal Newfoundland subdivisions benefited from an increase in the trade certificate rate. By contrast, these same subdivisions suffered from a decrease in non-university and university diplomas after 1992. The next section will focus on comparing these results with results from models performed with different control groups.

3.2 Placebo Tests

Placebo tests are effective to determine whether the selected control group is a suitable counterfactual to the treatment group. In addition to the examination of parallel trends pre-treatment, it is useful to see if the results change significantly when the control group varies (Pistolesi, 2025). The main model interpreted in the previous section used a synthetic control group made up of coastal subdivisions from New Brunswick, Prince Edward Island, and British Columbia. In this section, placebo models formed by each province individually are tested.

Table 3.2: Robustness Check with New Brunswick as the Control Group

	Outcome Variable							
	Without Covariates				**With Covariates**			
	TPS	TC	NUD	UD	TPS	TC	NUD	UD
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
cod	-0.051***	-0.011**	-0.024***	-0.016***	0.002	4.86×10^{-4}	7.43×10^{-4}	0.002
	(0.007)	(0.004)	(0.005)	(0.003)	(0.006)	(0.003)	(0.004)	(0.003)
mor	0.153***	0.075***	0.016**	0.033***	0.117***	0.076***	-0.010	0.022***
	(0.008)	(0.005)	(0.006)	(0.004)	(0.008)	(0.004)	(0.006)	(0.004)
did	-0.002	0.015**	-4.95×10^{-4}	-0.005	0.002	0.023***	-0.005	-0.003
	(0.010)	(0.005)	(0.007)	(0.004)	(0.008)	(0.005)	(0.006)	(0.004)
Median Income					2.78×10^{-6}***	4.04×10^{-7}***	1.40×10^{-6}***	8.59×10^{-7}***
					(1.59×10^{-7})	(8.90×10^{-8})	(1.18×10^{-7})	(7.47×10^{-8})
Female Ratio					0.548***	-0.030	0.312***	0.178***
					(0.091)	(0.051)	(0.068)	(0.043)
Age 15 to 24 Ratio					-0.241***	-0.695***	0.335***	-0.190***
					(0.049)	(0.028)	(0.037)	(0.023)
Age 25 and Over Ratio					-0.002	-0.162***	0.132***	-0.016
					(0.036)	(0.020)	(0.027)	(0.017)
Non-movers Ratio					-0.225***	-0.018	-0.109***	-0.074***
					(0.019)	(0.011)	(0.014)	(0.009)
Primary Industry Ratio					-0.206***	-0.028**	-0.120***	-0.046***
					(0.017)	(0.010)	(0.013)	(0.008)
Observations	2,003	2,003	2,003	2,003	2,003	2,003	2,003	2,003
R^2	0.37	0.36	0.04	0.13	0.60	0.55	0.24	0.33

Note 1: TPS = Total Post-Secondary, TC = Trade Certificates, NUD = Non-University Diplomas, UD = University Diplomas.
Note 2: `cod` indicates the treatment group (Newfoundland), `mor` is a post-treatment dummy (after the moratorium), and `did` is the interaction term capturing the difference-in-differences estimator, i.e., the key coefficient of interest.
Note 3: Coefficients are shown with standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.3: Robustness Check with Prince Edward Island as the Control Group

	Outcome Variable							
	Without Covariates				**With Covariates**			
	TPS	TC	NUD	UD	TPS	TC	NUD	UD
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
cod	-0.048***	-0.011*	-0.013*	-0.024***	-0.039***	-0.003	-0.014*	-0.018***
	(0.008)	(0.004)	(0.006)	(0.004)	(0.007)	(0.004)	(0.005)	(0.003)
mor	0.185***	0.073***	0.035***	0.050***	0.120***	0.067***	-0.005	0.031***
	(0.011)	(0.006)	(0.007)	(0.005)	(0.010)	(0.005)	(0.007)	(0.005)
did	-0.033**	0.016*	-0.020*	-0.022***	-0.003	0.027***	-0.011	-0.012*
	(0.013)	(0.007)	(0.008)	(0.005)	(0.011)	(0.006)	(0.008)	(0.005)
Median Income					2.83×10^{-6}***	5.47×10^{-7}***	1.38×10^{-6}***	9.35×10^{-7}***
					(1.73×10^{-7})	(9.60×10^{-8})	(1.28×10^{-7})	(8.08×10^{-8})
Female Ratio					0.258**	-0.038	0.207**	0.055
					(0.096)	(0.053)	(0.071)	(0.045)
Age 15 to 24 Ratio					-0.286***	-0.635***	0.310***	-0.210***
					(0.054)	(0.030)	(0.040)	(0.025)
Age 25 and Over Ratio					0.019	-0.133***	0.139***	-0.014
					(0.040)	(0.022)	(0.030)	(0.019)
Non-movers Ratio					-0.211***	-0.019	-0.102***	-0.074***
					(0.021)	(0.012)	(0.015)	(0.010)
Primary Industry Ratio					-0.203***	-0.033***	-0.112***	-0.051***
					(0.018)	(0.010)	(0.013)	(0.008)
Observations	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776
R^2	0.37	0.35	0.04	0.18	0.59	0.53	0.21	0.37

Note 1: TPS = Total Post-Secondary, TC = Trade Certificates, NUD = Non-University Diplomas, UD = University Diplomas.
Note 2: `cod` indicates the treatment group (Newfoundland), `mor` is a post-treatment dummy (after the moratorium), and `did` is the interaction term capturing the difference-in-differences estimator, i.e., the key coefficient of interest.
Note 3: Coefficients are shown with standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.4: Robustness Check with British Columbia as the Control Group

	Outcome Variable							
	Without Covariates				**With Covariates**			
	TPS	TC	NUD	UD	TPS	TC	NUD	UD
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
cod	-0.039***	-0.012**	-0.011*	-0.016***	0.020**	-0.007	0.019***	-0.001
	(0.008)	(0.004)	(0.005)	(0.003)	(0.008)	(0.004)	(0.006)	(0.004)
mor	0.176***	0.070***	0.028***	0.043***	0.141***	0.069***	0.013*	0.027***
	(0.009)	(0.005)	(0.006)	(0.004)	(0.008)	(0.004)	(0.006)	(0.004)
did	-0.024*	0.019***	-0.013	-0.015**	-0.033***	0.027***	-0.022**	-0.018***
	(0.011)	(0.006)	(0.007)	(0.005)	(0.009)	(0.005)	(0.007)	(0.004)
Median Income					2.50×10^{-6}***	2.07×10^{-7}*	1.07×10^{-6}***	9.94×10^{-7}***
					(1.49×10^{-7})	(8.19×10^{-8})	(1.09×10^{-7})	(7.07×10^{-8})
Female Ratio					0.392***	-0.094*	0.298***	0.110**
					(0.084)	(0.046)	(0.062)	(0.040)
Age 15 to 24 Ratio					-0.298***	-0.585***	0.196***	-0.185***
					(0.050)	(0.027)	(0.037)	(0.024)
Age 25 and Over Ratio					0.095**	-0.125***	0.115***	0.038*
					(0.031)	(0.017)	(0.023)	(0.015)
Non-movers Ratio					-0.197***	0.010	-0.119***	-0.044***
					(0.018)	(0.010)	(0.013)	(0.009)
Primary Industry Ratio					-0.151***	-0.039***	-0.060***	-0.050***
					(0.017)	(0.009)	(0.013)	(0.008)
Observations	2,027	2,027	2,027	2,027	2,027	2,027	2,027	2,027
R^2	0.33	0.33	0.03	0.12	0.57	0.47	0.20	0.36

Note 1: TPS = Total Post-Secondary, TC = Trade Certificates, NUD = Non-University Diplomas, UD = University Diplomas.
Note 2: `cod` indicates the treatment group (Newfoundland), `mor` is a post-treatment dummy (after the moratorium), and `did` is the interaction term capturing the difference-in-differences estimator, i.e., the key coefficient of interest.
Note 3: Coefficients are shown with standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Tables 3.2, 3.3, and 3.4 show the difference-in-differences results using coastal subdivisions from New Brunswick, Prince Edward Island, and British Columbia, respectively, as control groups. The most striking result is the consistent pattern observed for trade certificates across all specifications. The DiD coefficient for this outcome is positive and statistically significant regardless of the control group and remains stable, within a range of 0.023 to 0.030 for models with covariates included. As trade certificates represent a more direct pathway to employment in alternative sectors to cod fishing, these findings suggest that the moratorium led workers affected by it to seek diplomas that give them access to jobs in related fields. The robustness of this result across specifications strengthens the interpretation that the moratorium induced a substitution effect toward skill acquisition in such fields.

The results for university diplomas are more nuanced. On the one hand, the main specification shows a negative and significant effect of the moratorium (-0.010), which is consistent with the Prince Edward Island (-0.012) and British Columbia (-0.018) control groups. However, the New Brunswick control yields a non-significant coefficient, suggesting that the effect of the moratorium on university diplomas may be sensitive to the specific composition of the control group. This variation could reflect inherent differences between the coastal subdivisions of Newfoundland and New Brunswick. The fact that the DiD coefficient loses significance when New Brunswick is the sole control group also suggests that the negative effect the moratorium has on university diplomas may not be as robust as initially indicated.

Furthermore, the total post-secondary results also present a complex pattern across placebo tests. The main specification shows a non-significant coefficient, which aligns with the New Brunswick and Prince Edward Island control groups. However, the British Columbia control yields a significant negative effect (-0.033), introducing uncertainty about the overall direction of the moratorium effect on total post-secondary attainment. This divergence highlights an important limitation of the analysis: the heterogeneity in control group characteristics may be driving some of the observed effects. As British Columbia is located next to the Pacific Ocean, coastal divisions from this province may be more diversified, in terms of economic structures, than those in Newfoundland, which rely on traditional Atlantic fisheries. Consequently, the findings on total post-secondary education reveal that British Columbia may not be the most appropriate counterfactual to Newfoundland.

Lastly, the non-university diplomas outcome shows considerable sensitivity to control group selection. Although the main specification produces a significant negative effect (-0.011), this result is not replicated in any of the individual control groups, except for British Columbia (-0.022). This inconsistency suggests that the effect found on the non-university diplomas may be caused by the synthetic control group weighting rather than the causal effect of the moratorium. Consequently, the reliability of this particular category can be questioned due to the lack of robustness across different specifications.

Conclusion

The purpose of this dissertation is to assess whether the 1992 cod moratorium had an impact on higher education in fishing-dependent communities of Newfoundland. Scholars such as Merrill and Kitson (2022) and Valero (2021) consider education to be a response to an economic shock in resource-based communities and a tool for long-term adaptation. However, the results of this study highlight a more nuanced educational response to the moratorium. Although education can be considered as a pathway for new opportunities for fishing-dependent subdivisions, not all types of education yield the same results.

Firstly, across different specifications, the rate of trade certificates increased in coastal subdivisions of Newfoundland after the moratorium, which is consistent with the findings of scholars such as Power et al. (2014). Young people realizing that the fishing industry was a less viable option due to the cod collapse, instead turned to other industries, highlighting the need for vocational skills offered by trade certificates. Authors like Bukodi and Goldthorpe (2012) show that educational pathways of children are heavily influenced by parents' social origins. As their parents likely went into the fishing industry directly after high school, children did not grow up in an environment where higher education was considered and instead followed their family's footsteps (Power et al., 2014). With the moratorium, the change in career opportunities may have led them to obtain a diploma, thus opting for a vocational one, such as the trade certificate.

However, the findings for non-university and university diplomas vary and show that the moratorium led to a decrease in the rate of university degrees in fishing-dependent communities of Newfoundland. Lastly, no significant effect was found on total post-secondary attainment. However, considering the robustness checks made on different control groups, these results should be interpreted with caution.

The 1992 cod collapse thus had an impact on higher education for coastal communities in Newfoundland that relied on the fishing of Atlantic cod. However, the increase of educational attainment is only found for shorter, and more professional pathways, namely trade certificates.

Limitations

Overall, the results demonstrated sensitivity to the choice of control groups (except for the trade certificates ratio). These variations in the findings raise questions about the external validity of the estimations and about the robustness of the counterfactual. Regarding the non-university diplomas, the goodness of fit measured by the R^2 indicates that the model fails to efficiently measure the variations of non-university diploma rates caused by the moratorium in Newfoundland, as it explains only 21% of the changes in outcome for this category, and only 4% without covariates. A more in depth analysis of similar characteristics between the treatment group and the counterfactual may reduce sensitivity-related issues.

Moreover, to evaluate the impact of the moratorium in Newfoundland, semi-aggregated data was drawn from Statistics Canada, using subdivisions as units of observation. However, this type of data may mask heterogeneous behaviors between individuals such as motivation to pursue higher education or proximity to post-secondary institutions (universities, community colleges, vocational centers, etc.). For instance, residents in municipalities closer to St. John, the capital of Newfoundland, which houses the Memorial University of Newfoundland and several vocational schools, may find it easier to pursue higher education compared to residents in more remote fishing-dependent communities. Applying group characteristics on individual behaviors exposes the model to an ecological fallacy risk (Freedman, 1999): conclusion are drawn on individuals although the data is collected at the subdivision level.

While the model provides valuable insight, the designation of fishing-dependent subdivisions as coastal areas may oversimplify local economic conditions, as some subdivisions may have diversified to a greater extent than others (Merrill and Kitson, 2022; Woodrow, 1998). For instance, some towns that initially relied heavily on fishing may have shifted toward other industries (such as tourism or manufacturing) following the moratorium, which the primary industry workers rate might not have entirely captured. This diversification could have mitigated the economic shock from the collapse of the cod fishery, reducing the need for residents to seek education as a response to the ban.

Further research on the topic might benefit from exploring alternative matching strategies or considering the inclusion of control variables that better capture the economic and demographic characteristics of fishing-dependent communities in Newfoundland.

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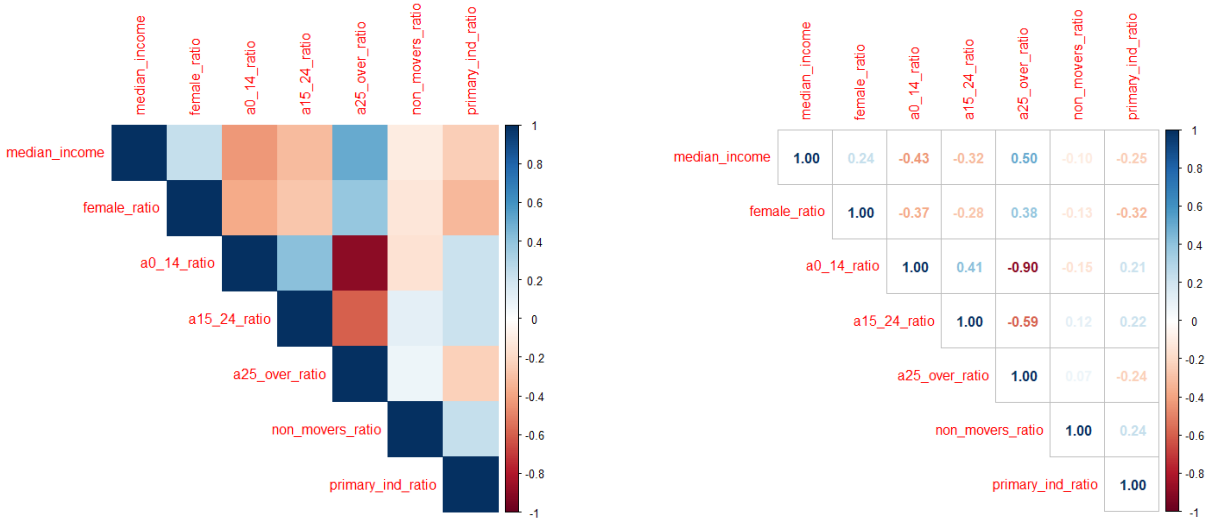
A. Appendix

Figure A.1: Correlation Matrix between Independent Variables



Note: Although the matrix shows an important negative correlation between the "Age 0 to 14" and the "Age 25 and over" variables *(-0.9)*, only one of them is included in the regression, to avoid any risk of multicollinearity.

Figure A.2: Distribution of Outcome Variables

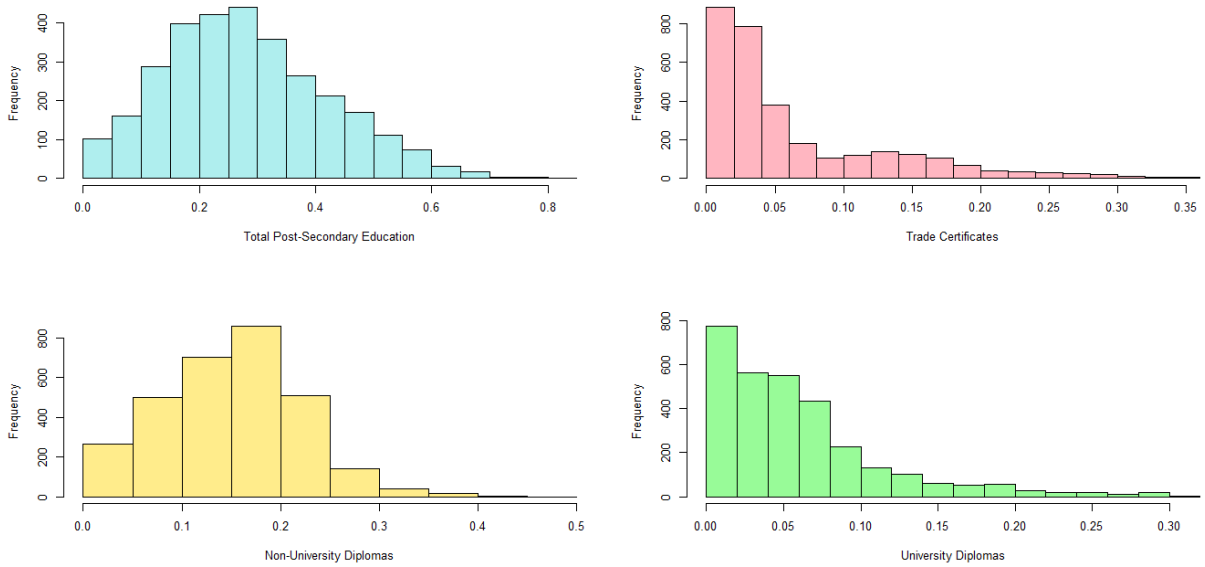
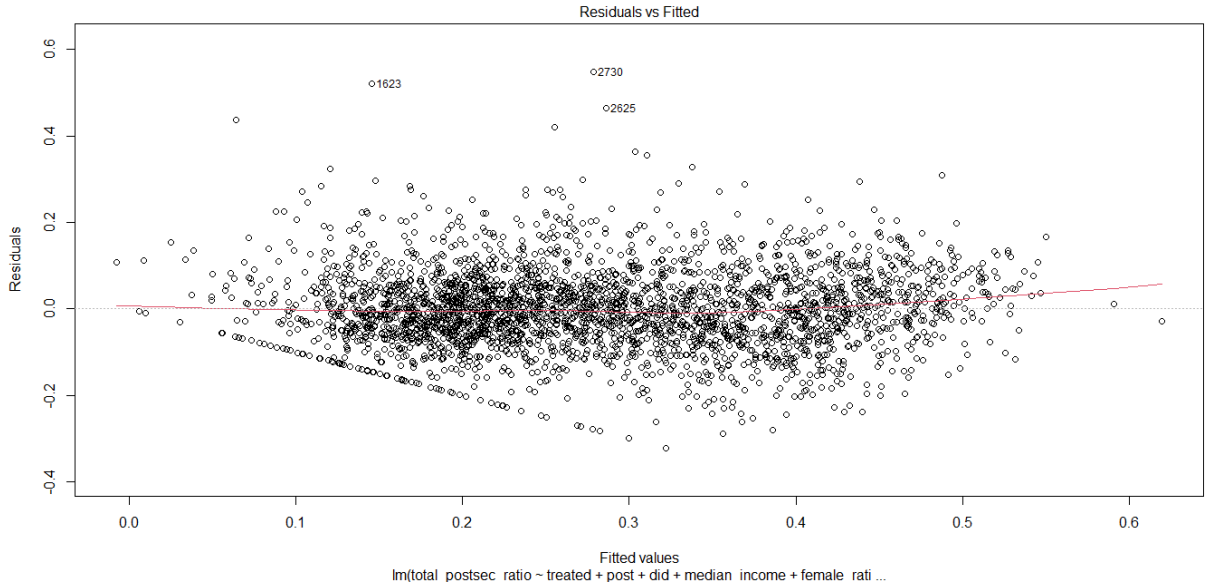
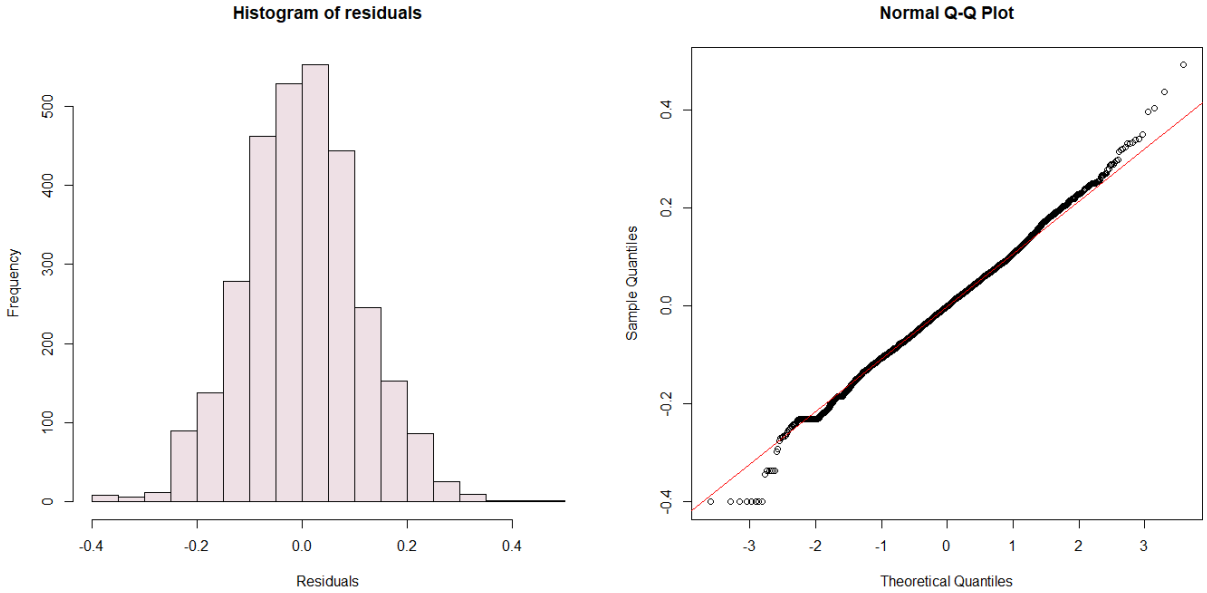


Figure A.3: Linearity of Parameters



Note: Residuals are spread equally around the red line, which is a good indication of a linear relationship.

Figure A.4: Normal Distribution of Residuals



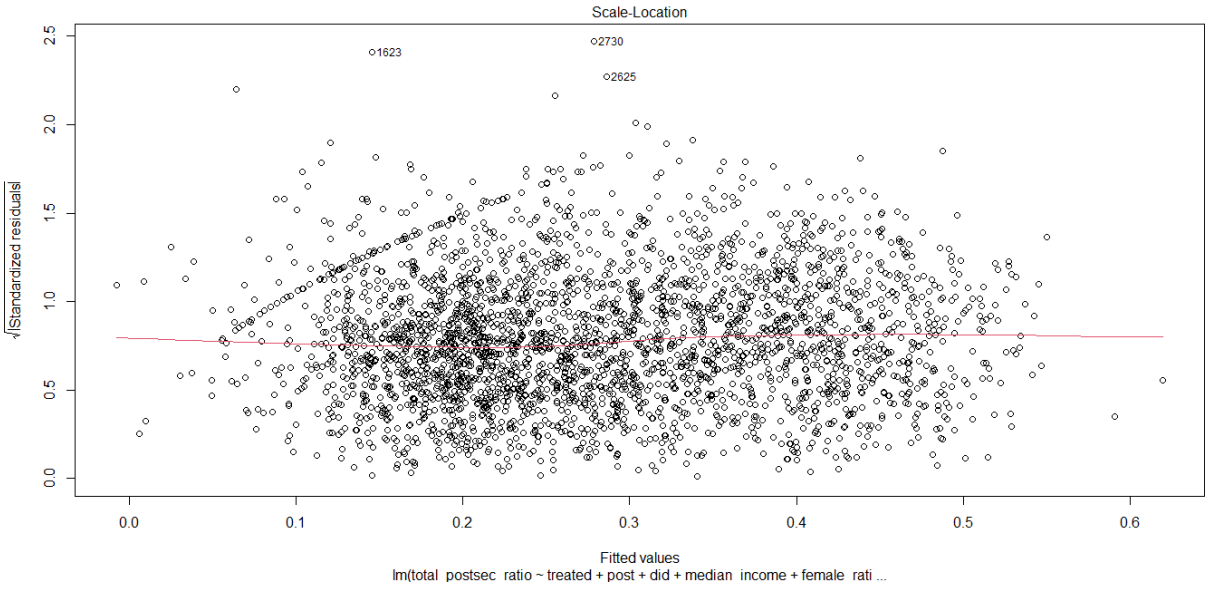
Note: This figure shows that residuals for the main specification seem to be normally distributed. Moreover, the Kolmogorov-Sminorv (KS) test was performed and yielded a p-value of 0.1843 (> 0.05), indicating that the residuals follow a normal distribution.

Table A.1: Multicolinearity Inspection using VIF

Variable	**VIF**
cod	2.17
mor	2.33
did	2.73
median_income	1.36
female_ratio	1.22
a15_24_ratio	1.66
a25_over_ratio	2.70
non_movers_ratio	1.40
primary_ind_ratio	1.20

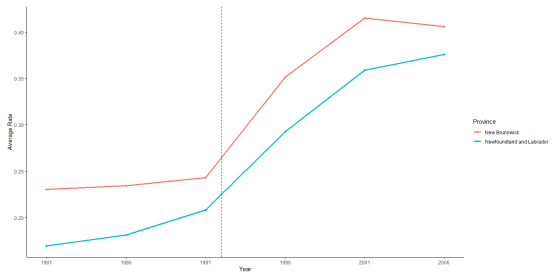
Note: Variance Inflation Factors (VIF) values above 5 typically indicate problematic multicollinearity; all variables here are below that threshold.

Figure A.5: Homoscedasticity of Residuals

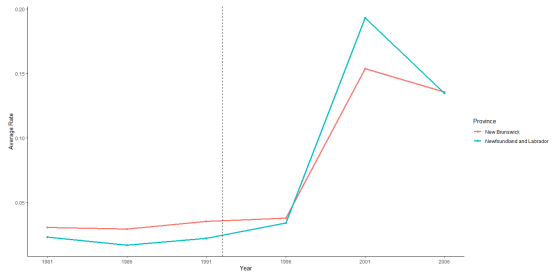


Note: The residuals seem to be spread randomly around the red line, which seems to be more or less horizontal. There is no clear sign of heteroscedasticity (no clear deviation from the line, no funnel shape, etc.); the variance of the error term is thus assumed to be constant.

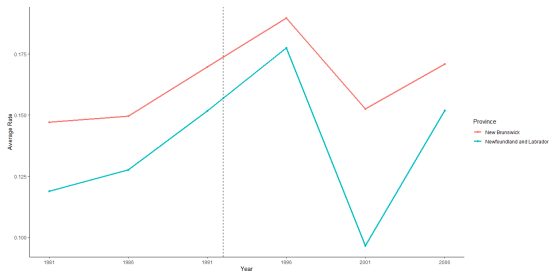
Figure A.6: Parallel Trends for Post Secondary Education Rates: Newfoundland Against New Brunswick



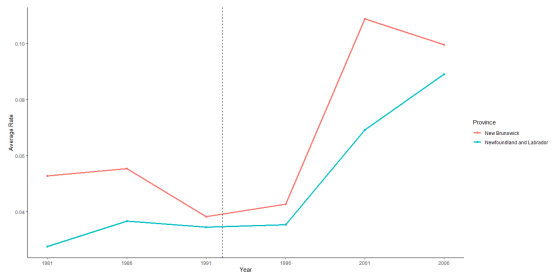
Y = Total Post Secondary Education Rate



Y = Trade Certificates Rate



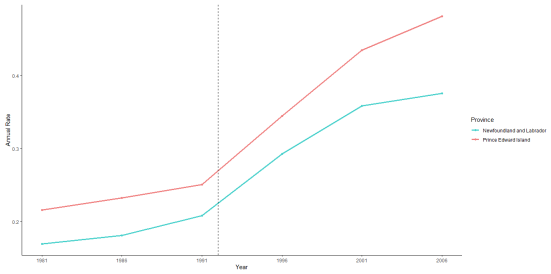
Y = Non-University Diploma Rate



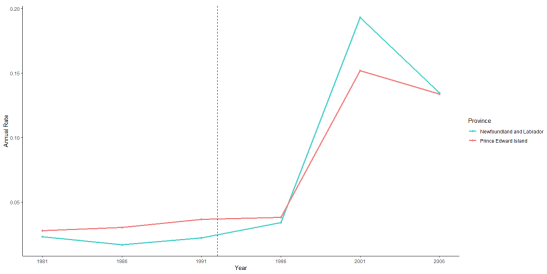
Y = University Diploma Rate

Note: New Brunswick is represented by red lines, and Newfoundland by blue lines. The vertical dotted line marks the 1992 moratorium.

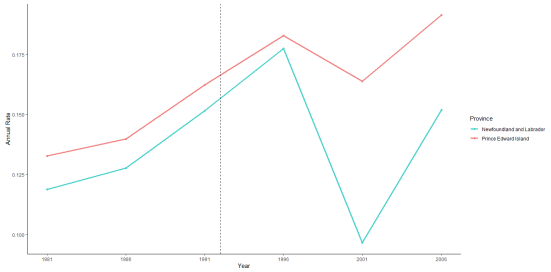
Figure A.7: Parallel Trends for Post Secondary Education Rates: Newfoundland Against Prince Edward Island



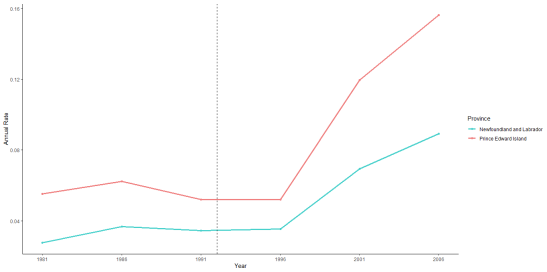
Y = Total Post Secondary Education Rate



Y = Trade Certificates Rate



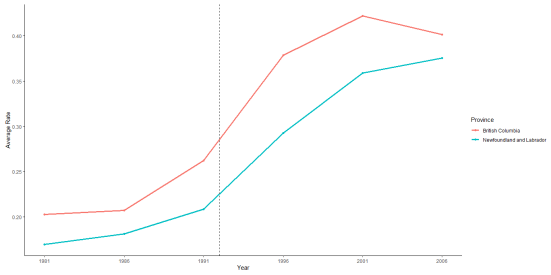
Y = Non-University Diploma Rate



Y = University Diploma Rate

Note: Prince Edward Island is represented by red lines, and Newfoundland by blue lines. The vertical dotted line marks the 1992 moratorium.

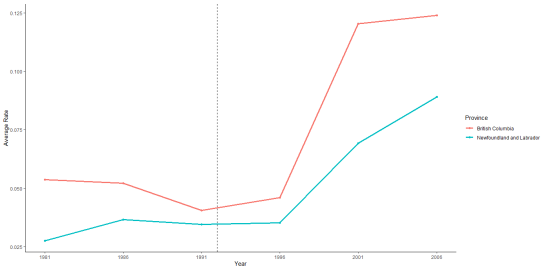
Figure A.8: Parallel Trends for Post Secondary Education Rates: Newfoundland Against British Columbia



Y = Total Post Secondary Education Rate

Y = Trade Certificates Rate

Y = Non-University Diploma Rate



Y = University Diploma Rate

Note: British Columbia is represented by red lines, and Newfoundland by blue lines. The vertical dotted line marks the 1992 moratorium.