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Domestic Transport Costs, Canada, and the Panama Canal

Camilo Umana Dajud

Highlights

- I exploit a natural experiment provided by the opening of the Panama Canal and intercoastal cargo routes connecting the west and east coasts of Canada through the canal to examine the causal impact of a reduction of domestic trade costs.

- Using least cost path routes along the Canadian transport grid I determine treated municipalities.

- The paper documents a positive impact of the reduction of transport costs on population and the value of real property but a negative impact on nominal wages.

Abstract

By reducing transport costs infrastructure can impact wages, the distribution of population and welfare among other important variables. In this paper I exploit a natural experiment provided by the opening of the Panama Canal and intercoastal cargo routes connecting the west and east coasts of Canada through the canal to examine the causal impact of a reduction of domestic trade costs. The particular characteristics of this setting allow me to estimate the causal impact without recurring to instrumental variable strategies. The estimates are also not confounded with the Keynesian effect of building new infrastructure since no infrastructure was actually setup in Canada. Using least cost path routes along the Canadian transport grid I determine treated municipalities. The paper documents the positive impact of the reduction of transport costs on population and the value of real property but a negative impact on nominal wages. I then use a simplified version of an economic geography model with perfect mobility of workers to compute domestic trade shares between Canadian municipalities and productivities at the municipal level. I use these empirical results and the model, to quantify general equilibrium changes in wages, population and trade shares triggered by the reduction in domestic transport costs. Finally, I show that the opening of intercoastal shipping routes had a large positive welfare effect across Canadian municipalities.

Keywords

Trade Costs, Infrastructure, Panama Canal, Canada, Welfare Effects.

JEL

O18, R12, R42.

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RESEARCH AND EXPERTISE
ON THE WORLD ECONOMY

Domestic transport costs, Canada, and the Panama Canal

Camilo Umana Dajud*

February 15, 2017

1 Introduction

While new or improved domestic infrastructure naturally reduces transport costs, it can also impact wages, population distribution and welfare among other important variables. Both theory and empirical evidence have indeed shown that changes in transport costs can have significant effects as agglomeration and dispersion forces come into play. But what is the magnitude of these effects? The question is particularly difficult to tackle as infrastructure is not randomly built. It is however an important question as these numbers should, for example, be pondered when deciding to invest in infrastructure projects. Not surprisingly there is an increasing interest in the subject. A significant number of recent papers try for example to answer this difficult question by instrumenting the placement of highways or railroads.

In this paper I tackle this question in a related but different manner. I use an exogenous shock that reduced domestic transport costs in Canada with no infrastructure actually built inside the country. The variation of domestic costs is triggered by the opening of a regular ocean freight line connecting Vancouver to the East cost of Canada through the Panama Canal. As explained in some detail below, Canada was not involved in any way in the design or construction of the Panama Canal. This particular setting has two advantages. First, being an exogenous shock, it eliminates the endogeneity bias introduced by the non-random placement of infrastructure. This feature allows me to estimate the causal impact without using instrumental variables. Second, since no infrastructure was actually built inside Canada, this framework allows me to purely identify the effects of a reduction of domestic transport costs without the noise introduced by the "Keynesian" effect of expenditure on the construction of infrastructure.

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I use historical maps of Canada's transport network to build least cost path routes between all Canadian municipalities. I then take advantage of historical data on Canadian municipalities to show empirically that the domestic transport costs reduction led to population and real property value increases while diminishing nominal wages in treated municipalities. I next use a multi-region model of economic geography[1] to solve for municipalities bilateral trade flows, amenities and housing consumption. Finally, I use the model's general equilibrium to quantify welfare gains arising from this reduction of transport costs.

The variation of domestic costs I use in this paper is the establishment of intercoastal cargo routes connecting Montreal to Vancouver through the Panama Canal. The Panama Canal was opened in 1920 to regular traffic. However the first regular intercoastal line connecting the St. Lawrence River with Atlantic ports and ports in British Columbia started to operate only during the second half of the year 1923. The opening of these intercoastal lines substantially reduced transport costs between the east and west coasts of the country. For non perishable goods the opening of these connections through the Panama Canal was reported to have reduced transport costs between Vancouver and Montreal by almost 70% (Innis and Plumptre (1934)). This considerably reduced domestic transport costs between many Canadian cities when compared to the transport costs via Canada's railroads and internal waterways. A telling example of this is given by trade costs between Regina in the province of Saskatchewan and Montreal. In 1921 the distance separating these two cities through the Canadian transport network was of 2629 km while the distance through the Panama Canal was of more than 15000 km. Most goods were nevertheless more cheaply shipped between these two cities via the Panama Canal than through the country's internal transport network.

It should be noted that it took almost four years for the firsts Canadian domestic routes through the Panama Canal to be opened. International shipping routes connecting Vancouver and Montreal to foreign ports through the canal were, in contrast, put in place soon after its opening in 1920. The reduction of international trade costs brought about the opening of the Panama Canal thus took place four years before.

To empirically examine the impact of this reduction, I begin by determining the length of least cost routes between all Canadian municipalities in 1927. I do this by georeferencing the Canadian transport network in 1927 including roads, railways and internal waterways. I then combine these least cost path routes with data on transport costs between London and different points in East Canada through the Panama Canal in order to measure transport costs of the canal route. Using this information, I determine which municipalities were treated by the opening of the new intercoastal trade route.

I combine next the data on least cost path routes with a historical yearly dataset of Canadian municipalities to empirically show the causal impact of the reduction of domestic transport costs. I show that the reduction of trade costs led to an increase in the population of treated municipalities. The decrease in domestic transport costs

[1] The model is a simplified version of Redding and Turner (2014)

increased also the value of real property. The opening of the intercoastal route reduced however nominal wages in treated municipalities.

I then use a simplified version of the multi-region model of economic geography developed in Redding and Turner (2014) to determine bilateral trade shares between municipalities as well as municipalities' productivities and housing consumptions. The model allows me to compute changes in bilateral trade shares between municipalities and to quantify welfare gains arising from the reduction in transport costs.

This paper is related to a recent and growing body of empirical literature examining the impact of infrastructure and the reduction of domestic transport costs on different outcomes. It is directly linked to a number of papers that have used the unintended connection of small towns or cities to highway grids. These studies exploit the fact that highways are often build to connect major cities. Michaels (2008) uses the construction of the US Interstate system to study the impact on skill premia. Faber (2014) and Banerjee and Duflo (2012) use the development of Chinese highways. Banerjee and Duflo (2012) focus on long term economic growth while Faber (2014) focuses on economic growth and industrial output. This paper is also related to empirical studies examining the impact of railroads. Atack et al. (2010) and Donaldson and Hornbeck (2013) study the impact of railroads in the United States. Donaldson (2010) examines their impact in India.

Compared to the existing empirical literature this paper presents several differences and advantages. First, the estimation strategy does not rely on an instrumental variable approach. This allows to avoid pitfalls associated with instruments: correlation with the omitted variables, weak instruments, or functional forms of the two-stage estimations. Second, cities of all sizes are impacted and not only small or medium towns and cities not taken into account in the planning of the transport infrastructure. Third, no actual infrastructure was built in Canada, hence estimates do not confound with the "Keynesian" effect of spending on infrastructure.

This paper also relies on a recent quantitative literature in international trade and economic geography. It is above all indebted to Redding and Turner (2014) and Redding (2016). The model I use to quantify general equilibrium outcomes and welfare changes is a simplified version of the models presented in these two papers. This literature builds on the recent advances in the quantitative trade literature. In particular, it builds on Eaton and Kortum (2002), Alvarez and Lucas (2007), Dekle and Eaton (2007) and Arkolakis and Costinot (2012).

The paper is organized as follows. In the next section I document the importance of the intercoastal trade route through the Panama Canal and discuss the data used to estimate its impact. In section 3, I present the empirical results of the causal impact of the reduction of domestic trade costs. In section 4, I present the theoretical model and determine bilateral trade shares, productivities and housing consumption at municipality level. I also quantify changes in bilateral trade shares and welfare. Section 5 provides conclusions and implications.

2 Intercoastal trade routes in Canada

2.1 Empirical context

The exogenous shock I exploit in this paper is linked to the opening of the Panama Canal. The opening date of this major infrastructure project remained extremely uncertain throughout its construction. The history of the Panama Canal was indeed a tumultuous one. Its construction was started in 1881 by a French private company. The company, however, went bankrupt in 1889. A second French company then took over the project in 1894, but also went bankrupt. In 1903, the Colombian government signed a treaty with the United States for the construction of the Canal. The Colombian congress refused however to ratify the treaty. Theodor Roosevelt decided then to finance a revolt in Panama to gain control of the strip of land required to build the canal. The revolt led to the independence of Panama. The new country's government granted total control to the United States during 99 years of the 77 km long strip of land needed to build the canal. Theodor Roosevelt declared: "I took the Isthmus, started the canal and then left Congress not to debate the canal, but to debate me." Its construction proved nonetheless extremely complex. Tropical diseases and numerous landslides delayed the project multiples times. The canal was finally about to open in 1914 but WWI was declared. That year the canal was opened only to military vessels. Only in 1920 the canal was finally opened to regular commercial traffic.

The first regular intercoastal line connecting Montreal to Vancouver through the Panama Canal was established in 1923. It may come as some surprise that the first intercoastal route was opened three years after the opening of the Panama Canal to regular traffic. The development of Canadian intercoastal trade through the Panama Canal was indeed hindered by a decision of the Dominion Department of Customs. The Canadian custom authorities decided that goods transported by steamships connecting Montreal to Vancouver but making a stop in New York would be classified as foreign for tariff purposes (The British Columbia Daily Colonist, 129). However, after the establishment of the first regular intercoastal line opposition to the treatment of Canadian merchandises going through the canal as foreign grew in British-Columbia (The Analyst November 19 cited in the Panama Canal Records v. 23). Businessmen in the western province demanded the appointment of Canadian customs officials in the port of New York to inspect Canadian inter-coastal trade. The British-Columbia government championed the request and introduced a resolution denouncing a violation of the Canadian Constitution (The Analyst November 19). In January 1924 the effort of the government of British-Columbia was finally successful and the Federal authorities accepted the appointment of a Canadian customs official. The main task of the officer was to inspect the Canadian origin of shipped goods. Goods from western Canada were thereon no longer treated as foreign goods (Isthmian Canal Commission (1923), p. 370).

The first steamship of an intercoastal line departed from Vancouver and crossed the

Table 1: Canadian domestic cargo tonnage going through the Panama Canal

Year	East coast to west coast	West coast to east coast	Total
1925	na	na	21,243
1926	33,290	85,175	118,465
1927	50,033	94,404	144,437

Author's own calculations based on information taken from several Panama Canal Records.

Panama Canal in June 1923. It carried lumber and salmon to Montreal and returned to Vancouver with general cargo including canned goods, salt and pianos (Isthmian Canal Commission (1923)). Right after the decision of the Federal Government of Canada to stop treating goods originating in Canada but going through the Panama Canal as foreign, the establishment of several new intercoastal regular lines was announced. By the summer of 1924, 11 ships were covering regular inter-coastal lines. Four steamships belonging to the Canadian Government Merchant Marines, 4 of the Huston Company and 3 Thomao Hading & Son ships (Isthmian Canal Commission (1923), p. 566). Intercoastal traffic grew rapidly. In 1927 144,437 tons of cargo were domestically traded in Canada by intercoastal shipping lines going through the Panama Canal (Isthmian Canal Commission (1927), p. 410).

It should be highlighted that international routes connecting Vancouver and Montreal started to operate soon after the opening of the Panama Canal to commercial vessels. Almost four years separate the opening of international routes and domestic routes through the Panama Canal. The impact of the reduction on transport costs on international trade was therefore at least partly absorbed before the opening of domestic routes. It should be also noted that large infrastructure projects such as highways or railroads also often reduce transport costs from inland cities to ports and reduce transport costs for international trade.

The very low transport costs via the Panama Canal, when compared to inland routes, explain the large amounts of goods shipped using intercoastal lines. In 1923, the freight rate for bulk cargo between Montreal and Vancouver through Canadian lakes and railroads was of 96 cents per ton (Canadian dollars). In contrast, the rate between these two cities, through the Panama Canal, for bulk cargo was almost 70% lower (30 cents per ton) (Isthmian Canal Commission (1923)). Table 2 compares shipping rates from Montreal to different points in Canada through the Panama Canal versus using Canada's internal lakes and railroads. The destinations are ordered from west to east. The most western destination in the sample is Vancouver while the most eastern is Winnipeg in the central province of Manitoba. The difference in average shipping rates

Table 2: Average Canadian domestic shipping rates in 1931 £ via the Panama Canal and via lake and rail

From	To	Rate via Panama Canal	Rate via lake and rail	Ratio Panama Canal / Lake and Rail
Montreal	Vancouver	2.40	18.82	0.13
Montreal	Calgary	10.10	33.40	0.30
Montreal	Edmonton	11.69	18.55	0.63
Montreal	Saskatoon	14.05	15.83	0.89
Montreal	Regina	14.05	14.77	0.95
Montreal	Winnipeg	15.99	11.43	1.40

Author's own calculations based on information taken from Innis and Plumptre (1934). The computations are based on shipping rates from London to the Canadian municipalities listed on the table. They are corrected for the difference in the distance of the maritime leg of the trip (i.e. from Montreal to Vancouver instead of London to Vancouver). The rates are an average of shipping rates of representative products: boots and shoes, crockery, hardware, cast iron pipe, machinery, wire rope, cotton and woolen goods, engine and lubricating oil, groceries and canned goods, confectionery, tea and coffee beans.

is for some destinations extremely large. The average rate from Montreal to Vancouver via the Panama Canal is only 13% of the average rate via lake and rail shipping. Figure 1 shows the geographical location of west Canada main municipalities. Shipping rates are lower as far west, from Vancouver, as Regina. This made shipping goods cheaper from Montreal to Regina, passing through the canal and Vancouver port, than using inland transport only. These two cities were separated by 1599.7 km through Canada's transport grid in 1923. The table shows that goods could be shipped from Montreal to municipalities located in the provinces of British Columbia, Alberta and Saskatoon at an average lower cost via the Panama Canal than via Canadian lakes and railroads.

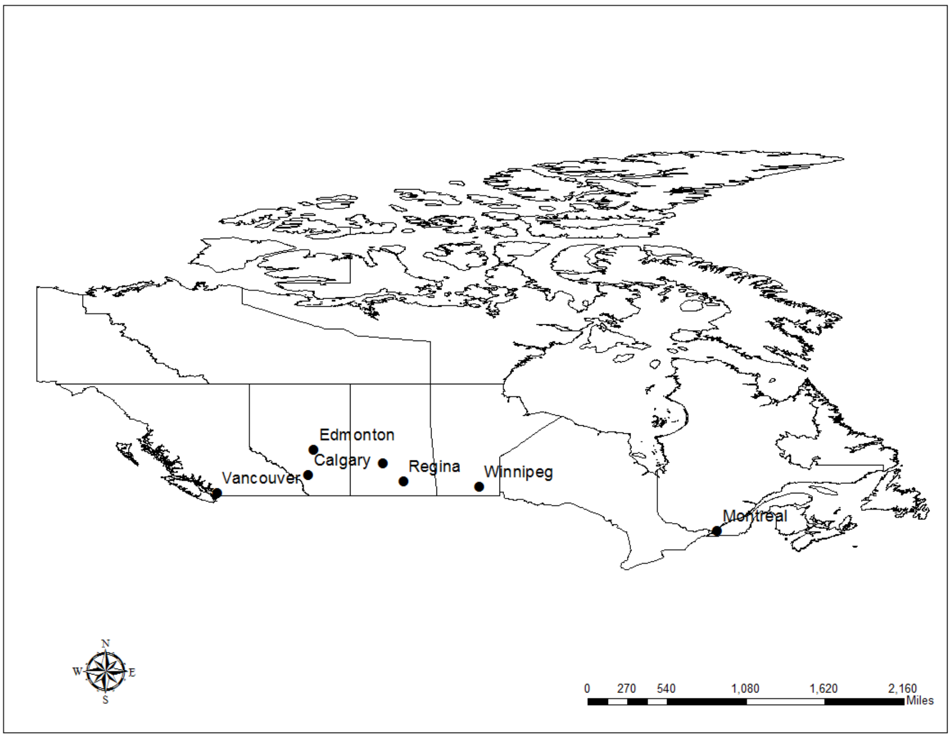
2.2 Data

The Canadian statistical authorities have collected data in a remarkably consistent way since 1870. The core of the data used here consists of historical Canadian statistics on population, wages, the value of real property and the development of the Canadian transport grid.

Data used for georeferencing Canada's historical transport grid comes from *The Canada Yearbook* which was published yearly between 1867 and 1967. Most of the data and maps used come from the 1927 Year Book. Data on municipalities coordinates comes from the Canadian Geographical Names Data Base (CGNDB). I construct least cost path routes between all Canadian municipalities through the country's transport network in 1927 by implementing Dijkstra's algorithm[2]. I use this data for the

[2] Dijkstra's algorithm is an algorithm to compute the shortest path between any two nodes in a graph.

Figure 1: Selected Canadian Municipalities



This map shows the main Canadian municipalities for which the difference of trade costs through the Panama vs. through Canadian railroads and lakes is presented in table 2.

empirical analysis (section 3) and to compute bilateral trade shares, amenities and housing consumption (section 4.2).

Data on population and the value of real property are taken from the yearly publication *Municipal Statistics*. It was published mainly for tax purposes and contains data on population, area, value of real property as well as assets and liabilities of all Canadian municipalities with a population of 10 000 or more. *Municipal Statistics* are the fruit of a deliberated effort to offer a "coordinated system" of "comparable data" throughout Canada. The data is used in section 3 to show the causal impact of the reduction in domestic transport costs.

Wage data come from census data. Since 1871 Canada has conducted mandatory censuses at least every 10 years. Data on wages comes from the 1921, 1931 and 1941 censuses. As a consequence these are also the years included in the sample used to estimate the causal impact on wages. The data is divided by gender. For 1921 average wages by gender for all municipalities were directly computed from individual responses to the census. The data is used to estimate the causal impact on wages as well as in section 4.2.

I employ additional data on shipping rates from Innis and Plumptre (1934) that documents the impact of the opening of the Panama Canal on the Canadian economy. Data on opening dates of intercoastal lines and of tons of cargo transported for Canadian domestic purposes through the Panama Canal comes from several volumes of the Panama Canal Records. The Panama Canal Records were published weekly since 1908 and contain detailed information on the construction, maintenance, and traffic going through the Panama Canal.

3 Empirical Analysis

In this section I use the opening of intercoastal freight lines connecting the west and east shores of Canada through the Panama Canal to estimate the causal impact of a reduction in domestic trade costs on three different outcomes. The chosen outcome variables are key variables in most economic geography models. I first discuss the empirical strategy and then show the impact of domestic trade costs reduction on population, nominal wages and the value of real estate property.

3.1 Estimation Strategy

To estimate the causal impact of the reduction of domestic trade costs on population, wages and the value of real estate property I exploit the exogenous shock provided by the opening of intercoastal shipping routes through the Panama Canal. Three features make the empirical setting particularly appealing. First, at no point in time Canada was involved in any way in the conception or construction of the Panama Canal. Trade with Canada wasn't either one of the reasons for which the canal was built. Second, as explained above, due to the complexity of the project the opening date of the canal remained extremely uncertain throughout its construction. Third, the reduction was triggered by opening intercoastal lines through the Panama Canal and therefore no infrastructure was actually built in Canada. The identified effect should therefore not be biased by Keynesian effects produced by the spending in the construction of new infrastructure.

I follow a number of estimation strategies to do this. The simplest one is a difference-in-differences strategy. I regress the log of the outcome variable in municipality m on year t, $outcome_{ms}$, on a dummy for treated municipalities, $TreatmentD_m$, a time dummy equal to 0 before the opening of the first intercoastal cargo line through the Panama Canal, $TimeD_t$, and on their interaction:

$$outcome_{ms} = TreatmentD_m + TimeD_t + TreatmentD_m \times TimeD_t + \epsilon_{mt} \tag{1}$$

The second estimation strategy is a fixed effects estimation. Specifically, I regress the log of the outcome variable on a treatment variable, $Treatment_{mt}$, equal to 1 for treated municipalities after the opening of the first intercoastal line, year fixed effects, FE_t and municipality fixed effects, FE_m:

$$outcome_{ms} = Treatment_{mt} + FE_t + FE_m + \epsilon_{mt} \tag{2}$$

The third strategy is based on a continuous treatment. It is similar to the estimation of equation (1) but this time the treatment variable is interacted with the log of the distance between municipality m and Vancouver which is the port from where intercoastal cargo lines departed. For treated municipalities the treatment is therefore equal to the log of the distance through the shortest path available using 1923 Canada's transport grid between each municipality and Vancouver. It is equal to 0 otherwise.

$$outcome_{ms} = Treatment_{mt} \times Dist_{mV} + FE_t + FE_m + \epsilon_{mt} \tag{3}$$

I determine the treated variables in three different ways. The three arise from the fact that before the opening of intercoastal trade lines through the Panama Canal, both the population and the production were concentrated in the eastern provinces of the country. In 1921, the population of eastern provinces accounted for nearly 80% of Canada's total population[3]. Moreover, as shown in table 1, cargo going from Vancouver to Montreal through the Panama Canal was almost three times larger in tons than cargo going in the opposite direction. Therefore, as a first strategy, I set as treated the municipalities located in the western provinces of British Columbia, Saskatchewan and Alberta. These are the provinces were, according to the information presented in table 2, the opening of the route reduced on average transport costs [Table 2]. The results are presented in tables 3, 6 and 9. I also determine treated municipalities exploiting Canada's transport grid in 1921. For this I compute the least cost path between each

[3]We considered as eastern provinces are Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario and Manitoba

Canadian municipality and Vancouver. I then do the same for Montreal and compare the length between the two least cost paths for each municipality. I then set as treated those municipalities where the least cost path route to Vancouver is shorter than the least cost route to Montreal. The results are presented in tables 4, 7 and 10. Finally, as already mentioned above, I also take into consideration differences in the intensity of the treatment by constructing a continuous treatment variable. For this, I take as treated the same municipalities as in the previous case and I interact the treated variable with the log of distance along the least cost path to Vancouver. The results are presented in tables 5, 8 and 11.

3.2 Population

The results of regressions (1) and (2) where the outcome variable is the log of population in each municipality are presented in table 3. The treated municipalities are the municipalities located in western provinces. The first column corresponds exactly to equation 1. The second column includes municipality fixed effects. The identification comes therefore from changes in transport costs and population. The third column (3) includes, in addition to municipality fixed effects, year fixed effects to control for average changes in transport costs and population in each year. The samples in the first three columns are unbalanced. Column (4) presents the results of using the same specification as in column (2) but on a balanced sample. Column (5) presents the results of using a balanced sample on the specification with municipality and year fixed effects. In all cases the opening of intercoastal routes had positive effect on the population of treated municipalities.

In the results presented in Table 4, the treated municipalities are the municipalities which are closer to Vancouver than to Montreal. To determine to which port a municipality is closer I use least cost paths along Canada's transport grid in 1923. The specifications are otherwise identical to those shown in table 3. The results are presented in the same order.

Table 5 presents the results of regression (3). The treatment dummy, defined in the same way as in table 4, is interacted with the log of the distance to Vancouver along the least cost path. The specification allows me to take into account differences in the intensity of the reduction of trade costs among treated municipalities. Column (1) presents the results of a simple difference-in-differences strategy with a continuous variable. Column (2) includes only municipality fixed-effects and column (3) includes both municipality and year fixed effects. Column (4) replicates the regression of column (2) on a balanced panel. Column (5) does the same for the specification of column (3). Finally, column (6) follows the difference-in-differences specification of column (1) on a balanced panel with municipality fixed effects.

The reduction of domestic transport costs had a positive impact on the population of treated municipalities. All the estimated coefficients estimated in table 3 are positive and statistically significant at the 10% level. In tables 4 and 5 the estimates are not

Table 3: Effect of transport cost reduction on Population I

	(1)	(2)	(3)	(4)	(5)
Time*Treatment Dummy	0.480[a]	0.863[a]	0.294[b]	0.837[a]	0.303[b]
	(0.168)	(0.138)	(0.152)	(0.158)	(0.169)
Treatment Dummy	-0.066				
	(0.272)				
Time Dummy	0.472[a]				
	(0.081)				
Constant	9.597[a]	9.793[a]	10.133[a]	9.980[a]	10.368[a]
	(0.134)	(0.012)	(0.039)	(0.044)	(0.053)
Year Fixed Effects	No	No	Yes	No	Yes
Town Fixed Effects	No	Yes	Yes	Yes	Yes
Balanced	No	No	No	Yes	Yes
R2	0.083	0.125	0.539	0.136	0.541
rmse	0.997	0.463	0.339	0.579	0.391
Observations	358	358	358	216	216

The dependent variable is the log of population in each town/city. Standard errors in parentheses are robust and clustered at the city/town level. Statistically signicant at [c] 15% [b] 10% [a] 5%

Table 4: Effect of transport cost reduction on Population II

	(1)	(2)	(3)	(4)	(5)
Time*Treatment Dummy	0.283	0.846[a]	0.210	0.846[a]	0.213
	(0.199)	(0.176)	(0.198)	(0.177)	(0.196)
Treatment Dummy	-0.228				
	(0.250)				
Time Dummy	0.563[a]				
	(0.092)				
Constant	9.831[a]	10.034[a]	10.454[a]	10.107[a]	10.545[a]
	(0.175)	(0.016)	(0.049)	(0.020)	(0.054)
Year Fixed Effects	No	No	Yes	No	Yes
Town Fixed Effects	No	Yes	Yes	Yes	Yes
Balanced	No	No	No	Yes	Yes
R2	0.099	0.094	0.572	0.109	0.586
rmse	0.958	0.565	0.392	0.577	0.399
Observations	230	230	230	186	186

The dependent variable is the log of population in each town/city. Standard errors in parentheses are robust and clustered at the city/town level. Statistically signicant at [c] 15% [b] 10% [a] 5%

always statistically significant at the 10% but remain positive.

Table 5: Effect of transport cost reduction on Population III

	(1)	(2)	(3)	(4)	(5)	(6)
Time*Cont. Treatment	0.006	0.063^a	0.016	0.063^a	0.017	0.017
	(0.020)	(0.013)	(0.015)	(0.013)	(0.015)	(0.014)
Time Dummy	0.602^a					0.630^a
	(0.087)					(0.077)
Constant	9.787^a	10.034^a	10.452^a	10.107^a	10.542^a	9.862^a
	(0.146)	(0.016)	(0.049)	(0.020)	(0.055)	(0.036)
Year Fixed Effects	No	No	Yes	No	Yes	No
Town Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Balanced	No	No	No	Yes	Yes	Yes
R2	0.095	0.095	0.573	0.111	0.587	0.320
rmse	0.958	0.565	0.392	0.577	0.399	0.506
Observations	230	230	230	186	186	186

The dependent variable is the log of population in each town/city. Standard errors in parentheses are robust and clustered at the city/town level. Statistically signicant at ^{c} 15% ^{b} 10% ^{a} 5%

3.3 Property Value

I present here the results where the outcome variable is the log of total value of real property. The value includes both land and buildings and was assessed in each year in every Canadian municipality for taxing purposes. As noted earlier the Dominion Bureau of Statistics made significant efforts to provide comparable data across Canada.

The results presented in this section follow the exact same order of the previous section. Table 6 presents the result of setting municipalities in British Columbia, Saskatchewan and Alberta as treated. In table 7 I use the least cost path strategy described earlier. In table 8 I use the distance to Vancouver through the least cost path to create a continuous treatment for municipalities for which the least cost path to Vancouver is shorter that the least cost path to Montreal.

The reduction of domestic transport costs had a significant positive impact in the value of real property. In all the estimations performed the coefficient associated with the treatment is positive. It is also statistically significant at the 10% level in all specifications presented in table 6. While the estimated coefficients presented in tables 7 and 8 are not always significant at the 10% level they remain always positive.

Table 6: Effect of transport cost reduction on the Value of Taxable Property I

	(1)	(2)	(3)	(4)	(5)
Time*Treatment Dummy	0.534^{a}	1.282^{a}	0.335^{b}	1.217^{a}	0.326^{b}
	(0.182)	(0.167)	(0.175)	(0.236)	(0.188)
Treatment Dummy	0.221				
	(0.327)				
Time Dummy	0.772^{a}				
	(0.096)				
Constant	15.896^{a}	16.291^{a}	16.781^{a}	16.723^{a}	17.336^{a}
	(0.167)	(0.014)	(0.046)	(0.066)	(0.064)
Year Fixed Effects	No	No	Yes	No	Yes
Town Fixed Effects	No	Yes	Yes	Yes	Yes
Balanced	No	No	No	Yes	Yes
R2	0.120	0.128	0.709	0.129	0.747
rmse	1.276	0.678	0.394	0.868	0.433
Observations	360	360	360	216	216

The dependent variable is the log of TotalValueTaxableProperty in each town/city.
Standard errors in parentheses are robust and clustered at the city/town level.
Statistically signicant at ^{c} 15% ^{b} 10% ^{a} 5%

Table 7: Effect of transport cost reduction on the Value of Taxable Property II

	(1)	(2)	(3)	(4)	(5)
Time*Treatment Dummy	0.530^{a}	1.259^{a}	0.255	1.259^{a}	0.320
	(0.237)	(0.202)	(0.222)	(0.203)	(0.222)
Treatment Dummy	-0.309				
	(0.269)				
Time Dummy	0.729^{a}				
	(0.123)				
Constant	16.358^{a}	16.643^{a}	17.175^{a}	16.732^{a}	17.295^{a}
	(0.210)	(0.019)	(0.083)	(0.024)	(0.107)
Year Fixed Effects	No	No	Yes	No	Yes
Town Fixed Effects	No	Yes	Yes	Yes	Yes
Balanced	No	No	No	Yes	Yes
R2	0.113	0.102	0.742	0.111	0.754
rmse	1.204	0.809	0.438	0.866	0.462
Observations	226	226	226	180	180

The dependent variable is the log of TotalValueTaxableProperty in each town/city.
Standard errors in parentheses are robust and clustered at the city/town level.
Statistically signicant at ^{c} 15% ^{b} 10% ^{a} 5%

Table 8: Effect of transport cost reduction on the Value of Taxable Property III

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time*Cont. Treatment	0.018	0.092^a	0.018	0.021	0.092^a	0.023	0.023
	(0.022)	(0.016)	(0.017)	(0.017)	(0.016)	(0.017)	(0.017)
Time Dummy	0.792^a			0.972^a			0.942^a
	(0.113)			(0.091)			(0.082)
Constant	16.292^a	16.645^a	17.177^a	16.187^a	16.735^a	17.297^a	16.372^a
	(0.170)	(0.020)	(0.083)	(0.047)	(0.025)	(0.108)	(0.040)
Year Fixed Effects	No	No	Yes	No	No	Yes	No
Town Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Balanced	No	No	No	No	Yes	Yes	Yes
R2	0.109	0.100	0.742	0.333	0.109	0.754	0.314
rmse	1.204	0.810	0.438	0.699	0.867	0.462	0.763
Observations	226	226	226	226	180	180	180

The dependent variable is the log of TotalValueTaxableProperty in each town/city.
Standard errors in parentheses are robust and clustered at the city/town level.
Statistically signicant at ^{c} 15% ^{b} 10% ^{a} 5%

3.4 Wages

This subsection presents the results of the estimations where the outcome variable is the log of nominal wages. The estimations are based on data from three different Canadian censuses: 1921, 1931 and 1941. The results are presented separately for males and females as well as pooled for both genders. Once again the results are presented in the same order. In table 9 municipalities in British Columbia, Saskatchewan and Alberta are set as treated. Table 10 uses the least cost path strategy described earlier and table 11 uses distance along the least cost path to Vancouver as a continuous treatment.

The estimated impact on wages is remarkably robust. The estimated coefficient is always negative and is statistically significant at least at the 15% level in 33 of the 35 different specifications presented in tables 9, 10 and 11. In table 9, all estimates are statistically significant at the 10% level. In table 10, only the estimation restricted to males that includes year and town fixed effects is not significant at the 10% level. In table 11 the specification presented in column (2) has the only estimated coefficient which is not significant at the 15% level.

Table 9: Effect of transport cost reduction on Wages I

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time*Treatment Dummy	-0.109^a	-0.096^a	-0.124^b	-0.183^a	-0.125^a	-0.248^a	-0.141^a	-0.083^b	-0.207^a	-0.266^a	-0.229^a
	(0.044)	(0.049)	(0.069)	(0.038)	(0.042)	(0.059)	(0.042)	(0.045)	(0.066)	(0.105)	(0.107)
Treatment Dummy	0.232^a	0.154^a	0.312^a								
	(0.041)	(0.040)	(0.068)								
Time Dummy	-0.101^a	-0.046^a	-0.112^a								
	(0.021)	(0.018)	(0.033)								
Constant	6.500^a	6.878^a	6.080^a	6.485^a	6.879^a	6.075^a	6.467^a	6.723^a	6.138^a	6.729^a	6.695^a
	(0.021)	(0.017)	(0.034)	(0.004)	(0.004)	(0.006)	(0.010)	(0.055)	(0.015)	(0.013)	(0.013)
Year Fixed Effects	No	No	No	No	No	No	Yes	Yes	Yes	No	No
Town Fixed Effects	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Balanced	No	No	No	No	No	No	No	No	No	Yes	No
Male Only	No	Yes	No	No	Yes	No	No	Yes	No	No	No
Female Only	No	No	Yes	No	No	Yes	No	No	Yes	No	No
R2	0.026	0.029	0.067	0.034	0.026	0.043	0.041	0.060	0.052	0.113	0.130
rmse	0.553	0.309	0.431	0.193	0.155	0.226	0.192	0.152	0.225	0.150	0.149
Observations	1942	991	951	1942	991	951	1942	991	951	234	234

The dependent variable is the log of nominal wages in each town/city. Standard errors in parentheses are robust and clustered at the city/town level. Statistically signicant at ^{c} 15% ^{b} 10% ^{a} 5%

Table 10: Effect of transport cost reduction on Wages II

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Time*Treatment Dummy	-0.227^{a}	-0.258	-0.195^{a}	-0.289^{a}	-0.348^{b}	-0.230^{a}	-0.245^{b}	-0.267	-0.222^{a}	-0.245^{b}	-0.289^{a}	-0.245^{b}
	(0.110)	(0.177)	(0.072)	(0.120)	(0.190)	(0.078)	(0.122)	(0.193)	(0.082)	(0.121)	(0.120)	(0.122)
Treatment Dummy	0.157^{a}	0.065	0.248^{a}									
	(0.064)	(0.056)	(0.081)									
Time Dummy	-0.066^{a}	-0.095^{a}	-0.037^{c}							-0.044^{a}		
	(0.021)	(0.024)	(0.025)							(0.019)		
Constant	6.741^{a}	7.146^{a}	6.336^{a}	6.722^{a}	7.100^{a}	6.343^{a}	6.685^{a}	7.145^{a}	6.348^{a}	6.747^{a}	6.727^{a}	6.690^{a}
	(0.027)	(0.030)	(0.036)	(0.012)	(0.020)	(0.008)	(0.014)	(0.024)	(0.015)	(0.017)	(0.013)	(0.014)
Year Fixed Effects	No	No	No	No	No	No	Yes	Yes	Yes	No	No	Yes
Town Fixed Effects	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Balanced	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Male Only	No	Yes	No	No	Yes	No	No	Yes	No	No	No	No
Female Only	No	No	Yes	No	No	Yes	No	No	Yes	No	No	No
R2	0.020	0.093	0.112	0.111	0.097	0.214	0.133	0.219	0.365	0.125	0.111	0.133
rmse	0.441	0.278	0.187	0.152	0.199	0.083	0.151	0.187	0.075	0.151	0.154	0.152
Observations	248	124	124	232	116	116	232	116	116	232	228	228

The dependent variable is the log of nominal wages in each town/city. Standard errors in parentheses are robust and clustered at the city/town level. Statistically signicant at ^{c} 15% ^{b} 10% ^{a} 5%

Table 11: Effect of transport cost reduction on Wages III

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Time*Cont. Treatment	-0.018^{a}	-0.020	-0.015^{a}	-0.023^{a}	-0.027^{b}	-0.018^{a}	-0.020^{a}	-0.022^{c}	-0.018^{a}	-0.020^{a}	-0.023^{a}	-0.020^{a}
	(0.008)	(0.014)	(0.004)	(0.008)	(0.014)	(0.004)	(0.008)	(0.015)	(0.005)	(0.008)	(0.008)	(0.008)
Treatment Dummy	0.162^{a}	0.073	0.252^{a}									
	(0.062)	(0.057)	(0.076)									
Time Dummy	-0.065^{a}	-0.093^{a}	-0.036^{c}							-0.041^{a}		
	(0.021)	(0.024)	(0.024)							(0.020)		
Constant	6.740^{a}	7.145^{a}	6.335^{a}	6.724^{a}	7.102^{a}	6.345^{a}	6.747^{a}	7.146^{a}	6.300^{a}	6.747^{a}	6.729^{a}	6.752^{a}
	(0.027)	(0.030)	(0.036)	(0.011)	(0.020)	(0.006)	(0.016)	(0.050)	(0.014)	(0.016)	(0.012)	(0.016)
Year Fixed Effects	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	Yes
Town Fixed Effects	No	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Balanced	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Male Only	No	Yes	No	No	Yes	No	No	Yes	No	No	No	No
Female Only	No	No	Yes	No	No	Yes	No	No	Yes	No	No	No
R2	0.021	0.097	0.116	0.127	0.108	0.251	0.146	0.228	0.401	0.139	0.127	0.146
rmse	0.441	0.277	0.186	0.151	0.198	0.081	0.150	0.186	0.073	0.150	0.152	0.151
Observations	248	124	124	232	116	116	232	116	116	232	228	228

The dependent variable is the log of nominal wages in each town/city. Standard errors in parentheses are robust and clustered at the city/town level. Statistically signicant at ^{c} 15% ^{b} 10% ^{a} 5%

4 General equilibrium changes

Since data on trade flows in this period of Canadian history is not available, in this section I use a simplified version of Redding and Turner (2014) to solve for bilateral trade shares between Canadian municipalities. The model also allows me to solve for municipalities' productivities and housing consumptions. More importantly, using the model I quantify changes in trade shares and welfare changes arising from the domestic transport cost reduction brought about by the opening of domestic Canadian intercoastal cargo routes through the Panama Canal.

4.1 The Model

The model I use in this paper is a simplified version of Redding and Turner (2014). There are $n \in N$ regions in the economy. In each region the consumption of the representative consumer is given by the following utility function:

$$U_n = C_n^{\mu} H_n^{\mu-1} \tag{4}$$

where C_n is the consumption of tradable varieties, H_n is the consumption of housing and $0 < \mu < 1$. The consumption of tradable goods is given by:

$$C_n = \left[\sum_{i \in N} M_i c_{ni}^{\frac{\sigma-1}{\sigma}} \right] \tag{5}$$

where M_i is the measure of varieties produced in i, c_{ni} is the consumption in municipality n of a variety produced in i. Trade of varieties is subject to iceberg costs. The price index is therefore given by:

$$P_n = \left[\sum_{i \in N} M_i p_{ni}^{1-\sigma} \right]^{1/(1-\sigma)} \tag{6}$$

where $p_{ni} = d_{ni} p_i$ and p_i is the price of differentiated varieties in municipality i and d_{ni} is cost of sending a good from i to n.

The income of workers is equal to wages plus the expenditure on housing which is redistributed to workers:

$$v_n L_n = \omega_n L_n + (1-\mu) L_n \tag{7}$$

where ω_n and L_n are the wage and the population in municipality n.

The production cost of variety i is given by:

$$x_i = \frac{(l_i - F)}{A_i} \tag{8}$$

where F is a fixed production cost, l_i is the labor required to produce x_i and A_i is the productivity in municipality i.

In this setting the equilibrium is given by the following system of equations [Redding and Turner (2014)]:

$$\omega_i \lambda_i = \sum_{n \in N} \pi_{ni} \omega_n \lambda_n \tag{9}$$

$$\pi_{ni} = \frac{\lambda_i (d_{ni} \omega_i / A_i)^{1-\sigma}}{\sum_{k \in N} \lambda_k (d_{nk} \omega_k / A_k^{1-\sigma}} \tag{10}$$

$$\lambda_n = \frac{\left[H^{1-\mu} \left(\frac{1}{\pi_{nn}} \right)^{\frac{\mu}{\sigma-1}} A_n^{\mu} \right]^{\frac{\sigma-1}{\sigma(1-\mu)-1}}}{\sum_{k \in N} \left[H_k^{1-\mu} \left(\frac{1}{\pi_{kk}} \right)^{\frac{\mu}{\sigma-1}} A_k^{\mu} \right]^{\frac{\sigma-1}{\sigma(1-\mu)-1}}} \tag{11}$$

where λ_n is the share of population of municipality n in Canada's total population (L_n/L) and π_{ni} is the share of trade flows originating in i and consumed in n in Canada's total trade flows. Following the spirit of "exact hat algebra" as proposed in Dekle and Eaton (2007) the system of equations describing the equilibrium can be used to perform counterfactuals. By solving only for changes in the main outcome variables data requirements are greatly reduced. The counterfactual values for changes can be obtained by solving the following system of equations:

$$\hat{\omega}_i \hat{\lambda}_i Y_i = \sum_{n \in N} \hat{\pi}_{ni} \pi_{ni} \hat{\omega}_n \hat{\lambda}_n Y_n \tag{12}$$

$$\hat{\pi}_{ni} \pi_{ni} = \frac{\pi_{ni} \hat{\lambda}_i (\hat{d}_{ni} \hat{\omega}_i / \hat{A}_i)^{1-\sigma}}{\sum\limits_{k \in N} \pi_{nk} \hat{\lambda}_i (\hat{d}_{nk} \hat{\omega}_k / \hat{A}_i)^{1-\sigma}} \tag{13}$$

$$\hat{\lambda}_n \lambda = \frac{\lambda_n \left[\hat{H}^{1-\mu} \hat{\pi}_{nn}^{-\frac{\mu}{\sigma-1}} \hat{A}_n^{\mu} \right]^{\frac{\sigma-1}{\sigma(1-\mu)-1}}}{\sum\limits_{k \in N} \lambda_k \left[\hat{H}_k^{1-\mu} \hat{\pi}_{kk}^{-\frac{\mu}{\sigma-1}} \hat{A}_k^{\mu} \right]^{\frac{\sigma-1}{\sigma(1-\mu)-1}}} \tag{14}$$

where the variables with “hats” are equal to the ratio of the variables after and before the counterfactual. That is in our case after and before the opening of intercoastal shipping routes.

The model also yields a convenient expression for welfare changes once changes in the main outcome variables have been computed. The following expression gives welfare changes in Canadian municipalities:

$$\frac{V_n^1}{V_n^0} = \left(\frac{\pi_{nn}^0}{\pi_{nn}^1} \right)^{\frac{\mu}{\sigma-1}} \left(\frac{L_n^0}{L_n^1} \right)^{\frac{\sigma(1-\mu)-1}{\sigma-1}} \tag{15}$$

4.2 Bilateral trade shares and municipalities' productivities

In a first step I use the model to compute productivities at the municipal level and bilateral trade shares among Canadian municipalities. For this we only need to observe wages, population shares and a measure of trade costs. Wages and population shares are taken from the Canadian census of 1921. Trade costs are set equal to $dist_{in}^{\phi}$ where $dist$ is the distance in km separating municipalities along the least cost path route. As in Redding (2016) ϕ is set equal to 0.33. This is consistent with the value routinely found for the elasticity of trade to distance [-1][4]. We also follow Redding (2016) in setting $\sigma = 4$ as estimated in Bernard et al. (2003) and $\mu = 0.25$ as estimated in Davis and Ortalo-Magné (2011).

Table 12 shows the productivities of Canadian municipalities obtained by solving equations 9, 10 and 11 for every municipality. The municipality with the highest productivity is Westmount. The largest Canadian municipalities are near the median productivity. Table 13 shows the 20 largest trade shares between Canadian municipalities. As expected, the largest trade shares occur between small municipalities and large cities located nearby. For example 33% of Quebec City's trade flows are absorbed by Montreal.

4.3 Counterfactual Changes

In this section I present counterfactual changes after the opening of intercoastal shipping routes through the Panama Canal and I quantify the effect on welfare. Counterfactual changes in wages, population and trade shares are obtained by solving equations 12, 13 and 14 for each municipality. In order to solve the system of equations data requirements are remarkably low. Only original trade shares, wages and population shares are required. Wages and population shares come from the 1921 Canadian census. Original trade shares are obtained by solving the model in the previous section.

The results of this counterfactual analysis are presented in tables 14, 15 and 16. Table 14 shows the 10 largest counterfactual changes in wages at the municipal level. The results presented are equal to the ratio of wages after and before the counterfactual. The largest increase in wages occurs in Outremont. Wages in Vancouver, the largest city in western Canada, are multiplied by 3.6.

Table 15 shows the 5 largest changes in trade shares for each one of the main western municipalities. Vancouver is the city that sees the largest increases in trade shares with eastern Canadian municipalities. Trade with Montreal for example is multiplied by 3.2. Vancouver trade with Trois-Rivières is multiplied by 3.8. Once we move toward municipalities located near the center of Canada, the increase in trade flows is smaller. Trade between Regina and Trois-Rivières is nonetheless multiplied by 1.16.

[4] See the meta-analysis performed in Disdier and Head (2008) and Head and Mayer (2013).

Table 12: Relative productivities of Canadian municipalities in 1921

City	Relative Productivity	City	Relative Productivity
Hull	.35	Sarnia	.54
Montreal	.36	Sydney	.54
TroisRivieres	.36	Verdun	.55
Guelph	.36	Brandon	.59
Quebec	.37	PortArthur	.6
Kingston	.37	NiagaraFalls	.61
Kitchener	.38	StBoniface	.61
Brantford	.38	Windsor	.61
Hamilton	.4	Calgary	.63
Stratford	.41	Winnipeg	.65
Peterborough	.42	Sherbrooke	.65
SaintJohn	.42	FortWilliam	.68
StCatharines	.45	Moncton	.69
Lachine	.45	Regina	.72
Toronto	.46	Edmonton	.73
London	.48	SaultSteMarie	.73
NewWestminster	.49	Outremont	.74
Vancouver	.49	MooseJaw	.75
StThomas	.51	Saskatoon	.8
Ottawa	.51	Westmount	1

Relative Productivity is the productivity of the municipality divided by the highest productivity of a Canadian municipality (i.e. Westmount).

Table 13: Largest bilateral trade shares among Canadian municipalities in 1921

Origin	Destination	Trade Share
StBoniface	Winnipeg	.53
NewWestminster	Vancouver	.53
Peterborough	Toronto	.46
Outremont	Montreal	.45
Verdun	Montreal	.45
Westmount	Montreal	.45
Lachine	Montreal	.45
Brantford	Toronto	.45
TroisRivieres	Montreal	.43
Sherbrooke	Montreal	.43
Hamilton	Toronto	.43
Guelph	Toronto	.42
Kitchener	Toronto	.42
Brandon	Winnipeg	.38
Stratford	Toronto	.36
StCatharines	Toronto	.36
NiagaraFalls	Toronto	.35
Ottawa	Montreal	.35
Hull	Montreal	.33
Quebec	Montreal	.33

Bilateral trade shares are equal to π_{in}. It is equal to the trade flow between two municipalities over total trade flows of a given municipality.

Table 14: Largest counterfactual changes in wages after the opening of the new trade route

Municipality	Change in Wages
Outremont	9.26
Verdun	4.88
Lachine	4.86
StBoniface	4.84
NewWestminster	4.74
PortArthur	4.64
FortWilliam	4.15
Westmount	4.11
Hull	3.66
Vancouver	3.62

This table presents the 10 largest counterfactual wage changes in Canadian municipalities. It is equal to the ratio of wages after and before the opening of intercoastal shipping routes through the Panama Canal $\hat{\lambda}_n$.

Finally, table 16 shows welfare changes computed using equation 15. We use as inputs the general equilibrium changes in population and trade shares obtained in the previous section. It is important to note that free movement of workers is a crucial assumption in the model. Because of this feature welfare changes are identical in all municipalities. Welfare increases in 66% across Canadian municipalities.

Table 15: Largest counterfactual changes in trade shares for the main municipalities of western Canada

Origin	Destination	Change in trade shares
Vancouver	TroisRivieres	3.79
Vancouver	Sherbrooke	3.79
Vancouver	Ottawa	3.29
Vancouver	Quebec	3.28
Vancouver	Montreal	3.18
Calgary	Sherbrooke	2.08
Calgary	TroisRivieres	2.02
Calgary	Quebec	1.87
Calgary	Kingston	1.8
Calgary	Ottawa	1.78
Edmonton	Sherbrooke	1.84
Edmonton	TroisRivieres	1.78
Edmonton	Quebec	1.66
Edmonton	Kingston	1.61
Edmonton	Ottawa	1.57
Saskatoon	Sherbrooke	1.42
Saskatoon	TroisRivieres	1.35
Saskatoon	Quebec	1.28
Saskatoon	SaintJohn	1.28
Saskatoon	Moncton	1.28
Regina	MooseJaw	1.54
Regina	Sherbrooke	1.22
Regina	TroisRivieres	1.16
Regina	SaintJohn	1.13
Regina	Moncton	1.13

This table presents the 5 largest changes in trade shares for each one of the main western municipalities. It is equal to the ratio of trade shares after and before the opening of intercoastal shipping routes through the Panama Canal $\hat{\pi}_{ni}$.

Table 16: Welfare Change

Welfare Change	1.66

This table presents the welfare change given by equation 15.

5 Conclusion

In this paper I exploit a natural experiment provided by the opening of the Panama Canal and intercoastal cargo routes connecting the west and east coasts of Canada through the canal. I use this natural experiment to examine the causal impact of a reduction of domestic trade costs on the distribution of population, wages and the value of real property. The particular characteristics of this setting allow me to estimate the causal impact without recurring to instrumental variable strategies. The estimates are also not confounded with the Keynesian effect of building new infrastructure since no infrastructure was actually setup in Canada. They are also not limited to small or medium urban agglomerations since Canadian municipalities of all sizes were affected by the opening of intercoastal trade routes.

Using least cost path routes along the Canadian transport grid I determine treated municipalities. Then using different estimation strategies the paper documents the positive impact of the reduction of transport costs on population and the value of real property but a negative impact on nominal wages. The average estimate of the effect of the reduction of transport costs on population growth of treated municipalities is 50%. For the increase of the value of real property, the average estimate is of 60%. The average estimate of impact on nominal wages is -15%.

I then use a simplified version of an economic geography model with perfect mobility of workers to compute domestic trade shares between Canadian municipalities and productivities at the municipal level. I use these empirical results and the model, to quantify general equilibrium changes in wages, population and trade shares triggered by the reduction in domestic transport costs. Finally, I show that the opening of intercoastal shipping routes had a large positive welfare effect of nearly 60% across Canadian municipalities.

References

Alvarez, Fernando and Robert E Lucas, “General equilibrium analysis of the Eaton–Kortum model of international trade,” *Journal of monetary Economics*, 2007, *54* (6), 1726–1768.

Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare, “New trade models, same old gains?,” *The American Economic Review*, 2012, *102* (1), 94–130.

Atack, Jeremy, Fred Bateman, Michael Haines, and Robert A Margo, “Did railroads induce or follow economic growth?,” *Social Science History*, 2010, *34* (02), 171–197.

Banerjee, Abhijit, Esther Duflo, and Nancy Qian, “On the road: Access to transportation infrastructure and economic growth in China,” Technical Report, National Bureau of Economic Research 2012.

Bernard, Andrew B, Jonathan Eaton, J Bradford Jensen, and Samuel Kortum, “Plants and productivity in international trade,” *The American Economic Review*, 2003, *93* (4), 1268–1290.

Davis, Morris A and François Ortalo-Magné, “Household expenditures, wages, rents,” *Review of Economic Dynamics*, 2011, *14* (2), 248–261.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum, “Unbalanced trade,” Technical Report, National Bureau of Economic Research 2007.

Disdier, Anne-Célia and Keith Head, “The puzzling persistence of the distance effect on bilateral trade,” *The Review of Economics and statistics*, 2008, *90* (1), 37–48.

Donaldson, Dave, “Railroads of the Raj: Estimating the Impact of Transportation Infrastructure,” *The American Economic Review forthcoming*, 2010.

Donaldson, Dave and Richard Hornbeck, “Railroads and american economic growth: A" market access" approach,” Technical Report, National Bureau of Economic Research 2013.

Eaton, Jonathan and Samuel Kortum, “Technology, geography, and trade,” *Econometrica*, 2002, *70* (5), 1741–1779.

Faber, Benjamin, “Trade integration, market size, and industrialization: evidence from China’s National Trunk Highway System,” *The Review of Economic Studies*, 2014, p. rdu010.

Head, Keith and Thierry Mayer, “Gravity equations: Workhorse, toolkit, and cookbook,” 2013.

Innis, Harold Adams, Arthur Fitz Walter Wynne Plumptre et al., *The Canadian Economy and Its Problems*, Canadian Institute of International Affairs, 1934.

Isthmian Canal Commission, US, "Panama Canal Records," *Panama Canal Records*, 1923, *Vol.17.*

Isthmian Canal Commission, US, "Panama Canal Records," *Panama Canal Records*, 1927, *Vol.21.*

Michaels, Guy, "The effect of trade on the demand for skill: Evidence from the interstate highway system," *The Review of Economics and Statistics*, 2008, *90* (4), 683–701.

Redding, Stephen J, "Goods trade, factor mobility and welfare," *Journal of International Economics*, 2016, *101*, 148–167.

Redding, Stephen J and Matthew A Turner, "Transportation costs and the spatial organization of economic activity," Technical Report, National Bureau of Economic Research 2014.