

Competition in Infrastructure Investment Among Canadian Provinces

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This paper evaluates the importance of the interaction between provincial governments on infrastructure spending. In addition to the interdependence between the provinces in infrastructure investments, the role of federal grants, demographics and urbanization is also discussed throughout the paper. In order to conduct this empirical study, we test whether there is any evidence of strategic interaction between Canadian provinces in infrastructure spending. The results indicate that provinces are not independent in their spending decisions and in some cases, they are significantly influenced by the spending of their neighbors. However, interdependency of provincial spending in infrastructure may not be as strong as expected.

1. Introduction

The state of infrastructure in Canada represents an important part of our potential to expand economically and compete internationally as well as within the country. Despite the enormous advances that have been made in technology, transportation and communications over the past few decades, there remains the challenge to maintain and at the same time innovate our infrastructures. The costs of repairs and new projects are quite significant and require the involvement of different levels of government.

Recent theoretical literature has emphasized how competition to attract mobile capital may lead to inefficient levels of investment in public infrastructure. Such outcomes suggest that there is an important role for coordination of infrastructure spending policies. However, there is a serious lack of empirical evidence on this subject. In this paper, we investigate how important the interaction between governments on infrastructure spending might be. Furthermore, we explore the other possible influences to provinces' spending decisions. To conduct this empirical study, we test whether there is any evidence of strategic interaction between Canadian provinces in infrastructure spending.

Thus, competition and coordination in infrastructure investment between the Canadian provinces will be the main focus of this paper. In addition to the interdependence between the provinces in infrastructure investments, the role of federal grants, demographics and urbanization will also be discussed throughout the paper.

First, we will present a short review of literature describing the evolution of different theories of fiscal competition. Theory on tax competition will be studied initially and then extended to public input competition, more specifically, infrastructure competition. Several models suggest that governments tend to under-invest in public goods and services. Comparisons between those who coordinate their policies and those who don't are made in order to evaluate how much interdependence is efficient between governments. Proposed solutions such as subsidies and revenue sharing are considered as well.

Second, the empirical literature inspired by Case, Rosen and Hines (1993) on fiscal interactions between governments is analyzed. Following their methodology and the ones from a more recent literature, we build the empirical model for this paper. Further, we describe the variables of the model that include annual observations for the Canadian provinces from 1981 to 2004. Several regressions will be tested as to determine the most influential variables in infrastructure spending.

In section 4, the results of the empirical study are presented. We determine whether or not provincial per capita spending is positively influenced by the expenditures of the neighboring provinces. The theory as well as the empirical literature suggest that the competing governments will behave strategically with each other and be positively affected by their neighbors' policy choices.

2. Review of the Literature

2.1 Theoretical Literature

Countries or regions within them compete with each other to attract new capital and enhance their productivity. To achieve their objectives, governments often use tax policy or public inputs in order to make their jurisdiction attractive for capital, labour and businesses. Several theories exist about the impacts of fiscal competition on tax policy and public spending. Most of the literature is focused on models that study tax competition. While it is not the main focus of this paper, tax competition will be briefly discussed in order to provide a better understanding of the fiscal competition process. Furthermore, it will be compared to the central issue of this paper, which is infrastructure competition.

Wilson and Wildasin (2004) broadly define tax competition as: “any form of noncooperative tax setting by independent governments.” The authors narrow their definition of tax competition by adding that interdependence exists between governments’ budgets. This interdependence can be explained by the fact that the governments are connected through their treasuries. More specifically, each region’s tax policy will influence the allocation of tax revenue across government treasuries (Wilson and Wildasin, 2004). This specifies the definition of tax competition where the authors describe the tax setting such that policies chosen by the governments “influence the allocation of a mobile tax base among regions.”(Ibid, 1067)

Wilson (1999) provides a summary of different theories of tax competition starting with the ideas from the early literature to the more recent models. The general view, particularly in the early literature, is that tax competition will lead to inefficient

outcomes such as very low tax rates and public expenditures. However, some authors have argued that fiscal competition may lead to efficient outcomes as well under some circumstances.

First, Tiebout's paper from 1956 about efficient provision of local public goods is an example of welfare-enhancing tax competition (Wilson and Wildasin, 2004). He focuses on the goods provided by local governments and examines what kinds of services will influence consumer-voter's choice of municipality. The "consumer-voter" will choose to live in a community which best satisfies his preferences for public goods and for the taxes required for those services (Tiebout, 1956). Tiebout explains that this helps solve the government's problem when providing public goods because individuals reveal their true preferences by moving from one community to another. In his model, the important assumptions are that consumer-voters are fully mobile and have all the information they need about services provided and taxes required in the other communities. Therefore, given these assumptions, moving into a new community or failing to do so will help reveal consumer-voter's demand for public goods (Ibid, 420). Moreover, Tiebout explains that communities' expenditures will then reflect the desires of their residents.

Later on, Oates (1972) made an important contribution to the modern literature on this subject. The main idea in his work is that competition can lead to inefficiencies for the governments when all of them are competing in the same manner. He explains that while governments tend to set low taxes to attract new workers and businesses, at the same time they reduce their public spending below the efficient levels (Wilson, 1999).

Zodrow and Mieszkowski (1986) provided one of the first formal analyses of tax competition. The main focus of their paper is to examine whether the use of distorting taxes, rather than the head taxes, reduces the provision of public services. In their model, there are identical jurisdictions between which there are no spillovers but capital is mobile. The authors believe that these assumptions correct for the inefficiencies such as the ones in Tiebout's paper, where the communities differ according to the tastes of their residents. Moreover, they assume that governments of the jurisdictions act as if their competitors did not respond to their actions regarding capital taxes (Zodrow and Mieszkowski, 1986, 359).

In the model, local governments want to maximize their residents' utility using public goods and tax rates (Wilson and Wildasin, 2004, 1069). In addition, Zodrow and Mieszkowski compare the capital tax equilibrium to the head tax equilibrium of their model. The main result of this study is that the use of taxes on mobile capital, as opposed to non-distortionary head taxes, will lower the overall government spending on public services below their efficient levels even though the overall national stock of capital is fixed.

Similarly to Zodrow and Mieszkowski, Wilson's (1986) conclusions are that tax competition will lead to inefficient levels of taxes and public expenditures. Furthermore, Wilson shows in his model that governments would be more efficient if they imposed lump sum taxes to their residents (Wilson, 1986). This efficiency results from the assumption that the government would stop trying to stimulate capital investment by using inefficient taxes.

Wildasin (1989) takes the main findings of previous authors and looks for a solution to the inefficiencies created by tax competition. First, he shows that those inefficiencies can be seen as externalities. For example, as the tax rate in one jurisdiction increases, the flow of capital into other jurisdictions increases as well (Wildasin, 1989). Since governments do not take into account the positive effect of an increase of their tax rate on the capital stock of other jurisdictions, tax policies involve externalities. The proposed solution is a proper subsidy. Wildasin suggests that this subsidy should be provided by the central government. It would need to ensure that each region receives a subsidy that is equal to the tax revenue that other regions receive as a result of an increase in its taxes. As for the financing of the subsidies, Wildasin assumes that the central government would use its own nondistortionary tax base to make transfers to local governments (Wildasin, 1989).

Zodrow and Mieszkowski, Wilson and Wildasin have focused mainly on how tax competition affected the levels of public spending. Extending the literature, Keen and Marchand (1997) have studied the impact of fiscal competition on the composition of public spending. They describe two forms of public spending that can be broadly referred to as spending on consumption public goods and on production public goods, or public inputs. The first one includes social services, for example, as well as any public good that directly provides consumption benefits to individuals. The second form of public spending includes factors such as infrastructure and training expenditures.

When comparing their findings with Zodrow and Mieszkowski's, Keen and Marchand find that the previous results are reliable only in a case where the only

instrument used for the policy is a tax on capital. Their analysis shows that governments may have a tendency to afford greater expenditures for public inputs and under-provide public goods. The reason behind this is that even if public goods benefit the people living in the particular jurisdiction, they will not allow for any increases in productivity and accumulation of new capital (Wilson, 1999). Moreover, Keen and Marchand highlight the importance of coordination between jurisdictions on both the level of taxes and the composition of public spending.

A general conclusion that can be drawn from the papers studied above, is that there are no clear-cut models that would provide significant results at all times. Over the years, the literature on fiscal competition has evolved as more aspects of it are studied. As newer models are developed, significant findings on competition in investment or public inputs have been presented.

Governments usually compete for mobile factors and while the taxes remain the main instrument in such competition, public investment competition has recently been studied considerably in the literature.

Public expenditures have an important role in stimulating growth and productivity of a region. Investment in infrastructure represents a significant part of these expenditures since its quality and size affect the regional income and the return on mobile factors. As a result, such investments attract mobile factors that in turn stimulate regional productivity. Harchaoui, Tarkhani and Warren (2004) studied the evolution and the main components of public infrastructure in Canada. What initiated them to look into this subject is the concern that public investment in Canada is not keeping pace with the economic growth. In the next section we will analyze the interdependence

between provinces' spending on infrastructure. However, before continuing it is useful to review the literature on public input competition. Recent contributions include Bucovetsky (2005; 2006), and Hendricks, Peralta and Weber (2005).

Bucovetsky (2005) considers public input competition between governments. Usually, in tax competition, regions attract mobile factors by lowering the source-based taxes (Bucovetsky, 2005). However, Bucovetsky's main goal is to illustrate how using public investment in infrastructure affects competition when governments do not cooperate. He finds that public investment in infrastructure attracts mobile factors and that it can lead to the creation of agglomeration economies. In that case, competition among jurisdictions using public investment is expected to be destructive (Bucovetsky, 2005, 1763). For example, Bucovetsky explains that the problems arise because the non-cooperative governments tend to invest too much which leads to inefficient distribution of public investment. Further inefficiencies arise because too many regions will choose to invest. Consequently, regions tend to ignore the negative effects their public investment has on the mobile factors of all the other regions (Bucovetsky, 2005, 1776).

Bucovetsky is interested in scale economies that may emerge as a result of the investments in public infrastructure. He explains that scale economies were studied in several recent growth models. For example, it was argued that in order to develop high-growth areas with different industries, investment in infrastructure is required (Ibid, 1764). This would lead to the concentration of some economic activities in specific regions. The behaviors of these regions' governments are studied, assuming that they do not cooperate and have no central authority. Part of the author's conclusion is that

competition between governments will dissipate the gains that could be acquired from attracting the mobile factors. Further, Bucovetsky concludes that in the presence of economies of scale at the regional level too many non-cooperative governments may invest too much when competing with each other. He suggests that in order to have an efficient outcome, only one region should do public investment. However, he recognizes that such equilibrium may not exist.

Bucovetsky (2006) extends his research on the subject and brings some modifications to his previous paper. First, while in the prior study the maximization of the gross value of regional output was analyzed, in the more recent one, regional governments are concerned with maximizing net regional income. As a result of that, it is expected that regions would be less competitive when factor payments to outsiders are not taken into account. The most important change from the previous paper is the new assumption that regions negotiate among themselves. The negotiations will occur only after each region has chosen its initial level of public investment. Transfers between regions will be the result of these negotiations. Furthermore, Bucovetsky assumes that public investment is irreversible, permanent and without depreciation.

The author establishes that when industries in a region have to pay in order to attract mobile factors, their governments will be less inclined to take on public investment. What usually occurs is that governments tend to under-invest. Bucovetsky proposes negotiation between the governments to solve this problem. He assumes that costs of public investments would be shared among regions, if they negotiate. The benefits of these investments would be shared between regions as well. However, it is assumed that if a region does not invest in public input, it will not attract any of the

mobile capital. (Bucovetsky, 2006, 4). In addition, in his results, Bucovetsky finds that as long as there is a possibility of future negotiation, there still might be under-investment. That is because of regions that do not want to see their bargaining position weakened due to high levels of investment (Ibid, 31).

Bucovetsky further concludes that whether governments can coordinate their actions when making public investment decisions or not, agreements on taxes can be very useful. In fact, the gains from tax coordination would allow the high-investment regions to induce a more efficient investment across other regions.

Another interesting part of the literature includes competition in taxes and investment under fiscal equalization. Hindricks, Peralta and Weber (2005) address the issue in a model where capital is mobile across regions and where taxes and public expenditures on infrastructure are the main competition instruments. They assume that regions first choose public investments and then the taxes. Following this assumption, even if regions set higher taxes, they can appear more attractive when offering a better set of public investments. Such interaction between taxes and public investment leads to certain inefficiencies.

Fiscal externalities problems might appear as a result of a mix of the competition instruments. Therefore, the authors propose to use revenue sharing to solve these problems. Revenue sharing has two different outcomes. Hindricks, Peralta and Weber define the first outcome as positive since it moderates the aggressive tax competition that results in tax rates that are too low. Furthermore, the second effect is defined as negative due to the moral hazard problem where certain governments will tend to invest less when the benefits are shared among regions. The authors explain that

revenue sharing is nevertheless desirable since it induces the regions to compete less aggressively.

In addition, Hindricks, Peralta and Weber conclude that revenue sharing has three effects. There are, the internalization of the fiscal externality and the discouraging of public investment. These are efficiency related effects. The third one is the redistributive effect. Also, revenue sharing affects positively the taxes and this effect is greater than the negative impact it has on public investments.

As for the two policy instruments studied, they conclude that using them in competition between regions leads to very different results. While public investments attract capital, taxes drive it away.

Finally, the most important conclusion is that there will be strategic under-investment in infrastructure even if there is no revenue sharing. The reason for this is that infrastructure investment leads to more aggressive tax competition, where regions set lower taxes. (Hindricks, Peralta and Weber, 2005).

In the more recent literature, tax and input competition have become important topics when discussing the European Union. Benassy-Quere, Goyalraja and Trannoy (2007) study the existence of a “race to the bottom” in those regions. They define this “race to the bottom” as: “any series of competitive and non-cooperative tax cuts made by national governments with the ambition of attracting more foreign capital”(Benassy-Quere, Goyalraja and Trannoy, 2007, 387). In their paper, they use Zodrow and Mieszkowski’s (1986) model and develop it to fit the EU situation and their firms’ production process. In the new model both firms and households use the public input. They show that different strategies can be implemented by the countries when setting

their combination of tax rates and public inputs. The combination should be set in accordance with the marginal private rate of return on public input. The higher the return, the higher the tax rate should be (Benassy-Quere, Goyalraja and Trannoy, 2007). They conclude that tax competition in EU countries leads to more complex results than the race to the bottom and that, beside taxes, financing of public goods is widely used by the competing governments.

Different models studied in this section reveal several common points about fiscal competition and more precisely about tax and public input competition. First, there is the general agreement that tax competition could lead to certain inefficiencies in public spending. However, the newer literature considers solutions such as subsidies, negotiation and revenue sharing in competitive environments. Further, the combination of the two policy instruments in competition is studied. Since each one of them can lead to very different outcomes, careful planning of governments' strategies in competition is required.

2.2 Empirical literature

One of the first empirical papers in this literature is by Case, Hines and Rosen (CHR) (1993), which provides the basic framework for the empirical investigation conducted in the current paper. Their study tested the hypothesis that public spending of state governments in United States depends on the expenditures of similar states or their neighbors. The model has been estimated using annual data on the continental United States from 1970 to 1985. They found that the expenditure levels of neighboring states positively affect states' per capita expenditures.

CHR start with the following equation:

$$E_{it} = \theta WE_{jt} + \beta X_{it} + u_{it}$$

where E_{it} denotes state i 's expenditures in year t , with $i=1, \dots, 48$ and $i \neq j$. The E_{it} variable depends on two main factors. First, on the characteristics of the state described by the X_{it} matrix and on the expenditures of the neighbors. X_{it} is a matrix of explanatory variables. This matrix includes variables such as population density, state per capita income and income squared, federal grants to states, fraction of population over 65, fraction of population between 5 and 17 and the fraction of population that is black. W is a weighting matrix that determines the neighborliness of the other states. For example, the i th row of W matrix assigns to E_{it} a weighted average of neighbors' spending: $\sum_j w_{ij} E_{jt}$ (CHR, 1993).

CHR find that there might be correlation between neighbors' levels of spending due to random shocks. This could lead to inaccurate conclusions since influences of one state on another can be discovered without them actually being

present. To avoid this problem, CHR allow for correlation between the error terms by writing:

$$u_t = \rho W u_t + \varepsilon_t$$

In this equation, ε_t is an error that is uncorrelated between the states (CHR, 1993).

Moreover, CHR propose different specifications of the weighting matrix. The first possibility is to use geographic proximity to weight the spending of the other provinces. For instance, states sharing a common border are more likely to interact with each other in their fiscal choices (CHR, 1993). CHR also propose to consider as neighbors all those states that have similar demographics or economic components. Therefore three matrices were constructed based on geographic proximity, per capita income and percentage of the population that is black. For each case, a time-invariant weighting matrix is created based on the average of the variable over time (Baicker, 2001).

CHR explain that the biggest challenge was the process of assigning neighbors. The main question was: "What is likely to be the most common factor among states that influence each other?" (CHR, 1993, 305) From the three possibilities explained above, the authors have found that the best performing measure was the one based on the percent of population that is black. When neighborliness is based on the percentage of black in the population, they found that a one-dollar increase in the other states' expenditures increases state spending by over 70 cents. On the other hand, a surprising result is obtained when the weights are based on the geographic proximity. They find that an increase of one dollar in neighbors' spending will decrease a state's spending by 22 cents.

Newer literature follows the basic features of CHR model but proposes some modifications to it in hope for more significant results. One of those papers is by Baicker (2001). She investigates how much state spending is affected by the spending of the neighboring states as well as the reasons behind it. While following the basic structure of CHR's paper, Baicker extends it and investigates the effects of neighboring states using an alternate methodology. Her work differs from CHR's mainly because she studies different weighting matrices in order to determine the most significant measure of neighborliness.

Baicker uses five measures of neighborliness and tests them in order to see which one performs the best. The measures used are based on: geography, income, percent of black population, population-weighted geography and interstate mobility. The results show that the percentage of black population and interstate mobility matrices are the most significant. However, even if CHR had a similar conclusion about the percentage of black population, Baicker finds that those results may not be significant enough and that they are misleading. According to her, the interstate mobility is the best predictor of spending interaction.

An important feature in Baicker's model is the use of instrumental variables in the regression. She tested the data using two different approaches in constructing the instrumental variables. First, Baicker defined the instruments as the neighbor values for all the variables of the X matrix. Second, she used "three sources of variation in state medical spending to instrument for the actual state spending of neighbors" (Baicker, 2001, 9). For instance, one of the instruments is based on the fact that changes in medical costs affect differently the state budgets from one year to another.

In a very recent paper, Redoano (2007) studies the fiscal interactions between the European countries. Fiscal interdependencies and competitive behaviors of different countries are observed. This paper is an extension of the study by Case, Hines and Rosen (1993). Apart from the fact that Redoano examines European countries rather than states within a country, there are several other specifications that are put forward. Unlike CHR and Baicker who study primarily public expenditures, Redoano examines both tax and public expenditure competition. Redoano estimates “reaction functions for taxes on income and capital, and public expenditures” (Redoano, 2007, 4). The data used is on western European countries from 1970 to 1999. The author explains that his paper is the first to study the European countries since the rest of the literature on this subject, such as work by CHR and Baicker, considers only the United States. Another important difference from the previous papers is that Redoano investigates whether the interdependencies between the European countries are due to strategic interactions such as tax competition and fiscal externalities or if they are simply common trends.

Redoano’s basic model, based on CHR’s, is the following:

$$E_{it} = \alpha_i + \sum \theta_{ij} E_{jt} + X_{it} \beta + u_{it}$$

where E_{it} represents public expenditures, as previously explained. It is dependent on the fiscal choices of the neighboring states, E_{jt} as well as on the vector of country specific control variables, X_{it} . Redoano includes in the equation the state fixed effect α_i and u_{it} is the random error.

The equation is modified, however, in the following way:

$$E_{it} = \alpha_i + \theta' A_{ij} + X_{it} \beta + t_{it} \gamma + u_{it}$$

where A_{ij} represents the weighted average of other states' fiscal choices. Redoano explains that the first version of the equation would be difficult to estimate since too many parameters θ_{ij} would have to be considered. Instead, the new specification of the equation includes A_{ij} that can be expressed as $\sum w_{ij}E_{jt}$ where w_{ij} represents the weights and $i \neq j$. Redoano also adds the variable t_{it} , which is the country-specific linear time trend allowing to control for macroeconomic shocks.

To provide more precision about w_{ij} , Redoano proposes different weighting schemes. First, there is a very simple one where the weight would be equal to $1/n-1$ where n is the number of states. Further, other weights are based on different definitions of neighborliness such as: geographical distance, GDP per capita distance weights, GDP and EU weights, and country openness (trade as a proportion of GDP). Using GDP as weights will allow allocating higher weights to countries with higher GDP (Redoano, 2007, 10). In the case of EU weights, the author simply calculates the weighted average of the GDP of the European Union members. She explains that the first two concepts follow the idea that countries will imitate those countries that are close to them geographically or have similar economic structure. On the other hand, using GDP and EU weights would allow to investigate whether certain countries follow a leader in their spending decisions (Redoano, 2007, 9).

The main conclusion in Redoano's paper is that governments react to each other when setting the income taxes and when deciding on their public spending. In both cases the reaction functions are positive. Moreover, Redoano finds that the best weighting scheme is the one based on GDP followed by the geographical distance. Therefore, European governments will follow the leader countries in tax and public

expenditures competition. The second best weighting scheme suggests that they will also follow the policies of the countries that are geographically close. Redoano's results show that the coefficients of the weighting matrices are higher and more significant during the periods of election. Finally, from the results of the regression with EU weights, Redoano finds that the countries are more competitive and interdependent before they join the European Union. Once they are a part of it, there seems to be less interdependence in their decisions on tax setting and public expenditures.

3. Methodology and Data

Based on the methodology initially proposed by CHR (1993), we want to investigate how infrastructure spending by the Canadian provinces is affected by that of the other provinces, as well as how other factors influence the provincial governments in their spending decisions. In contrast to the previous literature, this paper looks at Canadian provinces and focuses exclusively on infrastructure spending, which is the dependent variable of the model.

To conduct this empirical study, we use annual data on the ten Canadian provinces. Canadian territories are not included in this study given that the allocation of spending responsibilities between the federal government and the territories is not the same as between the federal government and the provinces. The model is estimated for the period from 1981 until 2004. The data has been retrieved from Statistics Canada's CANSIM database. The equation used is similar to the one presented by CHR, although variables included in the X matrix are not the same since they have been chosen here to reflect better the Canadian situation.

We consider the following equation:

$$E_{it} = \alpha_i + \theta WE_{jt} + \beta X_{it} + u_{it}$$

where E_{it} represents the level of per capita infrastructure spending by province i in year t , with $i=1, \dots, 10$, $t=1981, \dots, 2004$ and $i \neq j$. W is the weighting matrix. In this study, the explanatory variable representing other provinces investment level is simply constructed as the average level of per capita infrastructure spending of province's direct geographical neighbors. Therefore the measure of neighborliness is based on geography.

There are five control variables included in the X matrix that are estimated in the regression. They are: real provincial income per capita, real per capita federal grants from the federal government to the provinces, proportion of population over 65 and under 17, and the proportion of urban population for each province. All the variables that are expressed in dollars are also in per capita terms. Moreover, they are adjusted using the CPI with the base year being 1997.

Province-fixed effect, α_i is also included to control for other province-specific and time-invariant determinants of infrastructure investment. Therefore, the regression specification will allow us to measure how strongly infrastructure investment of the provinces is correlated to that of its neighbors after controlling for different characteristics of each province.

The data on infrastructure spending is retrieved from the CANSIM Table no. 3840004. The specific data used is the one on public investment in fixed capital and inventories.

First, we look at the real per capita income for each of the provinces. This data is obtained from CANSIM, Table no. 3840013. We want to investigate how per capita income affects the investment in infrastructure by different provinces. We would expect this relationship to be positive, assuming that larger the provincial GDP, larger the infrastructure investments. However, there is also the possibility that governments would increase their spending during recessions in order to stimulate the economy.

Second, we analyze the total federal grants to provinces, in per capita terms. This data is from Table no. 3840011. In order to understand how different provinces behave in their investments, we want to examine what role the federal transfers play in their decisions as well as in their interactions with the other provinces. This variable is particularly interesting and how it relates to the infrastructure spending will depend on the conditionalities that come with the grants.

Third, two sets of data on demographics for each of the provinces is taken into account. Both are from the CANSIM Table no. 510001. First, the fraction of the population that is between 0 and 17 years of age is used in the equation. Then, we look into effects on the infrastructure spending by the provinces depending on the fraction of older population it has. More specifically, data is on the fraction of the population that is over 65 years old. The reason why these two variables are chosen is because the Canadian population is aging very fast and the younger age groups are becoming smaller. Thus, we want to examine how significant, if at all, these demographic movements are on infrastructure provision.

Further, looking at some additional demographic figures, an interesting variable to consider is the urban population as the proportion of total population in each of the

provinces. The data is from CANSIM Table no. 153-0037. With this variable we want to test the hypothesis that provinces with higher proportion of urban population spend more on infrastructure than those with lower urbanization rates.

The descriptive statistics of these data are presented in Table 1.

Table 1
Descriptive Statistics of the Variables Used in the Model

Variables	Mean	Standard Deviation	Minimum Value	Maximum Value
Infrastructure investment	376.705	144.023	165.175	1 229.783
Provincial income	25 307.020	5 940.415	14 322	42 383
Federal grants to provinces	1 639.820	778.458	442.784	3 817.943
Population above age 65	0.119	0.017	0.072	0.149
Population below age 17	0.256	0.027	0.200	0.362
Urban population	65.885	14.293	36.3	84.7

Notes: (1) All dollar figures are in real per capita terms.
(2) Demographic variables represent the proportion of the total population.

In order to control for different shocks that could affect provinces over a certain period of time, regressions are run with the data expressed relative to the cross-section mean. Therefore, each observation is divided by the mean of the variable in each year.

In addition to our benchmark regression described above, four other regressions are conducted to verify the robustness of the results. Two regressions exclude some of the demographic variables in order to determine how influential they are. As will be seen below, the investment pattern of Alberta is not typical. Therefore we run a

regression excluding Alberta to verify that the results are not driven by the Alberta data. Finally, we test the model without taking into account the cross-section fixed effects.

Throughout this study, the main structure and methodology follow that of Case, Hines and Rosen. However, specification put forward by Baicker and Redoano such as the determination of the suitable instrumental variables is taken into consideration as well. As pointed out by Redoano (2007), if provinces react to each other's actions, then the weighted average of other provinces' fiscal choices will be correlated with the error term u_{it} and the regression may be subject to an endogeneity problem. Following Redoano (2007), we therefore estimate the model using two-stage least squares. The instrumental variables used are the average values of the direct neighbors' control variables.

4. Results

Table 2 presents the results of the five regressions. First, we estimated the equation that includes all the components of the X matrix: real per capita income, total per capita federal grants to provinces, the proportions of the population over 65 and under 17 and the proportion of urban population in each province. The null hypothesis for all the coefficients of these variables is that they equal zero and therefore do not affect the provincial spending on infrastructure. The alternate hypothesis is that the coefficient has a value different than zero.

Table 2
Provincial Infrastructure Spending from 1981 to 2004 Using Geographical Proximity As the
Weighting Matrix

Explanatory Variables	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5
Neighbors' spending	0.059 (0.017)*	0.132 (0.014)*	0.479 (0.033)*	0.043 (0.012)*	0.285 (0.045)*
Provincial income per capita	-0.863 (0.088)*	-0.732 (0.097)*	-1.061 (0.109)*	-0.758 (0.060)*	-0.380 (0.142)*
Federal grants to provinces	-0.179 (0.039)*	-0.235 (0.040)*	-0.533 (0.053)*	-0.167 (0.027)*	-0.024 (0.051)
Population above age 65	1.986 (0.103)*	0.843 (0.098)*	-----	2.145 (0.070)*	0.150 (0.122)
Population below age 17	1.024 (0.091)*	1.148 (0.114)*	-----	1.188 (0.062)*	0.831 (0.157)*
Proportion of urban population	-1.369 (0.259)*	-----	-----	-1.551 (0.179)*	0.001 (0.117)
R-squared	0.905	0.881	0.877	0.897	0.881
Number of observations	240	240	240	216	240

Notes: (1) Standard errors in parentheses

(2) * significant a 1%; **significant at 5%; ***significant at 10%.

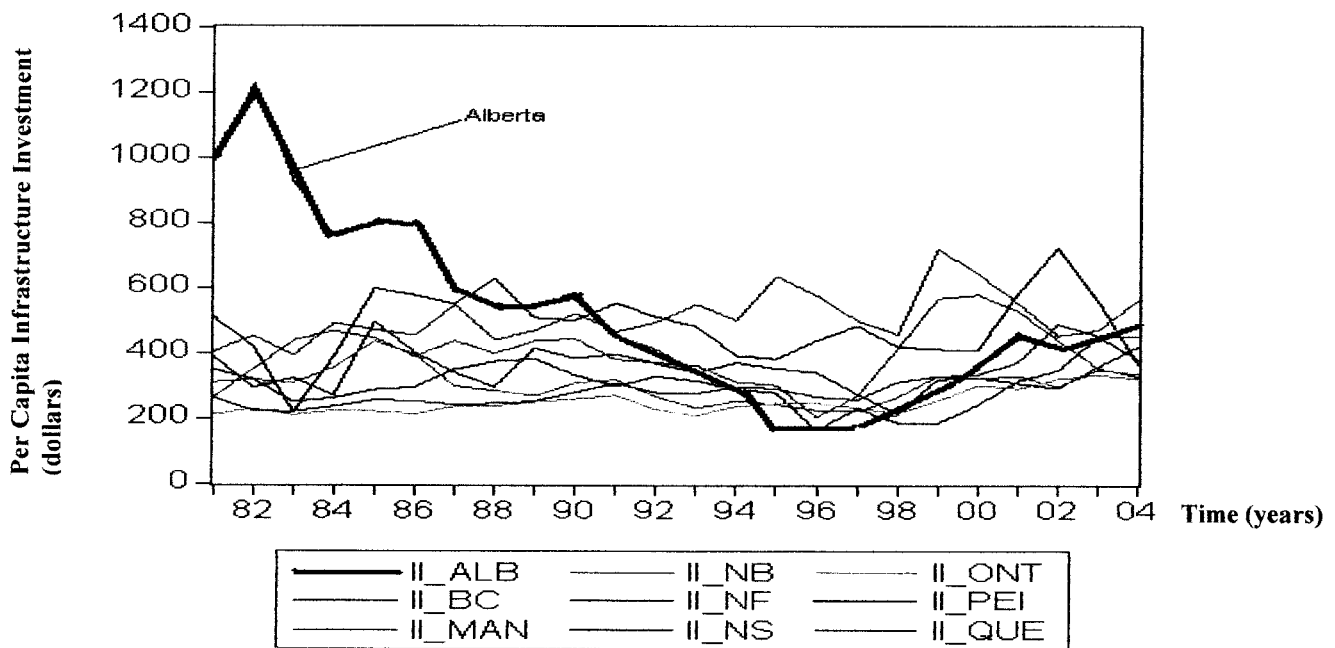
Since the proportion of urban population is fairly constant over time and that the regressions include province fixed effects, we exclude it when estimating the second equation. Similarly, to estimate the third equation, we exclude the urban population variable as well as the two other demographic variables, since they do not change much over time. We want to investigate whether these variables play an important role in influencing governments' expenditures on infrastructure and whether the estimated effect of neighbors spending on infrastructure is robust to alternative specifications.

Further, the fourth regression uses all the same variables in the X matrix as the first one. However, in this case, we exclude Alberta from the sample. When looking at Graph 1, we observe that Alberta's infrastructure investment is different from the investment trends of the other provinces. To make sure that the results are not influenced by the data for Alberta, we exclude it from the regression.

For the first four regressions, we have taken into account the cross-section fixed effects. In the last regression, we exclude them and observe what happens to the coefficients as well as to the general explanatory power of the model.

Graph 1

Per Capita Infrastructure Investment for 10 Canadian Provinces from 1981 to 2004



First, we will analyze the results obtained from the benchmark regression (Equation 1 in Table 2). The coefficient on neighbor's infrastructure spending has a positive value and suggests that a one-dollar increase in the average of neighbors' spending would increase the provincial expenditures by six cents. This variable is highly significant and the hypothesis that the coefficient equals zero can be rejected at the 1% level. However, quantitatively the correlation between the provincial spending on infrastructure and that of its neighbors is not as strong as expected.

Next, besides the neighbors' spending decisions, there are other internal factors that affect provincial spending decisions as well. For example, the per capita income variable has a negative coefficient. Although one might have expected a positive relationship between the per capita income and the per capita spending on infrastructure, we can possibly explain this negative effect by the fact that governments tend to increase spending on infrastructure during recessions in order to stimulate the economy. Therefore, the results suggest that the investment in infrastructure is countercyclical.

Moreover, the coefficient of the federal grants variable is negative and significant as well. While one would assume this relationship to be positive, there are a few explanations for the results that were obtained from this regression. First, it could be that the federal grants are largely unconditional. In principle, the central government would provide grants to provinces in order to try controlling the investment spillovers between them. However, if those grants are not conditional on specific infrastructure projects, they can be used to finance some other public goods or services that are

perceived as more essential to serve the population. Therefore, unconditional grants may not necessarily have a strong positive effect on infrastructure spending.

Second, there is the possibility of receiving equalization payments to reduce the differences in fiscal capacities among provinces. We can consider the case where the federal transfers have a significant equalization effect. Large transfers expected in the future can provide incentives to provinces to over-spend in certain areas and to under-invest in infrastructure, for example, given that infrastructure investment will tend to increase productivity and future fiscal capacity. Therefore, this negative relationship between grants and infrastructure investment may be capturing a moral hazard effect. The promise of future federal grants reduces the provincial incentives to invest in infrastructure in the present.

From the regression, the results that we obtain regarding the population variables have positive and significant coefficients. For example, the coefficient for the population above the age 65 is 1.98. Such result suggests that a one percent increase in the proportion of older population relative to the country's average would increase the spending on infrastructure by almost two percent relative to the average. In a report on the state of infrastructure in Canada by Mirza and Haider (2003), they expect that as the proportion of elderly increases, the investments in infrastructure would be greater to accommodate their needs. Therefore, apart from repairs and replacement, new infrastructures need to be designed as well, which demands more investment. Similarly, the coefficient for the population below the age 17 is large enough to suggest that as this age group increases, new and different needs from those of the older age group will need to be satisfied by investing in infrastructure.

Finally, the proportion of urban population in a province is negatively related to the infrastructure spending. This may appear surprising given that one might expect that provinces with higher proportion of urban population spend more on infrastructure than those with lower urbanization rates. However, this result could simply reflect the fact that as the proportion of urban population is smaller, the population is more dispersed geographically and the cost of infrastructure per capita becomes greater.

When studying the cross-section fixed effects (not reported in Table 2), we observe that some of the richer Canadian provinces tend to invest in infrastructure more than others, after controlling for the determinants of infrastructure spending included in matrix X . On the other hand, provinces like Manitoba or Nova Scotia invest less than the other ones. Alberta is the one province that has very different investment practices from the other ones as illustrated in Graph 1. Its large spending seems to be influenced by some effects particular to the province. Alberta's greater fiscal capacities than those of the other provinces could be one of these effects.

As for the explanatory power of this model, we can examine the R-squared value. It is 0.905 in the benchmark regression. Usually, higher the R-squared and closer it is to 1, better the regression model. Therefore, in this regression the variations in the explanatory variables explain most of the variation in infrastructure spending.

The second regression excludes the proportion of urban population variable. The coefficient on neighbors' spending is still positive and highly significant. In comparison to the original regression, we observe that the second one suggests a much greater correlation between the infrastructure investment in a specific province and the investments of its neighbors.

Per capita income and federal grants have very similar effects on the dependent variable as in the first regression. The R-squared value in this case is slightly lower than previously, but the explanatory power of the model remains high since the variations in the explanatory variables explain 88% of the variation in infrastructure spending.

In the third equation, all the population variables are excluded. They do not change much over time and given that there are province-fixed effects, those variables might not be very useful in the regression. The income and grants variables are still negatively related to the infrastructure spending in the similar manner as in the two previous equations. The neighbors' spending, however, has a much larger coefficient compared to the two first regressions.

In the equations 2 and 3, the results for cross-section fixed effects show that most of the provinces tend to under invest in infrastructure. The exception is once again Alberta that tends to invest significantly more. R-squared values are practically the same in these two equations, both suggesting high explanatory power of their respective models.

Following the results that show atypical investment trends in Alberta, data for this province was not included in the equation four. We want to investigate how the effects of the variables change, once this province with different spending tendencies in infrastructure is omitted from the regression. Qualitatively, the coefficients of the variables do not change. The neighbor's spending variable has the lowest coefficient value out of the four equations but is still positive and highly significant. Income and grants variables have very similar coefficients to the three previous regressions. Urban

population variable is still negatively related to the infrastructure spending, as in the first equation.

Finally, the fifth equation includes all the same variables as the first one. The only difference is that in the last case, we do not attempt to control for differences across provinces, so we exclude the cross-section fixed effects. The coefficient of the neighbor's spending is higher than in the benchmark regression and very significant. The variable representing the proportion of urban population did not provide the results that were expected. We expected it to have a greater impact on spending. Another variable that could be tested in further research is the population density, as proposed in Redoano (2007).

Looking at all five regressions, we can conclude that provincial spending on infrastructure is positively related to that of its direct neighbors. In all estimations, the coefficients of that variable are positive and very significant. It is when all demographic variables are excluded from the regression that we obtain the strongest correlation between provincial spending on infrastructure and the spending of its geographical neighbors. In any case, we can reject the null hypothesis that the estimated coefficients of the variables equal zero. When Alberta is excluded from the regression, the coefficient of the neighbor's spending is at its lowest, although it remains significant at the 1% level. Further, all five regressions have high R-squared values starting with 0.877 in equation 3 to 0.905 in equation 1. We can conclude that in these equations, the variations in the explanatory variables explain most of the variation in infrastructure spending.

5. Summary and Conclusions

The principal aim of this paper was to determine whether there is any evidence of strategic interaction between Canadian provinces in infrastructure spending. Five regressions were estimated, all using the geographic proximity as a weighting measure for neighborliness. Therefore, we investigated how provincial expenditures in infrastructure are affected by those of their direct neighbors. We find that provinces are not independent in their spending decisions and in some cases, they are quite significantly influenced by the spending of their neighbors. Moreover, this result was found to be robust to alternative specifications.

The general conclusions from the theory on tax and public input competition are that governments tend to lower taxes but may increase or decrease investment in public inputs when trying to attract the mobile factors to their region. However, to improve investments, recent findings propose solutions such as subsidies, negotiation and revenue sharing in competitive environments. Investment in infrastructure is an example of public input that can be used in competition among governments. Its quality and size affect the regional income and the return on mobile factors. Such investments attract mobile factors that in turn stimulate regional productivity.

Whether we study the paper by Case, Rosen and Hines (1993) and Baicker (2001) who test the data on the public expenditures for the United States or we look at Redoano's paper that uses data from the western European countries, similar conclusions can be drawn. There is strategic interaction between different states and countries in public expenditures.

Contrary to this paper where the weighting matrix is determined by the neighbor values in infrastructure spending, the three empirical models studied here propose different weighting schemes. For example, Redoano's results suggest that the best one is that based on the GDP weights. Therefore, European governments will follow the leader countries in tax and public expenditures competition. According to Baicker, the interstate mobility is the best predictor of spending interaction. Those weighting schemes could provide significant new findings if used in future research on this subject.

In all estimations, provincial spending on infrastructure is positively related to that of its direct neighbors. However, we expected the quantitative effect to be more important. The results obtained suggest that the need for coordination of provincial spending in infrastructure may not be as strong as initially thought.

Important results come also from the equation 4. We find that Alberta has very different spending trends from the other provinces. In fact, Alberta invests much more than the other provinces and is therefore quite influential on their infrastructure spending decisions. When Alberta is excluded from the regression, the coefficient of the neighbor's spending is at its lowest, although it remains highly significant.

Throughout the results of the equations, we find that per capita income and federal grants are negatively related to provincial investment in infrastructure. The first case can be examined by the fact that infrastructure investment might be countercyclical. The data on most of the Canadian provinces confirm this assumption, especially for last decade of the observed period.¹ In the case of grants, we explain the results assuming that they are often unconditional so provinces do not use them for

¹ However, in this case we do not control for the other variables used in our equation.

infrastructure. Further, there is the possibility that federal transfers have a significant equalization effect. Large transfers expected in the future can provide incentives to provinces to over-spend in certain areas and to under-invest in infrastructure. Therefore, in order to induce the provinces to invest more in infrastructure, federal government should modify the structure of its transfers by introducing more conditionality.

While interdependency of provincial spending in infrastructure may not be as strong as expected, different areas of public expenditures, such as spending on health or education, can be studied in future research. Furthermore, if direct neighbors do not influence enough provinces' spending, other weighting schemes could be developed to test the nature of the spending coordination between the provincial governments.

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