

**Natural Resource Blessing or Curse on Education and Income:  
A Study of Canadian Provinces**

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## **Abstract**

This major research paper analyzes the effects of natural resource abundance in Canadian provinces on its education level and income per capita. Past studies have found that a country with poor government governance have brought natural resource curse, where large natural resource reserves have decreased the education level and economic well-being of that country. By collecting the data from the Labour Force Survey and Statistics Canada, this paper tests if natural resource abundant provinces, such as Alberta and British Columbia have gone through natural resource curse or natural resource blessing in comparison to natural resource scarce provinces, like Ontario and Quebec. There are two regression methods used here, one following the simple regression used by most natural resource curse paper to test education level in the provinces, and one following Boyce and Emery(2011)'s income per capita regression. The first method of regression on education enrolment and government expenditure on education per capita did not return significant results, but the second method following Boyce and Emery (2011)'s regression method did return a result that resource rich provinces enjoy higher income per capita.

## Introduction

Is it reasonable to accept the hypothesis that Sachs and Warner (1995, 1999, and 2001) and many past researchers suggested in their papers that natural resource abundance is a curse to an economy? Overview of some historical facts may persuade that the natural resource curse hypothesis is not far away from being a fact. One of the historical examples is the slow economic growth of Nigeria until recently, even though Nigeria had a vast natural resource wealth to begin with. Xavier Sala-i-Martin and Arvind Subramanian (2003) suggests that the discovery of large natural resource reserves have caused stagnant growth in Nigeria by creating high corruption in institutions, weak governance, rent-seeking behaviors and etc. Other than institutional quality, Gylfason (2001) provides three more transmission channels that have negative impact in economic growth, which are Dutch Disease, Education and Human Capital, and Eviction of Physical Capital. Brief explanations of the transmission channels, including the institutional quality, are the followings:

- a. **Dutch Disease** is an economic concept that explains the inverse relationship between natural resource sector and manufacturing sector. It suggests that when a country has a large natural resource available for a development, the country tends to concentrate their money and time more on natural resource sector than on manufacturing sector. Therefore, long-run growth is slowed.
- b. **Institutional quality or the government corruption** level is another highly accepted reasoning of natural resource curse. It is found that in a country with a massive natural resource wealth, there is a great chance of having a highly corrupted government. It is also found that the countries with a large natural resource wealth have frequent civil wars over the natural resource rights,

distracting the development of a country, economically and in its development of institution. Therefore, in a country with high government corruption, it is likely that the natural resource revenues are used for personal gains rather than public investment such as constructing public buildings, improving education level, and etc. For example, Xavier Sala-i-Martin and Arvind Subramanian (2003) finds that Nigeria's cumulative revenue from oil export during the years 1965 to 2000 is around US\$350 billion at 1995 prices, which is calculated to be US\$325 per capita, but per capita GDP remained at 1965 level of US\$33. It seems to be that the revenue from oil export has not been used for public gains.

- c. **Education and Human Capital.** Many researches find that when a country is endowed with natural resources, it tends to undervalue education and therefore spends less of its government budget on developing the education system. This is because when a country is endowed with natural resource wealth, they have a tendency to depend on the revenues generated by natural resource sector, which does not require highly educated labor. Therefore, government policy does not provide incentives to people to attain higher education and most people in the country take the low-skilled job. Again, as a result, the long-run growth of its economy is stagnant.
- d. **Eviction of Physical Capital.** Similar to that of Dutch Disease, it is found that the concentrated investment in natural resource sector forces less investment in manufacturing sector thus eviction of physical capital is present. Using the Solow growth model, it can be seen that eviction of physical capital means lower capital per capita and this slows the growth.

The four transmission channels do not have to work separately and usually they are present in the economy as a mixture. For example, in a discovery of large natural resource wealth, a country goes into a civil war in order to gain power over discovered natural resource wealth. After the war, it is likely to have a corrupted government, which spends most of its money towards developing natural resource sector and less on developing human capital and education. Soon, due to low incentive to achieve higher education and investment, manufacturing sector will lose its share in the market. Therefore, in the long-run, the economy's growth will be stagnant, since growth cannot be sustained without the growth in manufacturing sector. Also, under-development of high-skilled manufacturing sector forces the country to import manufactured goods and high-skilled labor, causing downward pressure on its economic growth.

However, the history of Norwegian economy is a counter-example of a natural resource curse. Larsen (2004) analyzes why Norway was successful in turning the oil reserve discovered in the late 1960's into a blessing while others failed to do so. In her research, she compares Norway's economy with their neighboring countries, Denmark and Sweden, before and after the discovery of oil reserve in 1969, and tries to identify if whether the growth of Norway's economy was due to the discovery of the oil reserve. In accordance with her hypothesis, the history of economic statistics shows that Norway was able to catch-up with their neighboring countries, and even goes beyond them in economic development in later years. Larsen (2004) suggests a proper management of natural resource is the key to the 'natural resource curse' problem. So is it really the problem of corruption in other natural resource rich countries that decelerates their growth?

After reviewing the papers that questions whether or not a natural resource endowment is curse or blessing, an interesting question is brought up in my mind. If natural resource

abundance causes economic decelerations through the transmission channels, but not if a government manages them well, it would be interesting to compare similar governments with different natural resource wealth shows difference in their economic growth. For testing of this hypothesis, I have assumed that a low corruption rate indicates a well-structured government that has a potential to have a good management in the use of natural resources that they possess. Obviously, it is hard to find countries that have similar government body structure and have one with natural resource endowment and one without. In this paper, I have used Canadian provinces as a sample to test this hypothesis since each of the provinces has their own provincial government, but with very similar government structure. Also, the indices from Transparency International report that Canada was ranked 4<sup>th</sup> in corruption level in the year 1995, out of 41 countries, and 9<sup>th</sup> in year 2012, out of 176 countries. Therefore, it is reasonable to assume that Canada had low government corruption throughout 1980's to 2000's, the periods which my study is based on. For this paper, I have chosen two natural resource endowed provinces, British Columbia and Alberta, to compare with the comparably natural resource scarce provinces, Ontario and Quebec. I have used two measurements to see if there was a natural resource curse or blessing in the sample provinces, which are the following:

1. **Post-secondary enrolment rate and gov't expenditure on education per capita. (Method 1)** I have used post-secondary enrolment rate and gov't expenditure on education per capita as the measurement of natural resource curse or blessing. The reason is that if the natural resource is a curse, a government, even if it is not corrupted, may spend less investment in developing high-skilled labors (Dutch Disease) and thus lower the post-secondary enrolment rate and education expenditure per capita. As explained at the beginning, an economy

cannot pursue a long-run growth without development in manufacturing sector.

(Method 1)

2. **Growth of income per capita. (Method 2)** Boyce and Emery (2011) suggests that a natural resource slows the per capita income growth but increases per capita income. Therefore, natural resource is not a natural resource curse but a blessing. I have tested if the data on Canadian provinces follows this pattern. A detailed explanation of this paper is followed in literature review section.

Before testing the hypothesis, it is interesting to examine the case by using basic indications that may suggest natural resource curse or blessing. Since growth of income per capita is only available through collection and calculation of data, it will be tested in the later section. However, it is easy to find an indication that may suggest enrolment rate, or education level of a province. My prediction was that if a province has a natural resource curse, there should be lower number of universities or less number of undergraduate students compared to the province that comparably has lower natural resources. From the Wikipedia, I have searched for a list of Canadian universities by province and found that the data collected during the years 2008-2011 shows 6 and 15 universities for Alberta and British Columbia respectively, and 25 and 17 universities for Ontario and Quebec respectively. Furthermore, I have summed up number of undergraduate students in each province and found that there were approximately a total of 119,131 and 150,566 under-graduate students in Alberta and British Columbia respectively, and 391,498 and 216,560 under-graduate students in Ontario and Quebec respectively. I have summed only the under-graduates because usually post-doctors are more likely to move to provinces that offers better education quality. More details on this data are available in table 1. Therefore, the results are in accordance with the prediction that a natural

resource abundant province should have less number of universities and less number of undergraduate students. Using only these indicators, it seems to be that natural resource endowment does affect the education level of the province. However, it might be just that the larger population in Ontario and Quebec increased the number of university and number of students. Therefore, I cannot conclude from this indication whether or not Canadian provinces are having natural resource curse. Hopefully this paper will help to decide.

The regression result for method 1 on Canadian provinces returned that there are no strong evidences that natural resource is a curse in natural resource abundant provinces. However, the result of method 2 returned that provinces with natural resource endowment did enjoy higher in income per capita but slower income per capita.

The paper proceeds as the following: First, there will be a literature review of five papers that were helpful in testing my hypothesis. Secondly, I will provide some information on natural resource of Canada and statistics on the provinces. Thirdly, there is a data section that explains which data are used and reasons for choosing them. Fourthly, I will explain my estimated econometric model. Fifthly, results section presents the results from the test of econometric model. Then, conclusion, tables and figures, and reference are followed.

### **Literature Review**

In this section, I provide a review of five papers that are helpful to answer my question of interest. Gylfason (2001) finds the empirical results that natural resource abundance is a curse to economic growth by decreasing human capital accumulation. However, in the second paper by Stijns (2006), the author points out that the Gylfason's results about human capital accumulation are not robust when the measurement of natural resource abundance is changed, therefore he

refutes the natural resource curse on education. Papyrakis and Gerlagh (2004) find empirical results that natural resource itself does not cause natural resource curse, but only through the transmission channels. Boyce and Emery (2011) argues that natural resource is not a curse but a blessing based on having a perfect market, and uses U.S. data to prove it empirically. Lastly, Kjellstrom and Regner (1999) examine how distance from nearest university to residency determines people decision to enroll in higher education.

### **Gylfason (2001)**

Gylfason (2001) uses data from the World Bank to find out if natural resource has been a curse to various countries. He analyzes especially on the relationship between the level of education and natural resource abundance. He believes that the natural resource rich countries have too much confidence in their natural resource assets such that they tend to neglect their investment in education. First, he graphs annual growth of GNP per capita through 1965 to 1998 in 86 countries against share of natural capital in national wealth. The result is that an increase of 10% in share of natural resource decreases annual growth rate by 1%. This is very large, considering that the average growth rate of world economy since 1965 has been 1.5%. Figure 1 illustrates this relationship. Then to examine more closely on education, he graphs the share of natural capital in national wealth in 1994 against three different measures of education:

- i) Public expenditure on education (1980-1997) with 90 observations.
- ii) Expected years of schooling for females (1980-1997) with 52 observations.
- iii) Gross secondary-school enrolment (1980-1997) with 91 observations.

This is illustrated in Figure 2, 3, and 4. First, Gylfason comments that the i) is not a good measure of education level of a country since a country could be spending more money on

private education, which is not reflected on public expenditure. Also, the public education expenditure seems to vary a lot by countries. However, i) is still a good measure to observe a country's commitment to education. The calculation showed that 18% increase in natural resource share decreases 1% of public expenditure on education. Secondly, ii) shows that a 5% increase in natural resource share decreases average schooling year for a girl by 1 year. Lastly, and most closely correlated with economic growth, he uses secondary school enrolment rate in iii) and shows that 5% increase in natural resource share decreases 10% of secondary school enrolment. To see how important secondary school enrolment is to economic growth, Gylfason (2001) also graphs secondary school enrolment to annual rate of growth of GNP per capita. This is illustrated in figure 5. The result is that a 40% increase in secondary school enrolment increases annual growth of GNP per capita by 1%. Again, considering that the average world economy growth since 1965 is only 1.5% highlights the importance of secondary school enrolment in economic growth. Overall, the results from the graphs show that natural resource abundance is inversely related with education. Gylfason (2001) also uses seemingly unrelated regression (SUR) and Ordinary Least Squares (OLS) regression to show how important education variable is to economic growth, and finds that almost half of the effect of the natural resource on economic growth is due to education. Gylfason (2001) concludes that the reason for low education level in natural resource abundant countries is because natural resource based industries use mostly low-skilled labour and since natural resource based industry makes up a large part of a wealth, governments spend less on education.

### **Stijns (2006)**

Stijns (2006) published a paper that presented an argument against the empirical result of Gylfason (2001). Stijns (2006) argued that natural resources should be measured as subsoil

wealth per capita instead of ratio of natural wealth to total wealth. He argues that if natural resource abundance does increase physical and human capital, measuring the share of natural resource wealth against the total wealth is misleading, because total wealth will be larger. Moreover, he also argued that the way Gylfason defined natural resource abundance could also mislead the true effect. Stijns created a panel data consisting of 102 countries for years 1970 to 1999 by collecting data from Hamilton and Clemens (1991), Hamilton (2000), World Bank, Freedom House's Political Freedom Index, and International Financial Statistics (IFS). In his regression results, he finds that the negative correlation between natural resource abundance and education measured in Gylfason's (2001) paper is not robust. Therefore, the belief that natural resources are curse to human capital accumulation should not be accepted as a fact.

#### **Papyrakis and Gerlagh (2004)**

Papyrakis and Gerlagh (2004) have done an empirical study on the effect of natural resource abundance on economic growth through transmission channels by following the cross-country growth regression done by Kormendi and Meguire (1985), Grier and Tullock (1989), Barro (1991) and Sachs and Warner (1995, 1997), using the data from 1975 to 1996 in 47 countries. They have assumed a conditional convergence and have used a simple growth regression to estimate the coefficients for each of transmission channel variables that are predicted to be related to per-capita economic growth. The basic equation they have used to test their empirical study is the below:

$$G^i = \alpha_0 + \alpha_1 \ln(Y_0^i) + \alpha_2 R^i + \alpha_3 Z^i + \varepsilon^i \quad (1)$$

where  $i$  represents the country.  $G^i$  represents per-capita economic growth,  $Y_0^i$  represents initial per-capita income in 1975,  $R^i$  represents natural resource abundance measured by share of

mineral production in GDP, and  $Z^i$  represents the transmission channel variables. The independent variables included in  $Z^i$  are corruption level, investment, openness to trade, terms of trade, and schooling. In their first regression using equation (1), they did not include any variables for  $Z^i$ , and then included one transmission variable for the second regression and so on until they have include all the variables as the following order: corruption, investments, openness, terms of trade, and schooling. Table 2 in the tables and figures shows the results for OLS regression of equation (1). From the regression, they have found that as more transmission channels are added to the regression, the coefficient for natural resource abundance,  $\alpha_2$  becomes positive even though it is insignificant. Furthermore, for all the regression,  $\alpha_1$  had a negative signs, except in the first regression, with significance. Thus, the result is also in accordance with conditional convergence theory. Therefore, the authors conclude that natural resource abundance does not have a direct negative impact, but maybe a positive impact, if transmission channels are excluded. To further analyze which transmission channel caused the most indirect effects on economic growth, the authors first estimated the regression of the transmission channel on natural resource abundance using

$$Z^i = \beta_0 + \beta_1 R^i + \mu^i \quad (2)$$

where the variables are same as the ones used in equation (1). Then, they substituted equation (2) into equation (1) to have the following equation:

$$G^i = (\alpha_0 + \alpha_3 \beta_0) + \alpha_1 \ln(Y_0^i) + (\alpha_2 + \alpha_3 \beta_1) R^i + \alpha_3 \mu^i + \varepsilon^i \quad (3)$$

where  $\alpha_2 R^i$  and  $\alpha_3 \beta_1 R^i$  represents the direct and indirect effect of natural resource on growth, respectively and  $\mu^i$  represents the residual from equation (2). The estimation returned -9.61 for the estimated coefficient for natural resource abundance, therefore, a 1% increase in natural

resource abundance will decrease economic growth rate by 0.0961% when both direct and indirect effects are accounted. Table 3 shows the results. They have also calculated the relative importance of transmission channels, and have found that investment is the most influential indirect effect variable, accounting for 41% of the indirect effect. For my paper's interest, schooling has 11% relative contribution to other transmission channels on economic growth, which is twice as larger than corruption. Therefore, it is important to observe if economic growth of natural resource abundant provinces in Canada have been affected through education. The relative importance of all transmission channels are shown in the table 4.

### **Boyce and Emery (2011)**

Boyce and Emery (2011) tries to argue against Sachs and Warner's (1995, 1999, and 2001) natural resource curse theory by proving that the natural resource abundance may reduce the income per capita growth rate but the rents collected will increase the level of income per capita, and in the long-run the income per capita is not necessarily reduced. Therefore slower growth rate is not a natural resource curse, but a blessing. For this analysis, they have used data for the fifty U.S. states over the period 1970-2001 and the employment and income data are from Bureau of Economic Analysis and national and regional price indices are from the Bureau of Labor Statistics. The paper shows that when cross-sectional estimation is used, U.S. states with natural resource abundance returns slower growth rate, but when they use panel data, they find slower income per capita growth rate, but a higher income per capita in natural resource abundant states.

To develop their theory, they start from the Chambers and Gordon model (1966), a small-economy model with two sectors, which are exhaustible resource sector and a manufacturing

sector. They have used Hotelling's (1931) production of exhaustible resource theory for the resource sector. They have assumed that capital is perfectly elastic in supply so that labor allocation is the sole variable in economic growth equation. First, the production functions for each sector are written as

$$Q_R(t)=[L_R(t)A(t)]^\alpha \quad (4)$$

$$Q_M(t)=L_M(t)B(t) \quad (5)$$

$$L_R(t)+L_M(t)=L(t) \quad (6)$$

where  $Q_R(t)$  is quantity produced by resource sector at time  $t$ , and  $Q_M(t)$  is quantity produced by manufacturing sector at time  $t$ . It should also be noted that resource sector has positive, but diminishing marginal product of labor with  $0 < \alpha < 1$ , while manufacturing sector has constant returns to scale production function.  $L_R$  and  $L_M$  is the number of labor in resource sector and manufacturing sector respectively.  $A(t)$  and  $B(t)$  represents technology level in each sector. The price of output is exogenous since it is assumed that the economy is small. They have used manufacturing goods as a numeraire so  $p_m(t)=1$  for all  $t$ , and

$$g_R = \frac{\dot{p}_R}{p_R} \quad (7)$$

represents the rate of change in the relative price of the natural resource. Now, they add the Hotelling (1931) production of an exhaustible resource to the model. It is specified as

$$\dot{S}(t) = -Q_R(t), \quad S(0) = S_0 \quad (8)$$

Thus, one unit of natural resource is used to produce one unit of natural resource output.

After going through intense mathematical process and using the assumptions, they ended up with two propositions and were able to prove them mathematically. The propositions are the following:

“Proposition 1: With each factor paid its marginal product, technology described in equation (4) and (5), with a higher rate of technological change in manufacturing than in resource extraction, and with constant or declining real resource extraction, and with constant or declining real resource prices, (i) an economy with natural resources grows more slowly than a pure manufacturing economy, and (ii) labor flows out of the resource sector over time.”<sup>1</sup>

“Proposition 2: With each factor paid its marginal product and technology defined by (4) and (5), per capita income is always higher in an economy with a resource base than in a pure manufacturing economy.”<sup>2</sup>

Figure 6 illustrates proposition 1. It shows the positive level effect and the negative growth effect from natural resources. First, without considering the scarcity effect, the value of marginal product of labor line is  $\alpha[p_R(t) - \lambda e^{pt}]L^{\alpha-1}R A(t)^\alpha$  line. If the economy is pure manufacturing economy, they will earn  $B(t+dt)$  at the time  $t+dt$ . Therefore, the total gain for manufacturing economy as technology improves, is the difference between the rectangles  $B(t+dt)L(t+dt)$  and  $B(t)L(t)$ , which is a composition of growth due to increased marginal productivity and increase in the labor force. However, if the economy consists of exhaustible resource, their growth is not as large as pure manufacturing economy because they were already earning the shaded area between  $B(t)$  and  $B(t+1)$  by the owners collecting rents when wage was equal to  $B(t)$ . Therefore, when manufacturing technology improves, there will be less workers in

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<sup>1</sup> Boyce and Emery(2010), pg.4

<sup>2</sup> Boyce and Emery(2010), pg.5

resource sector,  $L_R(t) < L_R(t+dt)$  because they will be moving to manufacturing sector, and part of the higher wages earned by the all workers in this economy is just a redistribution of rents collected by natural resource owners to the workers. Thus, growth is slowed. Furthermore, with Hotelling's scarcity effects, the value of marginal product of labor line shifts downward, (dotted line in the figure) leaving only dark shaded line as the rents collected by natural resource owners. This is because with scarcity effect, the rental price of natural resource increases, causing net value of marginal product of labor to shift down, thus less demands for labor in the resource sector. Therefore, natural resource intense economy's growth is slower by the lightly shaded area. The proving of proposition 1 also indicates that corruption, and rent-seeking behavior is not necessary to have slow economic growth, since it can happen even if they have assumed perfectly function market.

Figure 7 illustrates proposition 2, and shows that an economy with natural resource ( $\hat{y}_R(0)$ ) jump starts in their income per capita level in compare to pure manufacturing sector ( $\hat{y}_M(0)$ ). Their reason is that if natural resource economy is earning rents, which is the shade area in figure 6, then the rent is above the cost of producing goods. Therefore, income per capita should be higher during the entire natural production phase  $[0, T]$  in the graph. However, at the end of natural resource production the economy should behave like as if they have never discovered natural resource. Therefore, they conclude that unless there is a failure in institution or government, the level of income per capita will decrease.

To summarize, the important conclusion from their theory is that slow growth rate is not because of failure in market or property rights, since it can be present even with the perfectly functioning market. However, a lower level of income per capita is present only if there is a failure in market or institution.

In the empirical section, they have used the panel data in three different ways. First, they tested cross-sectional growth estimates to prove that the natural resource curse theory supported by Papyrakis and Gerlagh (2004, 2007) still exists in their data if they use cross-sectional growth estimates. Table 5 is the result of this regression. The dependent variable is annual percentage rate of growth in per capita income over the period 1970-2001. The negative sign in coefficients for share of employment in resource sector variable in model (3) and model (4) proves that natural resource curse theory is present.

Secondly, they have a panel estimation of level effects of resources. The equation they used to test this is the definition of income in two-sector economy,

$$y = y_M + (y_R - y_M) \left( \frac{L_R}{L} \right) \quad (9)$$

which can be transformed to

$$y_{it} = \alpha_0 + \alpha_1 \left( \frac{L_{it}^R}{L_{it}} \right) + v_{it} \quad i=1, \dots, N, \quad t=1970, \dots, 2001 \quad (10)$$

where  $y_{it}$  represents the income level in state  $i$  at time  $t$ ,  $L_{it}^R$  represents the employment in resource sector, and  $L_{it}$  represents total employment. Thus  $L_{it}^R/L_{it}$  represents the share of employment in resource sector. Therefore estimated  $\alpha_0$  represents the average per capita gross state product in the manufacturing sector and  $\alpha_1$  represents the difference between average per capita gross state product between manufacturing sector and resource sector. However, for the regression they have used logarithm of real per capita income as a dependent variable. Table 6 is the regression results, ran two times, one with year effects and without year effects using OLS, fixed effect, and random effect to estimate. The results support their hypothesis that larger share

of natural resource labor should have higher level of per capita income, holding everything else constant. They also report that the magnitude of the findings were also very high, such that for Wyoming, an 8% average of labor share in natural resource sector gave 50% higher average income per capita level.

Lastly, they have panel estimation of growth effects of resources. The per capita income growth equation they formulated from their theory can be re-written as

$$\begin{aligned} \frac{\dot{y}}{y} = & \frac{g_A y_M}{y} + \left[ \frac{\alpha g_A y_R - g_B y_M}{y} \right] \left( \frac{L_R}{L} \right) + \left[ \frac{y_R}{y} \right] \left( g_R * \frac{L_R}{L} \right) \\ & - \left[ \frac{y_R - y_M}{y} \right] \left( n * \frac{L_R}{L} \right) + \left[ \frac{\alpha y_R - y_M}{y} \right] \left( \frac{L_R}{L} * \frac{\dot{L}_R}{L_R} \right) \quad (11) \end{aligned}$$

which can be transformed into

$$\begin{aligned} \ln\left(\frac{y_{it}}{y_{it-1}}\right) = & \beta_0 + \beta_1 \left(\frac{L_{it}^R}{L_{it}}\right) + \beta_2 \ln\left(\frac{p_t^R}{p_{t-1}^R}\right) \left(\frac{L_{it}^R}{L_{it}}\right) \\ & + \beta_3 \ln\left(\frac{N_{it}}{N_{it-1}}\right) \left(\frac{L_{it}^R}{L_{it}}\right) + \beta_4 \ln\left(\frac{L_{it}^R}{L_{it-1}^R}\right) \left(\frac{L_{it}^R}{L_{it}}\right) + \varepsilon_{it} \quad (12) \end{aligned}$$

for regression test. Similar to the variables in income level regression test,  $y_{it}$  represents the per capita income in state  $i$  at time  $t$ ,  $L_{it}^R$  represents labor in natural resource sector,  $L_{it}$  represents total labor,  $p_t^R$  represents the price of natural resource at time  $t$ , and  $N_{it}$  represents the population in state  $i$  at time  $t$ . The specification they used is similar to regression tests used in natural resource curse papers, except that in this equation, employment share of labor in resource sector interacts with rate of growth of natural resource sector ( $\beta_4$ ), the rate of growth in population ( $\beta_3$ ), and the rate of growth in real resource prices ( $\beta_2$ ), instead of having the growth in employment in

natural resource sector ( $\beta_1$ ) by itself. Table 7 shows the result of this regression, using OLS, fixed effect, and random effect estimation methods. Their result shows that  $\beta_1$  is negative in all methods but insignificant, except in fixed effect estimation. However, they have emphasized more on the random effect test following the suggestion of Hausman test that random effect estimation is better estimate than fixed effect test over their data.  $\beta_0$ ,  $\beta_2$ , and  $\beta_4$  are all positive and significant in all estimation, and  $\beta_3$  is negative and significant in all estimation. Thus, they conclude that the signs of estimated coefficients match with their prediction and that it returns lower growth rate in resource abundant states but higher income per capita.

Therefore, I believe it is also important that I test the Canadian province's income per capita level and growth, as well as their education enrolment rate and education expenditure per capita, to see if they are suffering from natural resource curse or is it that high natural resource provinces are enjoying higher income per capita while they are extracting natural resources. Since Canada is quite similar to the U.S., I predict a similar result in my regression.

### **Kjellstrom and Regner (1999)**

Kjellstrom and Regner (1999) studies if the geographical distance between the university and student's residency has an effect on enrolment rate in university. They believe that there are both positive and negative effects of having university near the residency. The negative is that if the university is far from residence of the potential student, they may view this as a higher cost to enroll in university, thus may discourage them to enroll in the university. The other view is that student's may view the university far away from home as an opportunity to live away from their family, such that it has no effect or even positive effect on enrolment rate. Furthermore, many studies on return to education have used distance from university as an instrumental variable. If

the distance is a valid instrument for return to education, then it should be also a significant on individual enrolment decisions. The data sample they use is a large sample of people born in Sweden in 1967. They have also gathered the sample's parental education and occupation, and the sample's intelligence test results at the age of 13. For measuring the distance to nearest university, they have used three different measures, the time it takes to reach university by car distance by car, and the shortest distance between the two cities (one with university and one without). It is measured by using geographic information system (GIS) application software. Table 8 reports the summary statistics of samples separated by distance to the university measure in km. Although it is not statistically significant, it is observable that as the distance becomes larger, there is a decrease in the percentage of people with university degree, score on intelligence tests, father's education achievement. Moreover, it is more likely that fathers have non-manual jobs if they live closer to the university.

Their empirical model is based on log likelihood test, and the purpose is to find which estimation model fits best with the given data and best represents the effect of geographical distance. Table 9 shows the result of log likelihood test with different type of variables. It shows that adding parental education and occupation improves the fit compare to one without, and adding ability (intelligence test result) improves the fit even further. Model D to N adds different types of distance measurement to model B. The result is that all of them improve the fit of the model. Therefore, they conclude that as well as parental education and occupation, and ability, the distance to university is an important determinant of enrolment rate in university.

Now, to test the impact of distance on enrolment rate, they choose the variables used in model D, F, and G because they showed significance even at 5%, 1%, and 1% respectively. They also included parental education and occupation, and ability variables in this model. This test

measures the odds ratios, the probability of attaining a university education, in each of distance columns, which are <26km, 26-60km, 61-100km, and >101. The odds ratios are calculated from estimated logistic regression coefficients. Table 10 shows the result. The result are interpreted relative to the people who live <26km away from the university. Therefore, odds ratio for people who live <26km is 1.0. For example, for model F, it is observed that people who live further than 101km from university has .71 odds ratio of enrolling in university. It is observable that in both model D and F, the odds ratio decreases as distance increases. However, in model G, the odds ratio for people who live further than 101km is 0.98 which is higher than the odds ratio for people who live in between the distance 26-60km and 61-100km, who has odds ratio of 0.78 and 0.76 respectively. But, because model G has a large confidence interval, reported in parenthesis, this result is not strong. Therefore, they conclude that distance does have an effect on odds of enrolment but the magnitude of the impact varies with distance measurement. Furthermore, another potential problem with this result is that they have used the area of residence of the sample person when they took the intelligence test at age 13. Although it is not reported as a result, when they used additional information of the samples residency later in their life, the test actually reported higher magnitude of distance effect.

From this paper, the use urbanization rate in my regression is justified, since higher urbanization rate usually means there will be more university near the residency.

### **Brief Information on Canadian Natural Resources**

Before I begin to test the relationships between natural resource abundance and education level, and natural resource abundance and income per capita in the four provinces, I would first like to give some brief information on natural resource market in Canada. Table 11 shows the

contribution of natural resource in Canada in numbers. Borrowing a quote from 'Natural Resource Canada,' "the natural resources sectors and earth sciences industries have been an engine of economic growth and job creation for generations. In 2010 alone, the sectors generated 11.5 percent, or \$142.5 billion, of Canada's gross domestic product (GDP) and directly employed close to 763 000 people."<sup>3</sup> As the statistics show, natural resource market in Canada is very important for the living of Canadian citizens and additionally, Natural Resource Canada reports that Canada has been a leader of natural resource-based technology and knowledge such that it contributes to the welfare of people in other countries. Therefore, it is also important to examine if the government have been wisely using the revenue generated by the natural resources to promote prolonged economic growth through education development.

I have also produced a graph to show the growth of provinces' post-secondary enrolment rate and share of gov't expenditure on education along with share of natural resource in province GDP to observe if they have been growing proportionally. Figure 8 to 12 illustrates the flow of share of natural resource and enrolment rate from 1984 to 2008 by province and pooled. It is observed that for Quebec, share of natural resource and enrolment rate goes in opposite direction at the beginning but seems to go in the same direction at the later years. For Ontario, share of natural resource and enrolment rate does not seem to have any similar patterns. However, for Alberta and British Columbia it seems that the two lines have more similar patterns in comparison with Quebec and Ontario. However, for the pooled data graph in figure 12 for the four provinces, the two lines do not seem to follow a similar pattern, except for the last few years where they both increased. Figure 13 to 17 illustrates the flow of share of natural resource and share of government expenditure on education for the years 1989 to 2008.

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<sup>3</sup> Natural Resource Canada, retrieved on May 4<sup>th</sup>, 2013, from <http://www.nrcan.gc.ca/statistics-facts/home/887>

## **Data**

The data used in this study is from the Labour Force Survey (LFS) and through the Canadian Socio-Economic Information Management system (CANSIM). The LFS and CANSIM are both provided by Statistics Canada. LFS measures the performance of the Canadian economy by collecting descriptive data for individuals who are 15 years of age or older, and classified as three subgroups – employed, unemployed, and not in the labour force. The population of interest is any civilian, non-institutionalized individuals who are living in Canada. CANSIM is a database created by Statistics Canada that provides many statistics that are related to Canadian socio-economics.

### **i) Testing post secondary enrolment rate and gov't expenditure on education as a dependent variable**

By collecting yearly September LFS data and yearly data from CANSIM, I have created time-series data from 1984 to 2008 for each province. The reason for choosing September LFS is because I believe students usually begin their school in September, and thus it should provide a better indication on school enrolment rate. I have used two western Canadian Provinces, Alberta and British Columbia that are rich in natural resources, and two provinces, Quebec and Ontario, who are not natural resource abundant in comparison to Alberta and B.C. Another reason for choosing these four provinces is because they were the only provinces that had all the data available through 1984 to 2008. It would have been better if the data were available from mid-1800's, when British Columbia have started mining, or before the late 1940's when Alberta started their development in oil and gas industry. However, the limitation in data from Statistics Canada only allowed me to collect the relevant data from 1984 up to 2008.

For the dependent variables which are, enrolment rate and government's expenditure on education per capita, I had to create my own time-series data for each province by using the variables from LFS and CANSIM. First, to calculate the school enrolment rate, I have counted the number of students enrolled in university, college or any other institution for the people who are between ages 17 to 21, and divided them by total number of people who are ages 17 to 21. The reason for choosing this age restriction is because I believe people decide their enrolment in post-secondary school between this ages and it is likely that people who are above this age group would decide their enrolment in post-secondary for many other reasons that are hard to be specified in the model. Therefore, I have applied age restrictions in all of my LFS data, and by using weights that are provided by the LFS each year, I have calculated the school enrolment rate in each province.

$$r_{it} = \left( \frac{N_{it}^{Univ}}{N_{it}^{17-21}} \right) * 100\% \quad (13)$$

where  $i$  and  $t$  represents the province and time respectively.  $r_{it}$  is the enrolment rate in province  $i$ , at time  $t$ .  $N_{it}^{Univ}$  is the number of people enrolled in university or college and is aged between 17 to 21.  $N_{it}^{17-21}$  is the total number of people who are 17 to 21 years old.

For share of government expenditure on education per capita, I first had to download government expenditure on education and total government expenditure for the years 1989-2008 and divide the former from latter to calculate the share of government expenditure on education in each year for each province.

$$g_{it}^{educ} = \ln \left[ \left( \frac{G_{it}^{educ}}{G_{it}} \right) / N_{it} \right] \quad (14)$$

where  $i$  and  $t$  represent the province and time respectively.  $g^{\text{educ}}_{it}$  is government expenditure on education per capita,  $G^{\text{educ}}_{it}$  is government expenditure on education,  $G_{it}$  is total government expenditure, and  $N_{it}$  is the population.

Now for the independent variables, my natural resource abundance measure is calculated by using the data from CANSIM. I first collected the sum of the provinces' "Forestry and Logging" revenue and "Mining and Oil and Gas" revenue and divided by total GDP of that province. The limits of measuring natural resource abundance in my study may affect the results since Stijns (2006) argues that measurement of natural resource share does produce different results. However, I have used the above calculation since it was the best measurement I could provide with the limited data available on natural resource by province.

$$R_{it}^{\text{NR}} = \frac{(Y_{it}^{\text{Forestry and Logging}} + Y_{it}^{\text{Mining, Oil and Gas}})}{Y_{it}} * 100\% \quad (15)$$

where  $i$  and  $t$  represents the province and time respectively.  $R^{\text{NR}}_{it}$  is the share of natural resource revenue in GDP of province  $i$  at time  $t$ .  $Y^{\text{Forestry and Logging}}_{it}$  is the forestry and logging revenue,  $Y^{\text{Mining, Oil and Gas}}_{it}$  is the mining, oil and gas revenue, and  $Y_{it}$  represents the total GDP.

Thirdly, GDP per Capita is calculated by using the data from CANSIM. I have divided each province's yearly GDP in current dollars by population in each year and then applied natural logarithm to convert it as percentage when regressed.

$$y_{it} = \ln\left(\frac{Y_{it}}{N_{it}}\right) \quad (16)$$

where  $i$  and  $t$  represents the province and time respectively.  $y_{it}$  represents the GDP per capita,  $Y_{it}$  represents the total GDP and  $N_{it}$  represents the population.

Fourthly, I have calculated share of trade variable by adding export and import and then dividing it by GDP of the province plus import and multiplied by 100%. The variable share of trade measures the openness of the economy to trading. The reason for adding import and GDP is because when the government calculates the GDP, they use import as expenditure from the GDP. However, the point here is to see the size of the trading, therefore, import expenditure has to be added back to GDP. The reasons for having share of trade as a variable is because it is found in Rodrik (1998) that more open economies have positive relationship with government importance. Even though the provinces are in one country, I believe that a province with larger trading across provinces and other countries should have larger provincial government body such that the governments are more able to spend their revenues in improving social welfare, which includes education. Therefore, it should increase the enrolment rate and government expenditure on education.

$$T_{it} = \frac{(EX_{it} + IM_{it})}{(Y_{it} + IM_{it})} * 100\% \quad (17)$$

where  $i$  and  $t$  represent the province and time respectively.  $T_{it}$  is the share of trade of the province  $i$  at time  $t$ ,  $EX_{it}$  is the export,  $IM_{it}$  is the import and  $Y_{it}$  is the total GDP.

Fifthly, I have created the working population rate variable by using the data from LFS. This is calculated by dividing population under 65 by total population in each year by province, applying the weights. I have assumed that when there is higher working population in the

province, there should be higher ratio of people who are willing to be educated and that the provincial government should be more interested to spend in education system.

$$N_{it}^W = \frac{N_{it}^{<65}}{N_{it}} * 100\% \quad (18)$$

where  $i$  and  $t$  represents the province and time respectively.  $N_{it}^W$  is the working population rate,  $N_{it}^{<65}$  is the population under the age 65, and  $N_{it}$  is the total population.

Finally, I have used urbanization rate data from Statistics Canada's website and used  $U_{it}$  as a representing variable. Urbanization rate is important in measuring enrolment rate because it is believed that there is a higher chance of achieving education level higher than high school if the family is living in a city. Therefore, if urbanization rate is higher, the province should have higher enrolment rate and larger expenditure on education. The Statistics Canada data is collected every five years, so I have assumed that the years that are not collected has the same urbanization rate as its formerly collected data years. For example, since the collected urbanization statistics data begins from 1981, it is used for 1984 urbanization rate and so on.

Table 12 provides the summary statistics for the variables that are used for the regression. The dependent variables, enrolment rate and natural log of government education expenditure per capita are 40.1% and 7.59 respectively. It is observed that average enrolment rate in Quebec is much higher than other provinces; the highest difference around 20% against Alberta. For the independent variables, the average share of natural resources in provincial GDP in years 1992 to 2008 is highest in Alberta with 24.4%. It is also higher in B.C. compared to Ontario and Quebec, but not as high as Alberta. Secondly, share of trade (T) has been roughly the same for all provinces. It is highest in Ontario with 76.3% and lowest in B.C. with 61.8%. It tells us that

Ontario has exported and imported a lot of goods and services compared to other provinces, which is likely to be true since Ontario has a larger manufacturing sector than other provinces. Thirdly, working population ratio was similar in all four provinces, averaging 85.7% in pooled. Fourthly, urbanization rate was highest in Ontario with 83.7% and lowest in Quebec with 78.4%. Lastly, the average natural log of GDP per capita is highest in Alberta with 10.75, and lowest in Quebec with 10.32.

## ii) Testing income level and income growth rate

The data for this regression test is also from CANSIM and LFS, which are both provided by Statistics Canada. The time period tested for this regression is from 1987 to 2012. Some of the data had to be calculated before I could use it for the regression. To calculate the relative price of natural resource, I have used average raw material index price for mineral fuels (coal, natural gas, crude mineral oil) and wood, since I have defined forestry and logging industry and oil and gas industry as the natural resource sector. The indices are fixed at 2002.

$$p_t^{NR} = \frac{(p_t^W + p_t^M / 2)}{p_t^f} \quad (19)$$

where  $t$  is the time.  $p_t^{NR}$  is the relative price of natural resource at time  $t$ ,  $p_t^W$  is the price index of wood,  $p_t^M$  is the price index of mineral fuels, and  $p_t^f$  is the price index of finished goods. The summary statistics are provided in the table 13.

**Econometric Model**

- i) **Post-secondary enrolment rate and gov't expenditure on education as a dependent variable**

$$r_t = \beta_0 + \beta_1 R_t^{NR} + \beta_2 \ln(y_t) + \beta_3 T_t + \beta_4 N_t^W + \beta_5 U_t + \varepsilon_t \quad (20)$$

$$r_{it} = \beta_0 + \beta_1 R_{it}^{NR} + \beta_2 \ln(y_{it}) + \beta_3 T_{it} + \beta_4 N_{it}^W + \beta_5 U_{it} + \lambda_t \text{Year Dummy} + \tau_i \text{Province Dummy} + \mu_{it} \quad (21)$$

$$g_t^{educ} = \beta_0 + \beta_1 R_t^{NR} + \beta_2 \ln(y_t) + \beta_3 T_t + \beta_4 N_t^W + \beta_5 U_t + \eta_t \quad (22)$$

$$g_{it}^{educ} = \beta_0 + \beta_1 R_{it}^{NR} + \beta_2 \ln(y_{it}) + \beta_3 T_{it} + \beta_4 N_{it}^W + \beta_5 U_{it} + \lambda_t \text{Year Dummy} + \tau_i \text{Province Dummy} + \mu_{it} \quad (23)$$

In this study, regression is ran four times with each province's time-series data using equation (20) and (22) and once using equation (21) and (23) for pooled panel data of the four provinces. The result is directly compared using the estimated beta to observe which provinces are the most effected by abundance in natural resources, which is my main study. The subscript i represents the province and the subscript t represents year.  $\beta_0$  is the constant that goes through y-axis in the linear model, and each  $\beta$  in front of the each variable represents the effect of the variable on dependent variable. Last terms are the error terms. I have used enrolment rate and government expenditure on education per capita as a dependent variable because data are available to be collected as a measurement of human capital. I believe that if the province is experiencing natural resource curse, enrolment rate and government expenditure on education per capita should decrease because of lack of government support on education and vice versa. For the independent variables, I have included natural resource share which is measured in terms

of share of provincial natural resource revenue in total provincial GDP. As noted in data section, the measurement of natural resource share could generate different results. However, due to limited gathering of data, I had no choice but to use share of GDP method.  $\beta_1$  is the most important estimation in this paper since this estimated  $\beta_1$  is the measure of natural resource on dependent variable. GDP per capita is also in the equation because I believe that higher GDP per capita should increase enrolment rate since richer the population, higher the chance that they pursue higher education. Thirdly, share of trade is included because when there is a lot of trade, there is more competition for the market and thus the jobs will require high-skilled labours to develop competitiveness, increasing the enrolment rate and thus government expenditure on education. Lastly, working population rate and urbanization rate are included because if a province has higher working population rate and higher urbanization rate, government will likely to spend more money on education than if the population is aged and less urbanized.

## ii) Testing income level and income growth rate

For this regression, I followed the econometrics model used by Boyce and Emery (2011). The equation estimated is similar to the equation mentioned in the literature review, but as Boyce and Emery have done in their empirical test, I have used natural logarithm of GDP per capita as a dependent variable. The equation for income level effect is,

$$\ln(y_{it}) = \alpha_0 + \alpha_1 \left( \frac{L_{it}^R}{L_{it}} \right) + v_{it} \quad (24)$$

where  $i$  and  $t$  represents the province and time. As explained in the literature review, the estimated  $\alpha_0$  measure the average income level in manufacturing sector, the estimated  $\alpha_1$

measures the average difference between the income level of resource sector and manufacturing sector over the studied period.

For the testing of income growth, I have used

$$\ln\left(\frac{y_{it}}{y_{it-1}}\right) = \beta_0 + \beta_1 \left(\frac{L_{it}^R}{L_{it}}\right) + \beta_2 \ln\left(\frac{p_t^R}{p_{t-1}^R}\right) \left(\frac{L_{it}^R}{L_{it}}\right) + \beta_3 \ln\left(\frac{N_{it}}{N_{it-1}}\right) \left(\frac{L_{it}^R}{L_{it}}\right) + \beta_4 \ln\left(\frac{L_{it}^R}{L_{it-1}^R}\right) \left(\frac{L_{it}^R}{L_{it}}\right) + \varepsilon_{it} \quad (25)$$

which is same equation (12) in the literature review. Similar to the regression test in Boyce and Emery (2010), for the regression of equation (24), I used OLS without cross-section and period fixed effect, OLS with only period fixed effect, OLS with cross-section effect, OLS with both fixed effect, OLS with cross-section random effect, and OLS with cross-section and period random effect. For the regression of equation (25), I did same effects equation (24), but excluded random effects because random effects are only available when the number of provinces is more than the number of variables.

## Results

### **1. Post-secondary enrolment rate and gov't expenditure on education as a dependent variable**

Table 14 shows the OLS regression results for each province and pooled result with panel data with enrolment rate as a dependent variable. It is observable that Quebec, Alberta and Pooled regression have negative estimated  $\beta_1$ , which aligns with the prediction when natural resource is a curse but Ontario and British Columbia have positive estimated  $\beta_1$ . Also, it is surprising to see that Quebec has the lowest estimated  $\beta_1$  with -3.28, instead of natural resource

rich Alberta or British Columbia. Among the three negative estimated  $\beta_1$ , Alberta actually has the highest estimated  $\beta_1$  with  $-.05$ . Since I have used percentage for the measurement, it means that in Quebec, a 1% increase in share of natural resource in total GDP will decrease the rate of enrolment in university or college by 3.28%. Moreover, in Alberta there is only 0.05% decrease in enrolment rate when there is 1% increase of share of natural resource in total GDP. However, none of the estimated betas were significant, even at 90% significant level. For positive estimated  $\beta_1$ , Ontario and British Columbia have positive  $\beta_1$  of 3.7 and .3 respectively. Therefore, a 1% increase in share of natural resource in total GDP will increase enrolment rate by 3.7% in Ontario and .2% as pooled, but again both were insignificant. The results indicate that resource rich Western Canadian provinces have been performing well to keep education level relatively unaffected by natural resources, although none of the results is significant to draw a definite conclusion. Moreover, large negative estimated beta one for Quebec tells us that they have not been doing well in using their natural resource revenue on developing higher education level. The reasons for this difference in each province could be because of the difference of political approach to natural resource handling, such as taxing or how the provincial government has spent the revenue generated. But again, it is not possible to draw any conclusion because the betas for all of them were not significant. Lastly, the positive  $\beta_1$  for Ontario could be because of early development in manufacturing sector such that Ontario does not rely on natural resources sector. Ontario already had a large manufacturing sector by 1989. Thus, the people in Ontario were already looking for high-skilled jobs rather than low-skilled jobs in natural resources sector and eventually there is no room for natural resource curse to occur in Ontario. However, it should be noted that this value was not significant even at 10% level as well. For the pooled

panel data,  $\beta_1$  is negative and insignificant. Therefore, I cannot draw conclusion on their performance as a pooled.

For share of trade, the result showed negative beta for Ontario, Quebec and Pooled, and positive estimated beta for Alberta and British Columbia. For Ontario and Quebec, more trades between countries and provinces have decreased the enrolment rate, while it increased the enrolment rate in Alberta and B.C. However, it was only insignificant for all of them. For working population rate, I expected positive estimated beta for all the provinces, but only Alberta and Pooled regression showed positive estimated beta. Therefore, as an overall, increase in working population rate should increase enrolment rate. For urbanization rate, each province showed positive beta but only British Columbia had a 99% significant level. Lastly, natural log of GDP per capita is negative for Pooled, Quebec and British Columbia. I expected positive estimated beta for all provinces since increase in GDP per capita is related to wealth of the population in that province, and should increase enrolment rate when GDP per capita is increased. The negative betas in all other provinces except British Columbia are again disappointing and it is 99% significant for British Columbia and 90% significant for Pooled. Overall, it should be noted that most of the result were not significant even at 90% significance level. Therefore, I can conclude that the regression variables used in most of the natural resource curse papers is not likely to explain natural resource curse in Canadian provinces or that there is strong relationship between natural resource and school enrolment rate in Canada. However, it is more likely that there are some missing variables that explain the dependent variable.

Now, in Table 15, the OLS regression results for each province and panel data of four provinces using government expenditure on education per capita as the dependent variable is available. I obtained that all provinces and pooled data have positive value for estimated  $\beta_1$ ,

which aligns with the prediction when natural resource is a blessing. Although the estimated  $\beta_1$ , is very small in most of them, it is surprising to see that all of them have a positive coefficient. Out of the all positive estimated  $\beta_1$ , Ontario has highest estimated  $\beta_1$  with .14 with 99% significance, Quebec has .07, Alberta has .00 with 95% significance, British Columbia has .01 and Pooled has .01 with 99% significance. In comparison to the first regression using enrolment rate as a dependent variable, the second regression shows much better significance. Therefore, it is likely that natural resource has more impact on how gov't spends their revenue than the enrolment rate. Since the dependent variable is in natural logarithm, it can be interpreted as a percentage change in government expenditure on education per capita. For example, it means that in Ontario, a 1% increase in share of natural resource in total GDP will increase the government expenditure on education per capita by 14%. However, it should be noted that not all of the estimated betas were significant. For Quebec and British Columbia, they were insignificant even at 90% significance level. The positive estimated  $\beta_1$ , for all the provinces and Pooled regression suggest that all of them have been doing well to use their revenue from natural resource on education level of the province. Although for Alberta, it seems that natural resource share did not have any effect on government expenditure on education. The positive estimated  $\beta_1$  with 99% significance for pooled regression suggests that as an overall, the four provinces did not have natural resource curse but a blessing.

For share of trade, the result showed negative beta or zero for all provinces. However, the estimated beta is very small and is only significant for Ontario and Quebec at 99% significant level, so it is hard to draw a conclusion from it. For working population rate, I expected positive estimated beta for all the provinces, but none showed positive estimated beta and Ontario and British Columbia showed negative value with 99% and 95% significance level respectively. It is

hard to interpret this result, since an increase in working population should increase government's interest in education. It might be that I should have used the ratio of young population, instead of working age as a variable. Therefore, as an overall, it is drawn that increase in Ontario and British Columbia, an increase in working population ratio decreases the government's expenditure on education per capita, which is not expected. For Urbanization rate, estimated beta for Pooled shows  $-.02$  with 99% significance level and Alberta shows  $.08$  with 99% significance level. The others showed very small estimated coefficient with no significance. There was no expected sign for this one, since increase in urbanization rate may mean that government is less pressured to provide education. Lastly, natural log of GDP per capita is negative for British Columbia and Pooled and positive for all other provinces. Again, I did not expect a particular sign for this estimated coefficient since an increase in GDP per capita may increase the government's spending on education by collecting more taxes, or it could decrease by providing less support on education since people are richer. Therefore, in Ontario, Quebec, and Alberta, it can be concluded that an increase in the wealth of the population increases the government expenditure on education while in British Columbia and Pooled, it decreases. However, it should be noted that British Columbia is insignificant at any level of significance.

I also like to note that the regression result in table 15 has some confusing results. For Urbanization rate and natural log of GDP per capita, it is hard to understand that the estimated coefficient beta for Pooled shows opposite sign in comparison to the majority of estimated coefficient betas for each province. For example, for the estimated coefficient beta of natural log of GDP per capita, I see that Quebec, Alberta, and Ontario show positive sign with significance level of at least 90%. However, the estimated beta for Pooled shows negative sign with 99%

significance. Similar results are shown in Urbanization Rate. Therefore, a closer examination at the regression and the data are required.

I believe my results give somewhat mixed result of natural resource effect. The first regression did not have any significance and the estimated beta did not follow the expected sign for natural resource curse or blessing. The second regression showed significance in some and positive sign for all of the estimated betas. Therefore, it can be concluded that the increase in share of natural resource increases the government's expenditure on education per capita, but does not necessarily increase the enrolment rate in post-secondary schools. Still, since the increase in share of natural resource does not decrease the education spending, it is a step closer to natural resource blessing rather than a curse. I believe this result is because Canadian provinces have a good quality provincial and federal government who are able to turn natural resource endowment into a blessing, similar to that of Norway. However, it could be also that my econometric model has endogeneity problems, especially omitted variable bias. There are two conditions that are satisfied in omitted variable bias; first, there is exclusion of the factors that affect the dependent variable, and secondly, that excluded factor is correlated with an explanatory variable. One of the factors that I wasn't able to include in this paper was political approach and transfers. It is not able to measure the importance of education in each province and there is also the equality system in Canada that transfers some revenue to the provinces that have less revenue. Another variable that might need to be included is the mobility of the population. Even though the provinces are large and separated by provincial government, it is easy for people in Ontario to search for a job in Alberta if they pay a higher wage. Therefore, it might be that provinces are specializing on what they are good at. For example, Alberta does not

have to spend large money on education to find a high-skilled labor from their own province, since it can be easily found from other provinces.

## 2. Income level and Income growth

### Income per capita level

The result in the table 16 shows that the values for  $\alpha_1$  and  $\alpha_0$  are positive in five of the six estimation methods, and four out of six have significant level of at least 90% for both estimated coefficients. Constants are all significant at 1% significance level. I have focused more on model (4) since it is more appropriate to use fixed cross-section effect and fixed period effect when using panel data. From the result, it can be interpreted that an increase in share of employment in the mining, forestry, and logging increases the level of income per capita, holding everything else constant. This result is same as what Boyce and Emery (2011) showed in their result with the fifty U.S. states data, but lower in magnitude. Since estimated  $\alpha_1$  is positive, the higher employment share in natural resource sector in Alberta and British Columbia does increase the income per capita level in their province. For example, using the average share of employment from the summary statistics, it can be calculated that Alberta, British Columbia, Ontario, and Quebec shows 10.51, 10.47, 10.46, and 10.46 respectively. Since I have used natural logarithm of income per capita as the dependent variable, the results are interpreted as a percentage differences. Therefore, on average, during the period 1987 to 2010, Alberta have enjoyed 4 percent higher income per capita in comparison to British Columbia, 5 percent higher income per capita in comparison to Ontario and Quebec. British Columbia has slightly higher natural logarithm of income per capita than Quebec and Ontario by 1%. It should be noted from the summary statistics table that the average share of employment in natural resource sector for

British Columbia is not much higher than Quebec. This may be because I have made measurement error, such as excluding an important natural resource sector in British Columbia, other than forestry, logging, natural gas, and mining. However, British Columbia still enjoyed higher in income per capita. It can be concluded that while Alberta enjoyed the most from natural resource extraction, Ontario had the lowest income per capita throughout the period.

### **Income per capita growth rate**

The results in table 17 shows that the values for  $\beta_3$  are negative and  $\beta_0, \beta_1, \beta_2, \beta_4$  are all positive, except for  $\beta_1$  model (4), in all four estimation methods, although there are some difference in magnitude of the estimated coefficients and not all of them are significant at 1%, 5%, and 10% level. However, in all four methods, it can be observed that holding everything else constant, an higher share of employment in natural resource sector will result in a lower income per capita growth rate since the magnitude for negative coefficients are much higher than the positive coefficients. I will focus more on model (4) since using cross-section fixed effects and period fixed effects are more appropriate in panel data. The signs of estimated coefficients in model (4) are same as the result in Boyce and Emery (2011), but different in magnitude. The estimated  $\beta_2$  is much larger in Boyce and Emery (2011) and  $\beta_3$  is much smaller in their paper. However, the basic result is same. A province with higher share of employment in natural resource sector has smaller growth in income per capita.

### **Multicollinearity Test**

I have performed simple correlation test on variables used in Method I. The results are in table 18. From the table, it can be observed that some of the correlations are higher/lower than +/- 0.8, which is the threshold of indication of high correlation. Although, high correlation does

not always pose a problem, this test can alert whether or not these correlations are likely to pose a problem. For Ontario, working population rate and urbanization rate shows high negative correlation, but this is confusing since higher urbanization rate should increase the working population rate. Another confusing result is between working population rate and GDP per capita. It has high negative correlation, indicating that increase in working population rate decreases GDP per capita. This again, is not understandable since higher working population should increase GDP per capita. However, this shows up in all of the provinces. Lastly, high correlation rate is between GDP per capita and urbanization rate, which is understandable since high GDP per capita should increase the urbanization rate or vice versa.

Quebec only shows high negative correlation between working population rate and GDP per capita. Alberta shows high negative correlation between working population rate and GDP per capita and high positive correlation between share of natural resource and GDP per capita. British Columbia shows many high correlations between the variables, which may indicate that the variables used may pose a multicollinearity problems. Overall, it seems that the variables used in this regression may pose a multicollinearity problem, since many of them have high correlations. To fix this problem, Greene (2011) suggests the followings:

1. Drop one or more explanatory variables.
2. Place restrictions on some of the coefficients.
3. Transform the explanatory variables.
4. Use principal components analysis to reduce the set of explanatory variables.
5. Use an alternative estimator
6. Add some extra information.

Therefore, for further research, it is preferable to use different variables for the regression equations.

## **Conclusion**

The regression result for the first method does not provide strong evidence of natural resource curse on Canadian provinces. From the multicollinearity test, it seems that variables that are used in the regression do cause some problem. Therefore, it will be better to find other variables that will give improved results. The question of whether there is a natural resource curse in Canadian province remains unresolved here. However, from the second method, following Boyce and Emery's (2011) work do show that resource rich western Canadian provinces do enjoy higher income per capita, although slower growth. Therefore, it can be concluded that rather than natural resource curse, natural resource is providing higher income for individuals in Eastern provinces for now. It is also confirmed from the summary statistics in table 12 and 13 that Alberta has the highest average income per capita, while Quebec has lowest. Although Ontario has second largest income per capita, it might be because British Columbia is not exploiting its natural resource as much as Alberta. It can be seen from the summary statistics table 12 that share of natural resource is 24.4% in Alberta, while only 6.2% in British Columbia.

The mixed result in method I could be because of the presence of good quality government in Canada and its government budget transfer system. However, it should be also noted that the some of the results in table 14 and 15 are not significant even in 90% level. Therefore, I believe there needs to be a further study on what factors should be included in econometric model. For example, one of the omitted variable biases could be share of government transfer that is used in developing education level. Another problem might be the measurement error in natural resource abundance. Stijns (2006) suggested that the way Gylfason (2001) measured the natural resource abundance resulted insignificant variables to be significant.

Therefore, to conclude, my regression results shows no signs of natural resource curse in the four provinces, and there needs to be further experiment in econometric model.

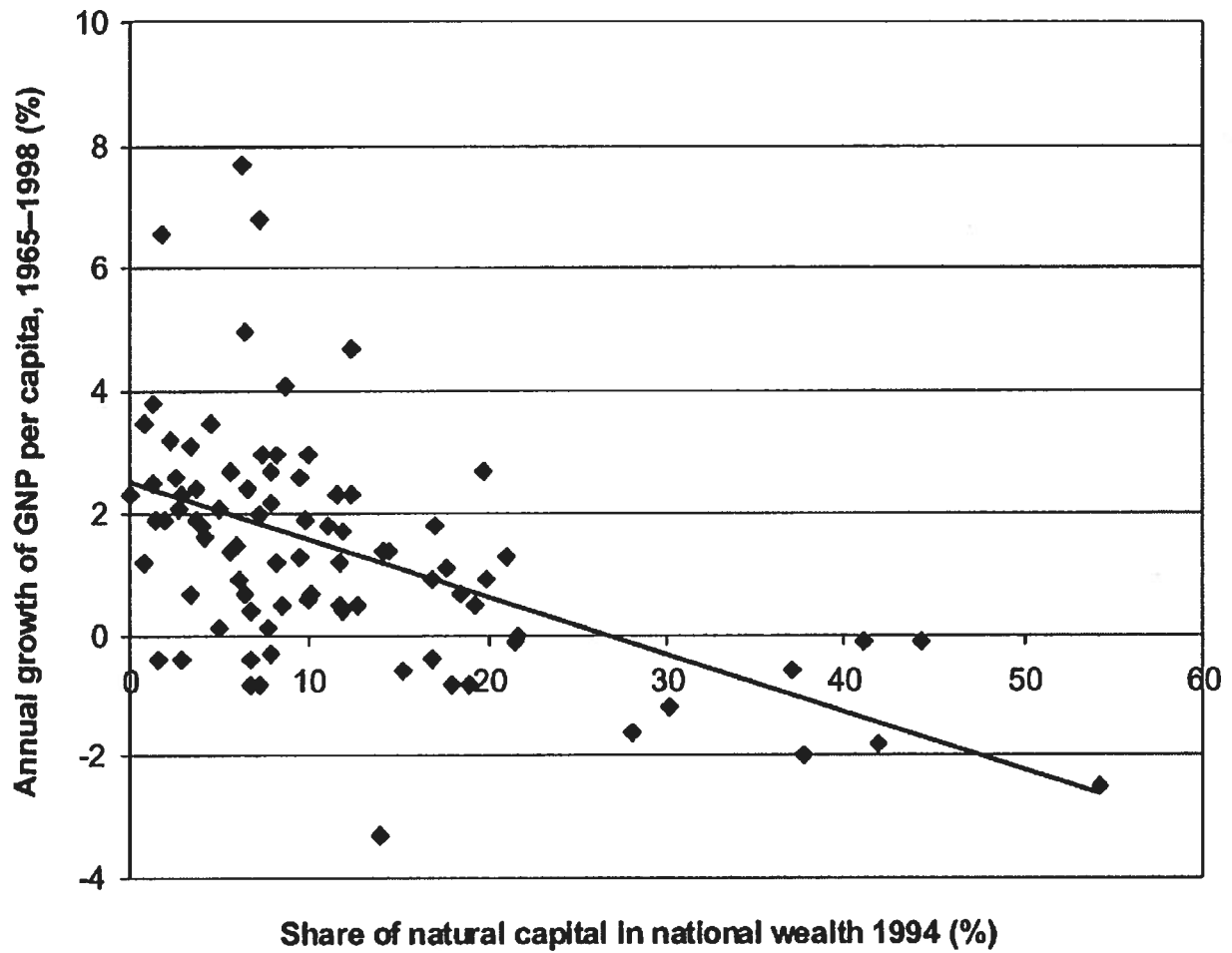
**Tables and Figures**

<b>Table 1: List of Universities by Province</b>			
	<b>Institution</b>	<b>Year Established</b>	<b>Undergraduate Enrolment</b>
<b>Alberta</b>	Athabasca University	1970	36,240
	Grant MacEwan University	1971	11,721
	Mount Royal University	1910	10,670
	University of Alberta	1906	29,250
	University of Calgary	1966	23,320
	University of Lethbridge	1967	7,930
<b>British Columbia</b>	Capilano University	1968	7,500
	Emily Carr University of Art and Design	1925	1,870
	Fairleigh Dickinson University	2007	78
	Kwantlen Polytechnic University	1981	16,811
	Quest University	2002	300
	Royal Roads University	1995	887
	Simon Fraser University	1965	29,697
	Thompson Rivers University	1970	13,072
	Trinity Western University	1962	2,130
	University of British Columbia	1908	41,700
	University of Victoria	1903	18,863
	University Canada West	2005	350
	University of the Fraser Valley	1974	8,124
	University of Northern British Columbia	1990	3,068
Vancouver Island University	1969	6,116	
			<b>Total: 150,566</b>
<b>Ontario</b>	Algoma University	2008	1,150

	Brock University	1964	15,747
	Carleton University	1942	20,950
	Dominican University College	1900	190
	Lakehead university	1965	7,300
	Laurentian University	1960	8,200
	McMaster University	1887	22,940
	Nipissing University	1909	6,300
	OCAD University	1876	3,450
	Queen's University	1841	16,700
	Saint Paul University	1965	430
	Tyndale University	1982	850
	Redeemer University College	1982	955
	Royal Military College of Canada	1876	1,040
	Ryerson University	1948	30,200
	Trent University	1963	7,700
	University of Guelph	1964	19,800
	University of Ontario Institute of Technology	2002	8,846
	University of Ottawa	1848	33,000
	University of Toronto	1827	60,660
	University of Waterloo	1957	20,500
	University of Western Ontario	1878	29,500
	University of Windsor	1857	14,700
	Wilfrid Laurier University	1911	13,750
	York University	1959	46,640
			<b>Total: 391,498</b>
<b>Quebec</b>	Bishop's University	1843	2,240
	Concordia University	1974	32,347
	Ecole de technologie superieure	1974	4,050
	Ecole nationale d'administration publique	1969	0*
	Ecole Polytechnique de Montreal	1873	4,060
	HEC Montreal	1907	9,390
	Institut national de la recherche scientifique	1969	0*

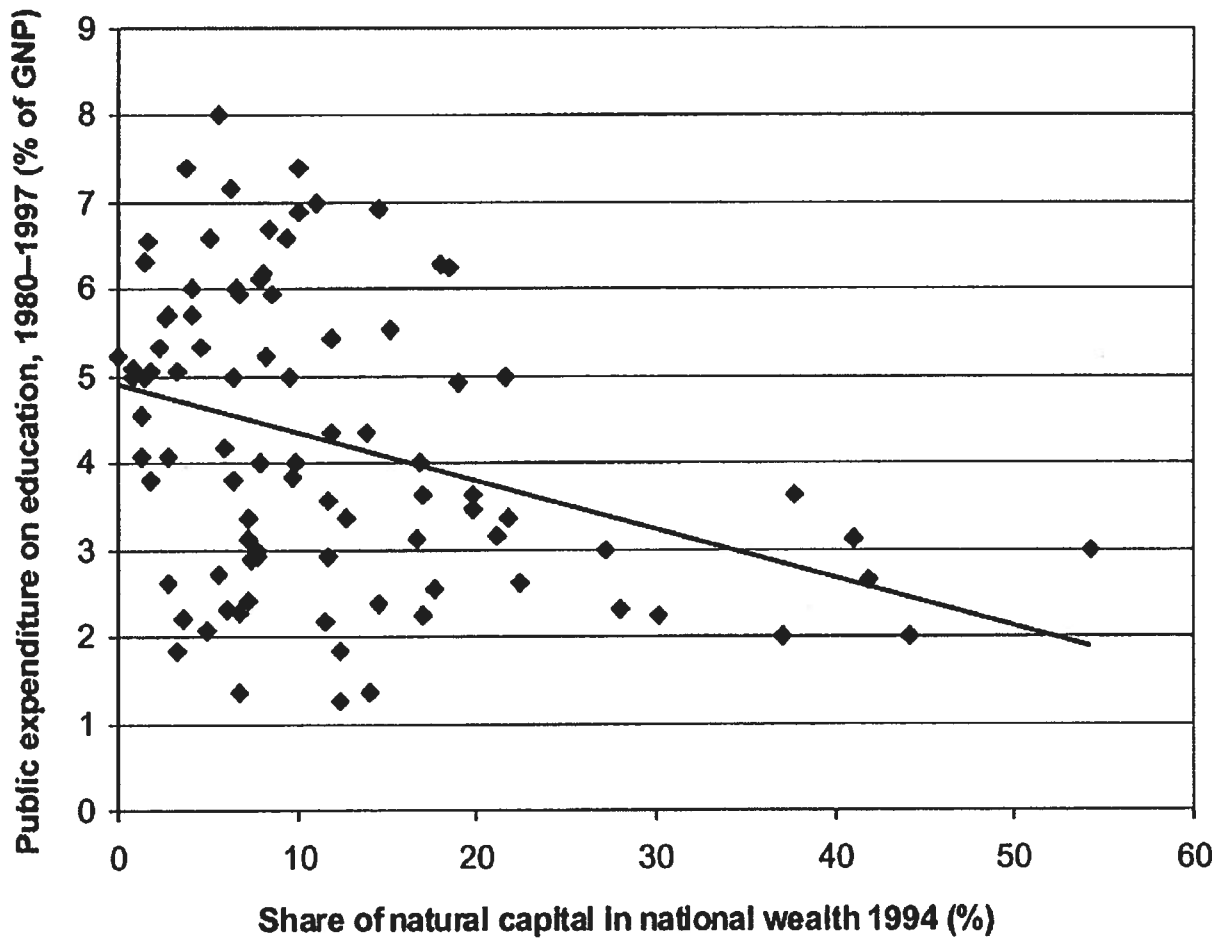
	McGill University	1821	23,758
	Universite de Montreal	1878	41,055
	Universite de Sherbrooke	1954	13,490
	Universite du Quebec en Abitibi-Temiscamingue	1970	2,260
	Universite du Quebec en Outaouais	1970	4,360
	Universite du Quebec a Chicoutimi	1969	5,140
	Universite du Quebec a Montreal	1969	33,100
	Universite du Quebec a Rimouski	1969	4,620
	University du Quebec a Trois-Rivieres	1969	9,160
	Universite Laval	1663	27,530
			<b>Total: 216,560</b>

\*Ecole nationale d'administration publique and Institut national de la recherche scientifique only had post-grad students.

**Figure 1. Economic Growth and Natural Capital**

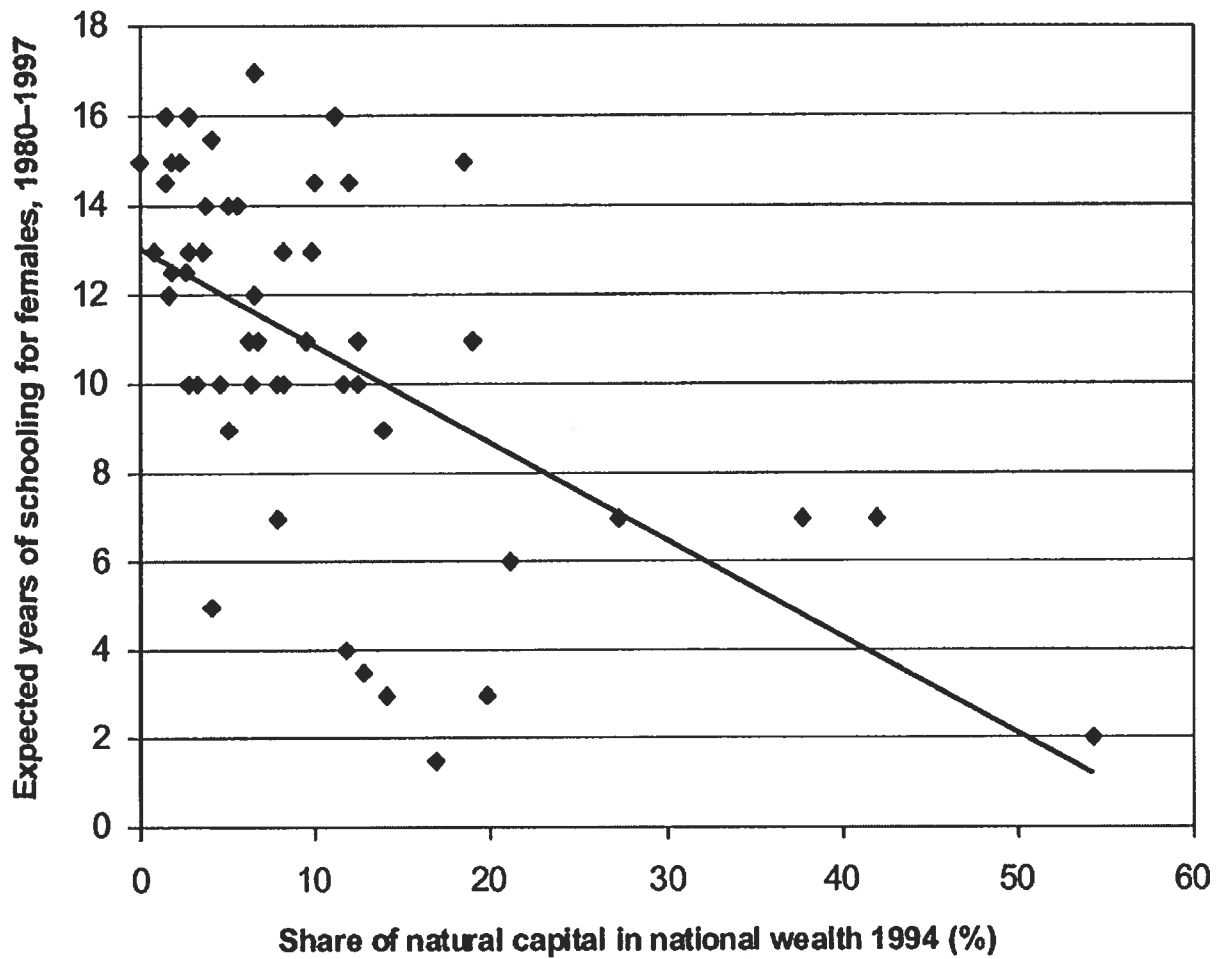
Source: Gylfason(2001)

Figure 2. Expenditure on Education and Natural Capital

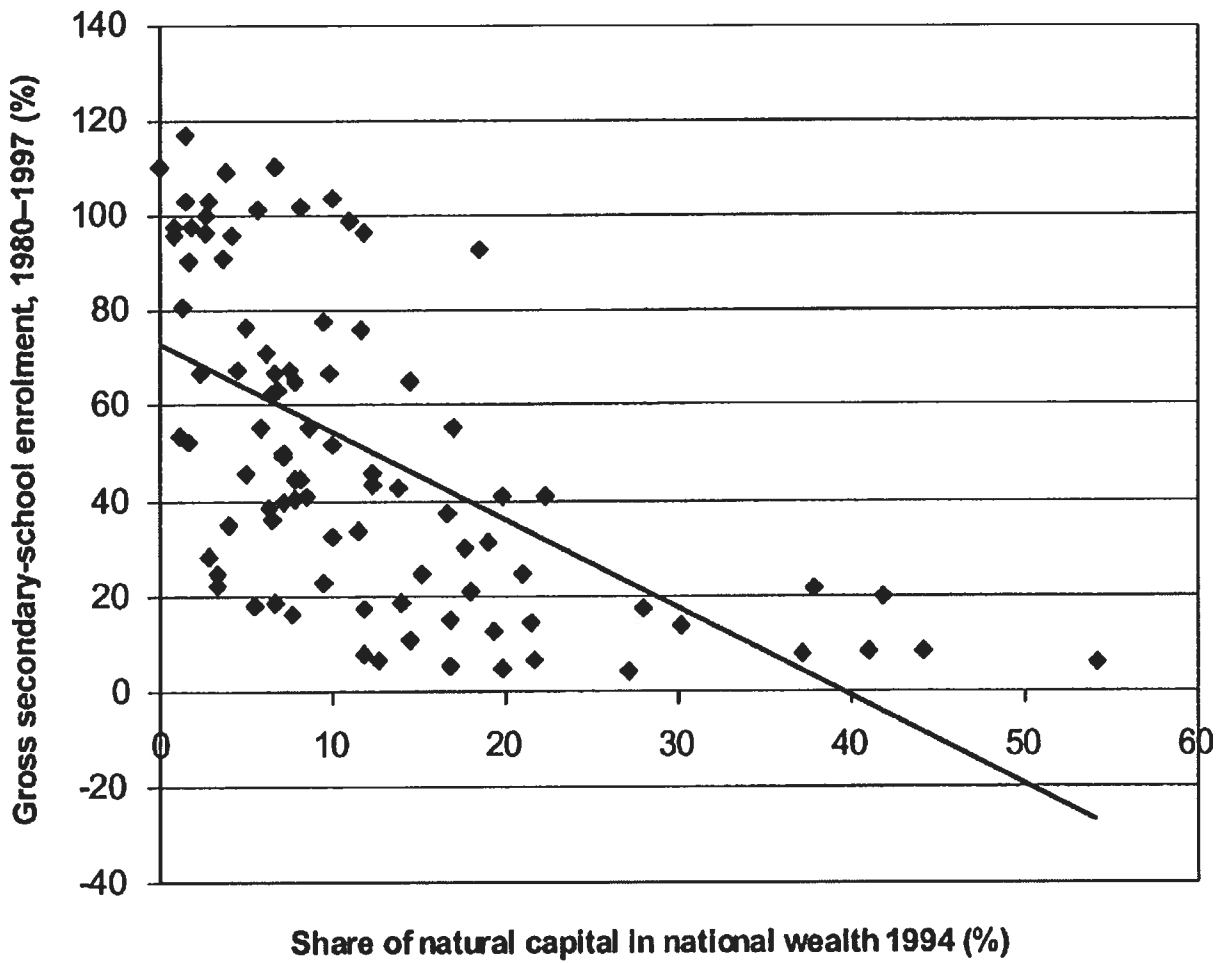


Source: Gylfason(2001)

Figure 3: Years of Schooling and Natural Capital

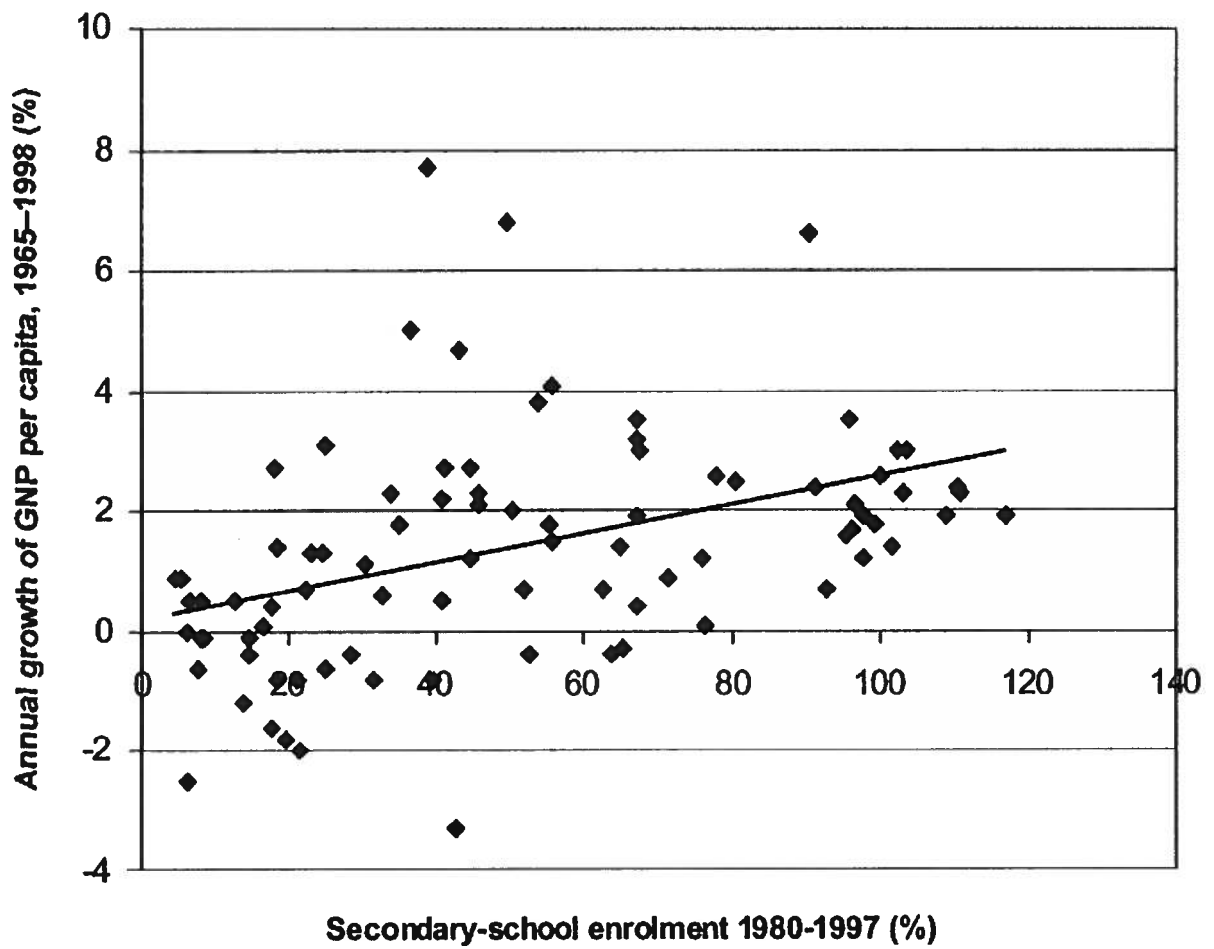


Source: Gylfason(2001)

**Figure 4: Secondary Enrolment and Natural Capital**

Source: Gylfason(2001)

Figure 5: Economic Growth and Education



Source: Gylfason(2001)

Table 2: Growth Regression Results with Transmission Channels

Dependent variable: $G_{75-96}$	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-2.62	10.03	11.66	12.87	12.33	12.03
$\ln Y_{75}$	0.52**	-1.16***	-1.61***	-1.77***	-1.76***	-1.61***
(0.89)	(2.48)	(-3.00)	(-4.93)	(-5.55)	(-5.98)	(-3.91)
SNR	-7.57***	-7.39**	-4.41	-3.11	0.93	1.59
(0.07)	(-4.09)	(-2.04)	(-1.47)	(-1.07)	(0.32)	(0.59)
Corruption		-0.44***	-0.30**	-0.26**	-0.19*	-0.09
(2.68)		(-3.06)	(-2.52)	(-2.25)	(-1.76)	(-0.86)
Investments			0.16***	0.13***	0.15***	0.16***
(8.06)			(4.82)	(4.15)	(5.07)	(5.56)
Openness				1.26**	1.64***	1.26**
(0.45)				(2.31)	(3.23)	(2.39)
Terms of trade					-0.27**	-0.31***
(1.90)					(-2.52)	(-3.23)
Schooling						0.58
(0.61)						(1.23)
$R^2$ adjusted	0.18	0.25	0.51	0.55	0.62	0.66
$N$	103	47	47	47	46	39

Notes: 1. The standard deviations for the independent variables are in parentheses, based on the sample of 39 core countries used in the regression in column (6). 2. The  $t$ -statistics for the coefficients are in parentheses.

\* 10% level of significance.

\*\* 5% level of significance.

\*\*\* 1% level of significance.

Source: Papyrakis and Gerlagh(2004)

Table 3: Total Effect Growth Regression Results

Growth regression, including indirect effects	
Dependent variable: $G_{75-96}$	(7)
Constant	16.53
Ln $Y_{75}$	-1.61 <sup>***</sup>
(0.89)	(-3.90)
SNR	-9.61 <sup>***</sup>
(0.07)	(-4.30)
$\mu^1$ (Corruption)	-0.091
(2.63)	(-0.86)
$\mu^2$ (Investments)	0.16 <sup>***</sup>
(7.82)	(5.56)
$\mu^3$ (Openness)	1.26 <sup>**</sup>
(0.43)	(2.39)
$\mu^4$ (Terms of trade)	-0.31 <sup>***</sup>
(1.82)	(-3.23)
$\mu^5$ (Schooling)	0.58
(0.59)	(1.23)
$R^2$ adjusted	0.66
$N$	39

Notes: 1. The standard deviations for the independent variables are in parentheses. 2. The  $t$ -statistics for the coefficients are in parentheses.

\*\* 5% level of significance.

\*\*\* 1% level of significance.

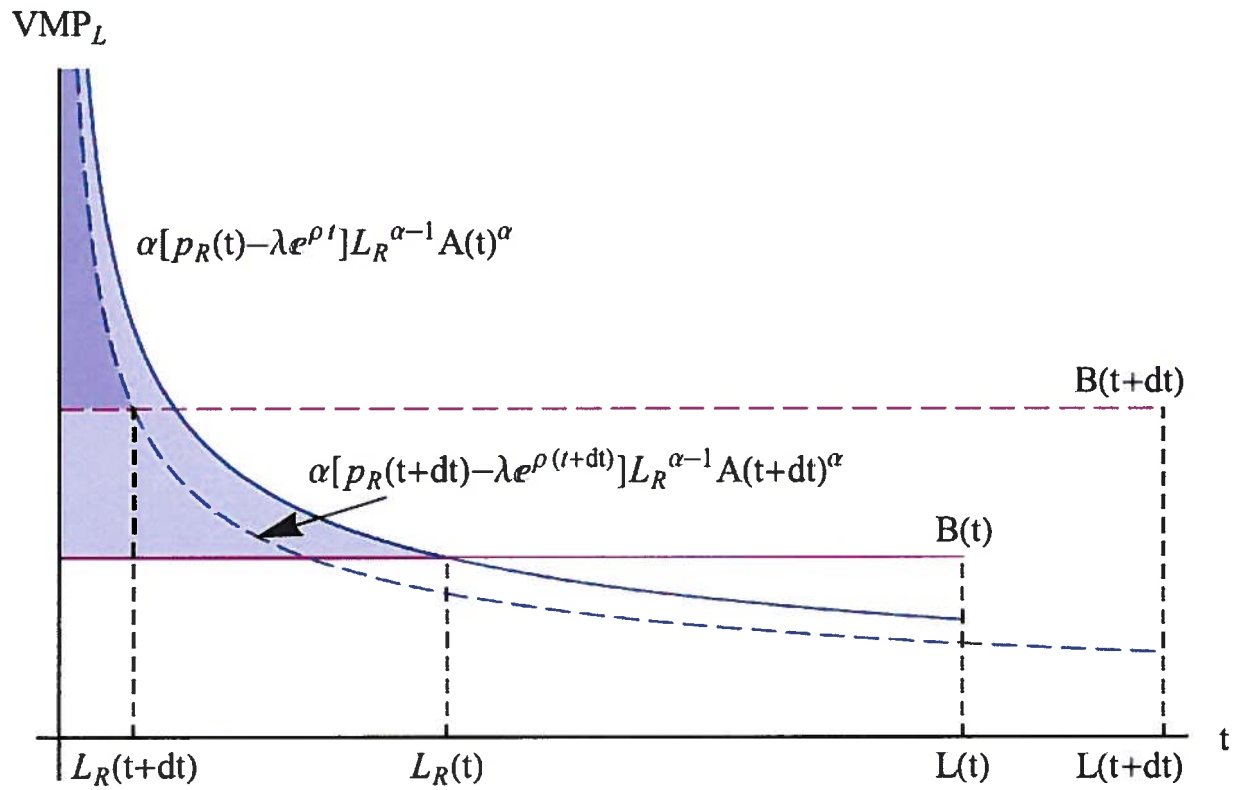
Source: Papyrakis and Gerlagh(2004)

**Table 4: Relative Importance of Transmission Channels**

Transmission channels	$\alpha_3$ (Table 1)	$\beta_1$ (Table 2)	Contribution to $\alpha_3\beta_1$	Relative contribution
<i>Corruption</i>	-0.09	7.21	-0.65	6%
<i>Investment</i>	0.16	-28.83	-4.61	41%
<i>Openness</i>	1.26	-1.82	-2.29	21%
<i>Terms of trade</i>	-0.31	7.75	-2.40	21%
<i>Schooling</i>	0.58	-2.16	-1.25	11%
<b>Total</b>			-11.2	100%

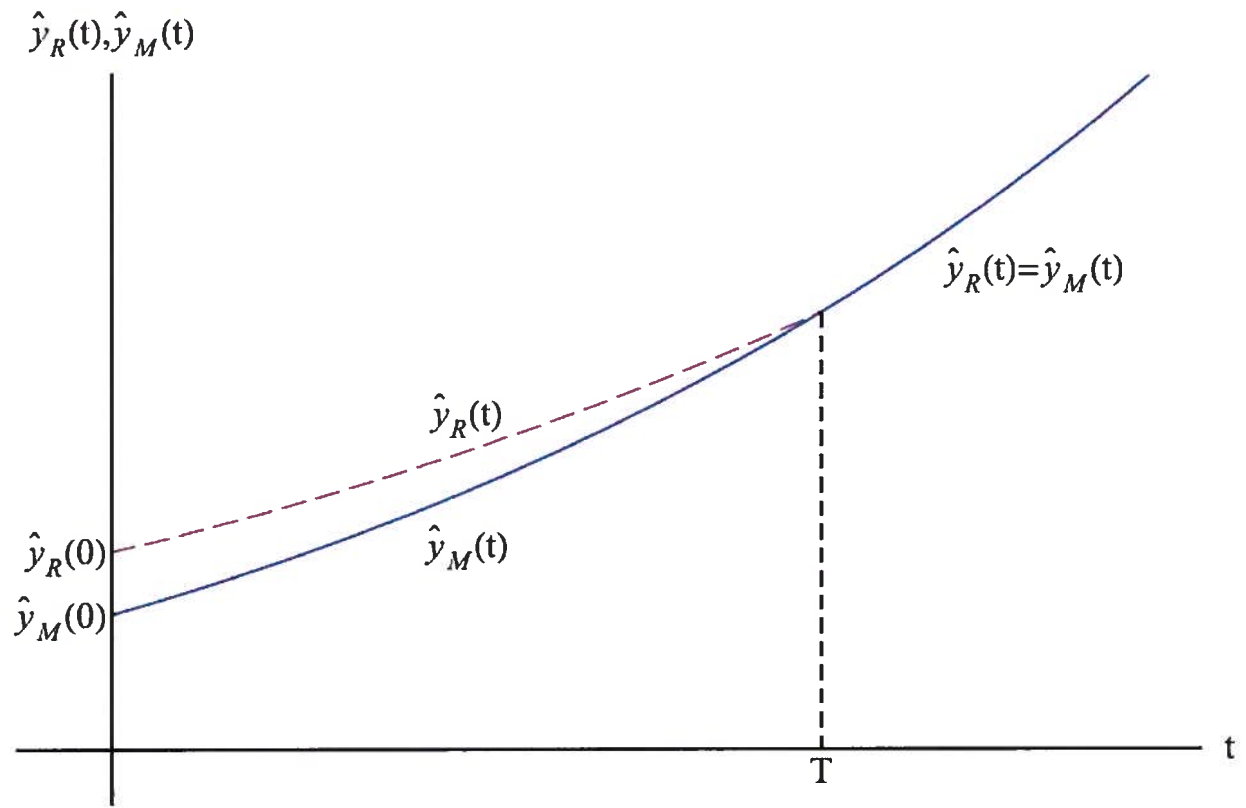
Source: Papyrakis and Gerlagh(2004)

Figure 6: The Positive Level Effect and the Negative Growth Effect from Natural Resources.



Source: Boyce and Emery(2011)

**Figure 7: Growth Rate of Natural Resource Economy and Pure Manufacturing Economy**



Source: Boyce and Emery(2011)

**Table 5: Cross-Section Regression Result**

Cross-sectional growth regressions, U.S. states 1970–2001.

	(1)	(2)	(3)	(4)
1970 mining employment share, $L_R/L$ ( $\times 100$ )	*** -0.117 (0.030)		*** -0.109 (0.029)	
1970 resource employment share, $L_R/L$ ( $\times 100$ )		*** -0.107 (0.028)		** -0.096 (0.028)
1970 log of (real per capita income)			* -0.007 (0.003)	* -0.006 (0.003)
Constant	***0.015 (0.001)	***0.016 (0.001)	*0.08 (0.030)	*0.076 (0.030)
Observations	50	50	50	50
Adjusted-R <sup>2</sup>	0.246	0.242	0.313	0.307

Notes: The dependent variable is the average annual real per capita GSP growth in state  $i$  over the period 1970–2001,  $\ln(y_{i,2001}/y_{i,1970})/(2001-1970)$ . The estimation method is ordinary least squares. Employment in the resource sector is measured as employment in mining, or in resource sectors, in the numerator, and total employment in the denominator. The ratio of producer price indices,  $p_M/p_{FG}$ , are crude materials in the numerator and finished goods in the denominator. Standard Errors in parentheses. "\*\*\*" statistically significant at 1% confidence level; "\*\*" statistically significant at 5% confidence level; "\*" statistically significant at 10% confidence level.

Source: Boyce and Emery(2011)

Table 6: Panel Level Effect Regression Result

Panel level effect regressions, U.S. states 1970–2001.

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	FE	FE	RE	RE
$\alpha_1$ : Mining employment share, $L_R/L$	***1.407 (0.292)	***2.201 (0.247)	–0.971 (0.542)	***6.143 (0.308)	–0.603 (0.504)	***5.93 (0.301)
$\alpha_0$ : Constant	***9.625 (0.006)	***9.385 (0.026)	***9.654 (0.007)	***9.333 (0.011)	***9.65 (0.024)	***9.337 (0.026)
Observations	1645	1645	1645	1645	1645	1645
Year effects	No	Yes	No	Yes	No	Yes
$R^2$	0.014	0.327				
$R^2$ within groups			0.002	0.752	0.002	0.752
$R^2$ between groups			0.033	0.031	0.033	0.031
$R^2$ Overall			0.014	0.271	0.014	0.275
$\sigma_u$			0.171	0.182	0.164	0.166
$\sigma_e$			0.146	0.073	0.146	0.073
$\rho$ (% of variation in $u_i$ )			0.579	0.86	0.559	0.836
Degrees of freedom, $\nu_2$	1	33	50	82	1	33
$\chi^2(\nu_2)$ , $H_0: \beta_1 = 0$					1.428	***4692.761
$F(\nu_2, N - 50 - \nu_2)$ , $H_0: \beta_1 = 0$	***23.307	***23.678	3.211	***143.265		
$F(49, N - 50 - \nu_2)$ Test, $H_0: u_i = 0$			***42.17	***169.02		
Hausman Test $\chi^2(\nu_2)$ , $H_0: u_i \perp X$					3.44	11.15
Breusch-Pagan Test $\chi^2(\nu_2)$ , $H_0: \sigma_u = 0$					***7797	***17558

Notes: The dependent variable is the average annual real per capita GSP in state  $i$  over the period 1970–2001,  $\ln(y_{i,t})$ . The errors are assumed to be of the form  $\epsilon_{it} = u_i + e_{it}$ , where  $u_i$  varies with state and  $e_{it}$  is white noise. The variance of  $u_i$  is  $\sigma_u$ , and the variance of  $e_{it}$  is  $\sigma_e$ . The estimation method is either least squares (OLS), fixed effects (FE), or random effects (RE). Employment in the resource sector is measured as employment in the mining sectors, in the numerator, and total employment in the denominator. Standard Errors in parentheses. “\*\*\*” statistically significant at 1% confidence level; “\*\*” statistically significant at 5% confidence level; “\*” statistically significant at 10% confidence level.

Source: Boyce and Emery(2011)

Table 7: Growth Effect Regression Result

Panel growth effect regressions, U.S. states, 1970–2001 (annual growth).

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	FE	FE	RE	RE
$\beta_1$ : mining employment share, $L_R/L$	-0.044 (0.067)	-0.071 (0.054)	** -0.373 (0.183)	*** -0.48 (0.162)	-0.044 (0.067)	-0.071 (0.054)
$\beta_2$ : mining employment share $\times$ real price growth, $(L_R/L) \times g_R$	*** 6.239 (0.741)	*** 2.515 (0.705)	*** 6.048 (0.758)	*** 2.269 (0.718)	*** 6.239 (0.741)	*** 2.515 (0.705)
$\beta_3$ : mining employment share $\times$ population growth, $(L_R/L) \times n$	*** -9.171 (2.809)	*** -9.91 (2.287)	** -7.209 (3.260)	*** -7.302 (2.682)	*** -9.171 (2.809)	*** -9.91 (2.287)
$\beta_4$ : mining employment share $\times$ mining employment Growth, $(L_R/L) \times (L_R/L_R)$	*** 4.77 (0.484)	*** 6.466 (0.415)	*** 4.823 (0.496)	*** 6.516 (0.424)	*** 4.77 (0.484)	*** 6.466 (0.415)
$\beta_0$ : Constant	*** 0.015 (0.001)	-0.008 (0.004)	*** 0.018 (0.002)	-0.003 (0.005)	*** 0.015 (0.001)	-0.008 (0.004)
Observations	1593	1593	1593	1593	1593	1593
Year effects	No	Yes	No	Yes	No	Yes
$R^2$	0.108	0.456				
$R^2$ within groups			0.109	0.46	0.108	0.458
$R^2$ between groups			0.149	0.161	0.188	0.233
$R^2$ overall			0.095	0.433	0.108	0.456
$\sigma_u$			0.007	0.008	0	0
$\sigma_e$			0.04	0.032	0.04	0.032
$\rho$ (% of variation in $u_i$ )			0.029	0.059	0	0
Degrees of freedom, $\nu_2$	4	35	53	84	4	35
$\chi^2(\nu_2)$ , $H_0: \beta_1 = 0$					***192.374	***1303.9
$F(\nu_2, N - 50 - \nu_2)$ , $H_0: \beta_1 = 0$	***48.093	*** 7.257	***47.281	***36.747		
$F(49, N - 50 - \nu_2)$ Test, $H_0: u_i = 0$			0.34	0.54		
Hausman test $\chi^2(\nu_2)$ , $H_0: u_i \perp X$					3.87	7.37
Breusch-Pagan test $\chi^2(\nu_2)$ , $H_0: \sigma_u = 0$					***13.85	***8.85

Notes: The dependent variable is the average annual real per capita GSP growth in state  $i$  over the period 1970–2001,  $\ln(y_{i,t}/y_{i,t-1})$ . The errors are assumed to be of the form  $\varepsilon_{it} = u_i + e_{it}$ , where  $u_i$  varies with state and  $e_{it}$  is white noise. The variance of  $u_i$  is  $\sigma_u$ , and the variance of  $e_{it}$  is  $\sigma_e$ . The estimation method is either least squares (OLS), fixed effects (FE), or random effects (RE). Employment in the resource sector is measured as employment in the mining sectors, in the numerator, and total employment in the denominator. Standard Errors in parentheses. \*\*\* statistically significant at 1% confidence level; \*\* statistically significant at 5% confidence level; \* statistically significant at 10% confidence level.

Source: Boyce and Emery(2011)

**Table 8: Means of Variables Separated by Distance to Nearest University in Km**

	< 26	26-60	61-100	> 100
1. University	0.16	0.14	0.12	0.10
2. Score on intelligence tests	68.9 (17.4)	68.8 (17.4)	69.2 (16.8)	63.0 (17.3)
3. Father's education				
Elementary	0.57	0.57	0.63	0.73
Junior secondary	0.14	0.16	0.12	0.12
Upper secondary	0.08	0.07	0.06	0.06
Post-secondary	0.13	0.12	0.11	0.06
Unknown	0.08	0.08	0.07	0.03
4. Mother's education				
Elementary	0.50	0.50	0.57	0.66
Junior secondary	0.13	0.14	0.10	0.12
Upper secondary	0.11	0.09	0.10	0.06
Post-secondary	0.16	0.16	0.16	0.11
Unknown	0.10	0.10	0.07	0.05
5. Father's occupation				
Unskilled manual	0.16	0.17	0.20	0.25
Skilled manual	0.19	0.22	0.19	0.22
Routine non-manual	0.09	0.08	0.09	0.07
Lower service	0.18	0.17	0.16	0.10
Upper service	0.11	0.10	0.08	0.06
Self-employed	0.10	0.14	0.14	0.10
Unknown	0.04	0.04	0.04	0.12
6. Mother's occupation				
Unskilled manual	0.29	0.29	0.33	0.28
Skilled manual	0.06	0.06	0.04	0.02
Routine non-manual	0.19	0.13	0.12	0.15
Lower service	0.11	0.10	0.10	0.10
Upper service	0.04	0.03	0.02	0.03
Self-employed	0.10	0.12	0.13	0.10
Unknown	0.25	0.31	0.30	0.33
Number of persons	4467	1822	1532	125

Standard deviations are in parentheses. University refers to at least 3 years of university education. All individuals live within 150 km of a university or university college.

Source: Kjellstrom and Regner(1999)

Table 9: Loglikelihood Ratio Test( $\chi^2$ ) Comparing the Fit of Different Models

Model	Description of model	Models compared	Results of comparison
Int	Intercept + dummy for gender		
A	Parental education and occupation	1. A versus Int	871.4 (20) <sup>b</sup>
B	A + ability	2. B versus A	616.8 (3) <sup>b</sup>
C	B + county dummy variables	3. C versus B	26.4 (15) <sup>a</sup>
D	B + travel distance	4. D versus B	5.8 (1) <sup>a</sup>
E	B + travel time	5. E versus B	6.1 (1) <sup>a</sup>
F	B + shortest distance	6. F versus B	7.1 (1) <sup>b</sup>
G	B + dummy variables of travel distance	7. G versus B	12.1 (3) <sup>b</sup>
H	B + dummy variables of travel time	8. H versus B	5.6 (2)
I	B + log(travel distance)	9. I versus B	2.8 (1)
J	B + log(travel time)	10. J versus B	2.9 (1)
K	B + log(shortest distance)	11. K versus B	3.7 (1)
L	B + travel distance + travel distance <sup>2</sup>	12. L versus B	6.2 (2) <sup>b</sup>
M	B + travel time + travel time <sup>2</sup>	13. M versus B	6.4 (2) <sup>a</sup>
N	B + shortest distance + shortest distance <sup>2</sup>	14. N versus B	7.4 (2) <sup>a</sup>

Estimated coefficient on travel distance using model D conditional on different explanatory variables

Travel distance/100	- 0.438 <sup>b</sup> [0.114]	- 0.241 <sup>a</sup> [0.122]	- 0.310 <sup>a</sup> [0.130]
Parental occupation and education		Yes	Yes
Ability			Yes

The number of persons studied was 7946. Degrees of freedom are in parentheses. Standard errors are in brackets. All models control for sex. The effect of distance is similar across models.

<sup>a</sup> Significant at 5% level.

<sup>b</sup> Significant at 1% level.

Source: Kjellstrom and Regner(1999)

**Table 10: Odds Ratios of the Likelihood of Enrolling in University Education**

Model	< 26	26-60	61-100	> 101
D	1.0	0.90 (0.83-0.98)	0.82 (0.70-0.97)	0.69 (0.51-0.94)
F	1.0	0.89 (0.81-0.97)	0.80 (0.68-0.94)	0.71 (0.55-0.92)
G	1.0	0.78 (0.66-0.93)	0.76 (0.63-0.93)	0.98 (0.51-1.90)

Confidence intervals (95 %) are within parentheses. Table II describes the models. The odds have been calculated using the mean distance within each category. All individuals live within 150 km of a university or university college.

Source: Kjellstrom and Regner(1999)

<b>Facts for 2010*</b>	<b>Forest</b>	<b>Minerals and metals</b>	<b>Energy</b>	<b>Total natural resources</b>	<b>Canada</b>
<b>Gross domestic product (GDP)</b>	\$23.5 B (1.9%)	\$34.7 B (2.8%)	\$84.3 B (6.8%)	\$142.5 B (11.5%)	\$1 234.9 B (100.0%)
<b>Direct employment** (thousands of people)</b>	191 (1.3%)	308 (2.1%)	264 (1.8%)	763 (5.2%)	14 701 (100.0%)
<b>New capital investments</b>	\$1.6 B (0.5%)	\$12.6 B (3.7%)	\$80.3 B (23.8%)	\$94.5 B (27.9%)	\$338.1 B (100.0%)
<b>Trade</b>					
<b>Total exports</b>	\$26.1 B (6.5%)	\$84.5 B (21.2%)	\$90.0 B (22.5%)	\$200.6 B (50.2%)	\$399.4 B (100.0%)
<b>Domestic exports (excluding re-exports)</b>	\$26.0 B (6.9%)	\$81.4 B (21.8%)	\$89.7 B (24.0%)	\$197.1 B (52.6%)	\$374.3 B (100.0%)
<b>Imports</b>	\$9.5 B (2.3%)	\$66.6 B (16.5%)	\$40.3 B (10.0%)	\$116.4 B (28.8%)	\$403.7 B (100.0%)
<b>Balance of trade</b>	+\$16.6 B	+\$18.0 B	+\$49.7 B	+\$84.3 B	-\$4.3 B

\* The data reported for each of the natural resources sectors reflect the value of primary industries and related downstream manufacturing industries as of October 2010. "Minerals" includes uranium and coal mining. "Balance of trade" is the difference between the total exports and the total imports of goods. Services and capital flows are not included.

\*\* Statistics Canada, Survey of Employment, Payrolls and Hours (SEPH).

Source: Natural Resource Canada, Retrieved on May 5<sup>th</sup>, 2013 from <http://www.Nrcan.gc.ca/statistics-facts/home/887>

Figure 8. Natural Resource Share and Enrolment Rate in Alberta

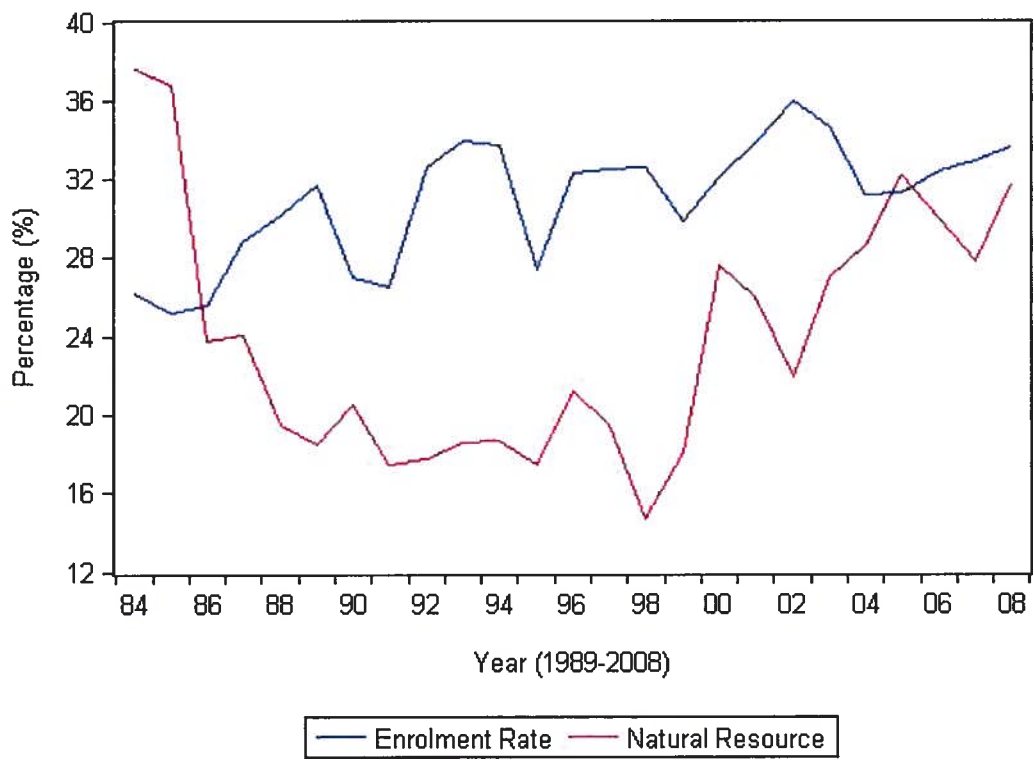


Figure 9. Natural Resource Share and Enrolment Rate in British Columbia

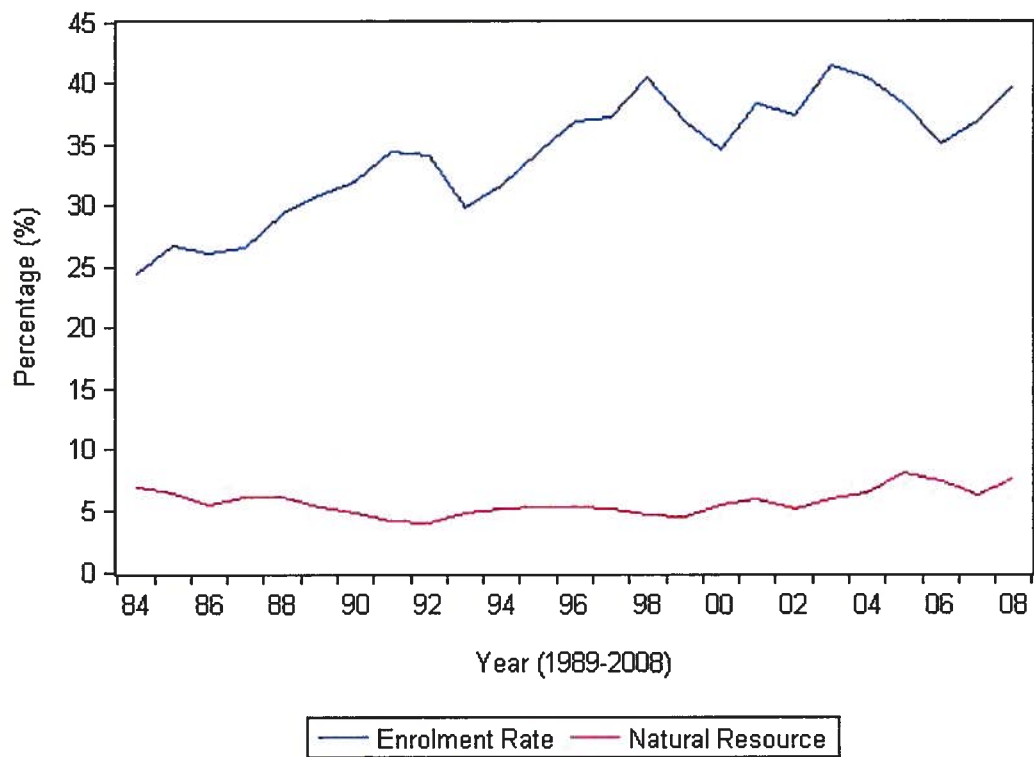


Figure 10. Natural Resource Share and Enrolment Rate in Ontario

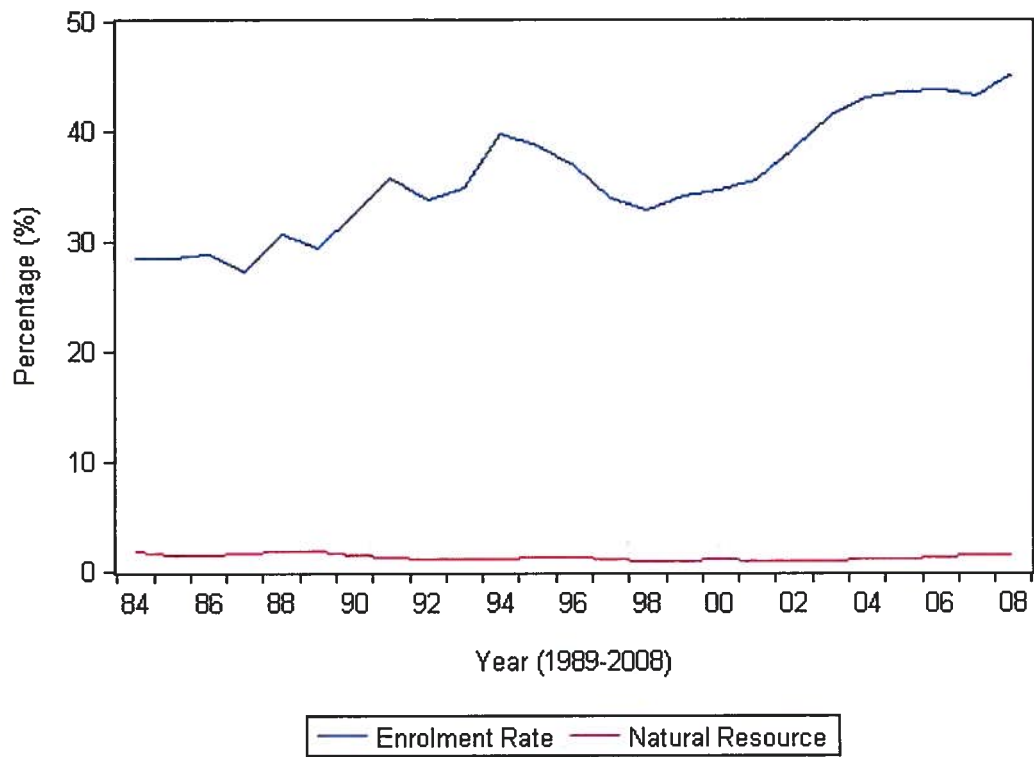


Figure 11. Natural Resource Share and Enrolment Rate in Quebec

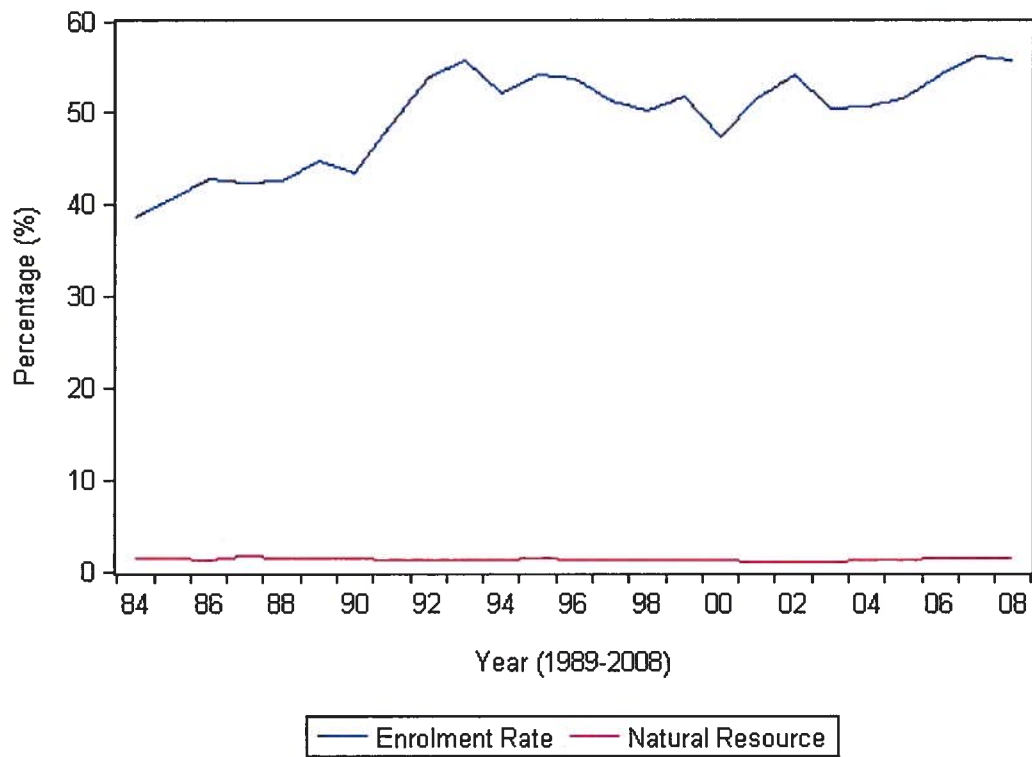


Figure 12. Natural Resource Share and Enrolment Rate for Pooled Data

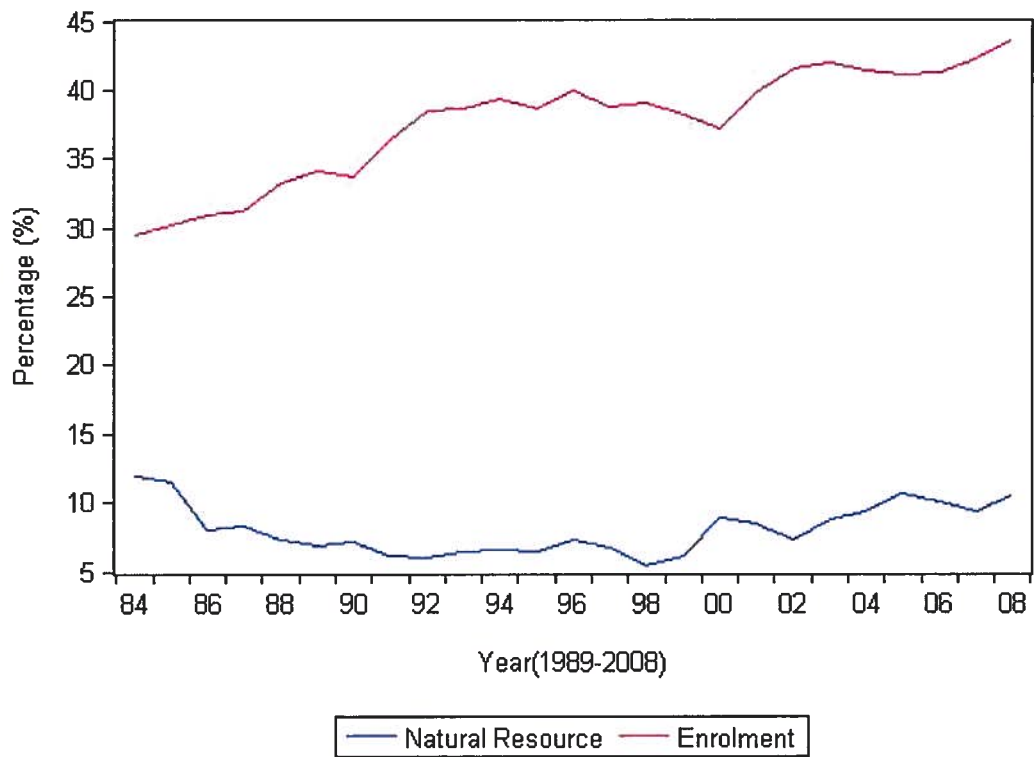


Figure 13. Natural Resource Share and Share of Gov't Expenditure on Education in Alberta

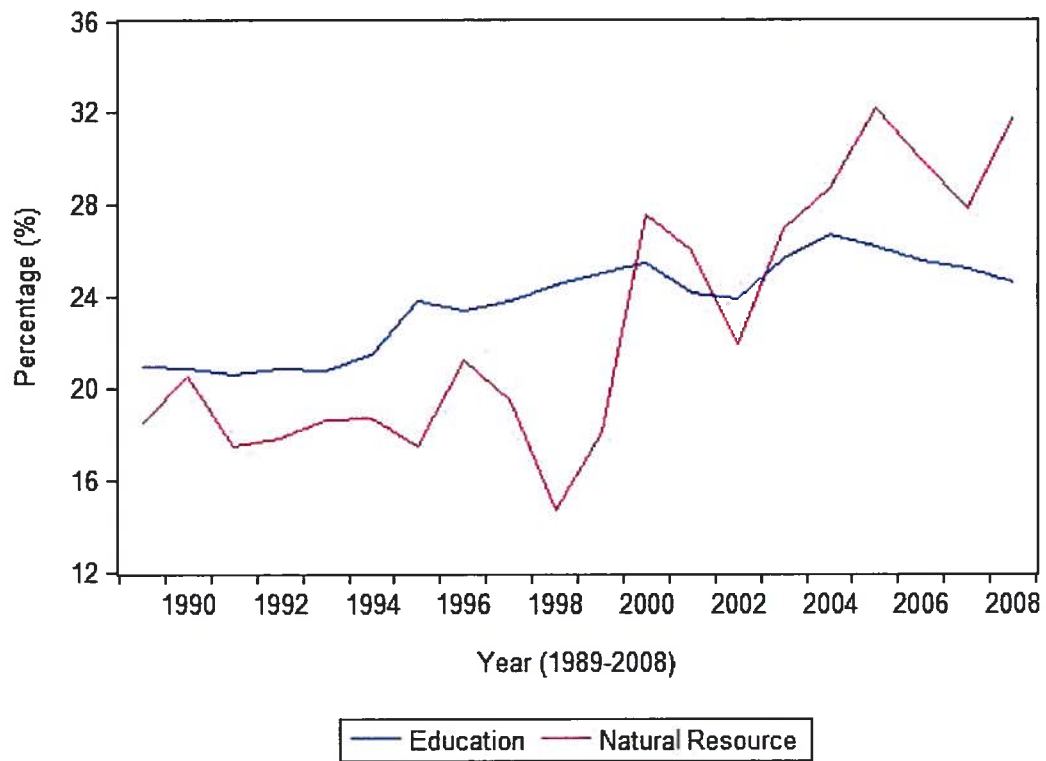


Figure 14. Natural Resource Share and Share of Gov't Expenditure on Education in BC

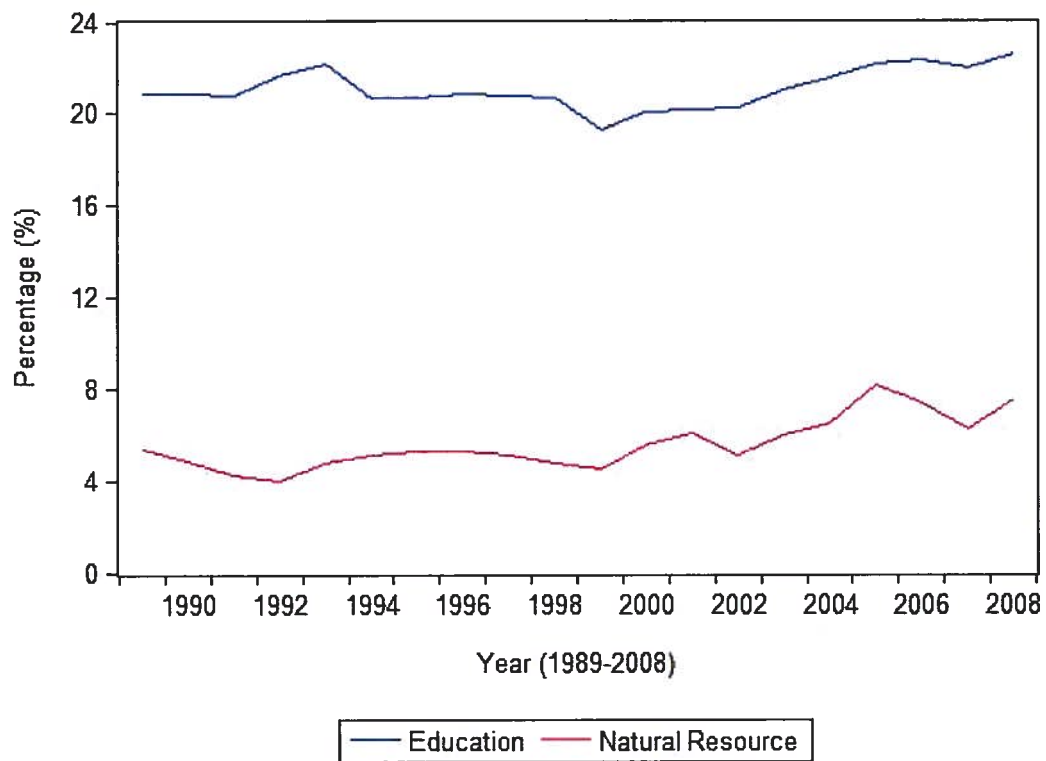


Figure 15. Natural Resource Share and Share of Gov't Expenditure on Education in Ontario

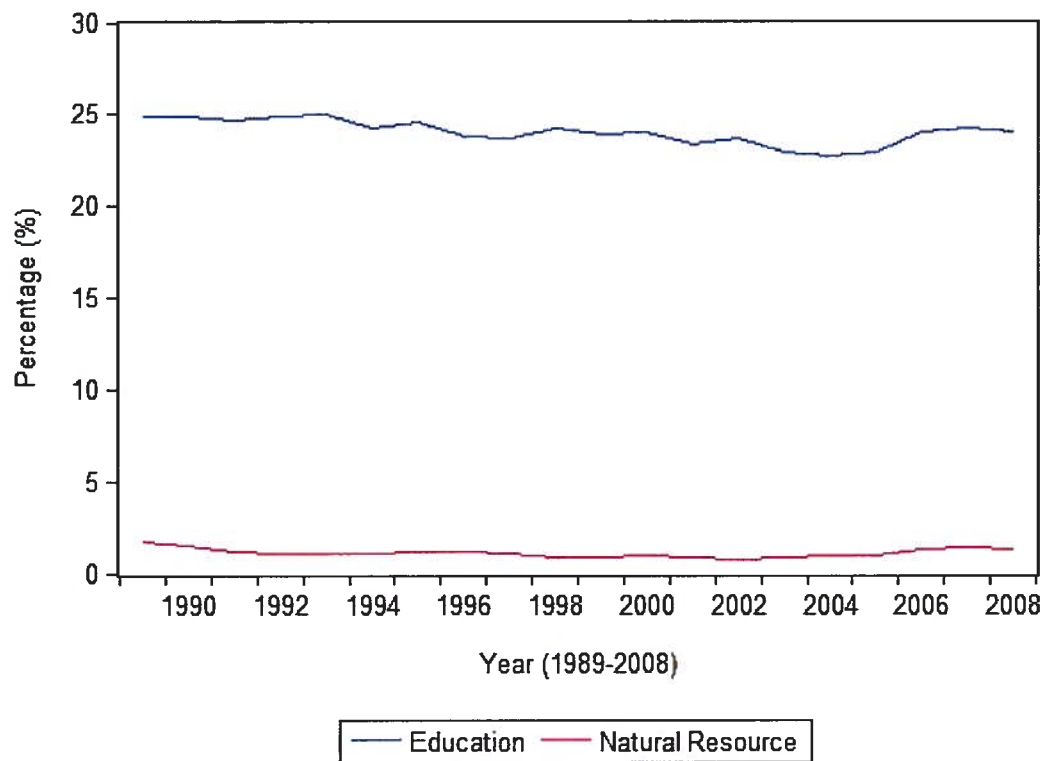


Figure 16. Natural Resource Share and Share of Gov't Expenditure on Education in Quebec

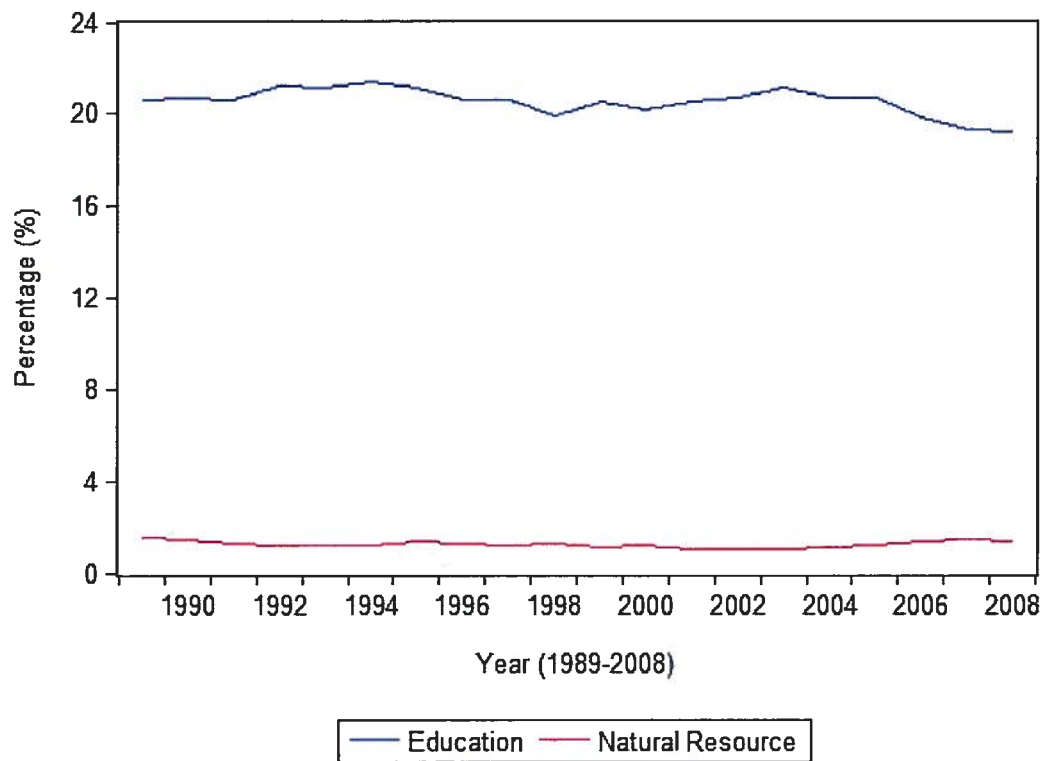
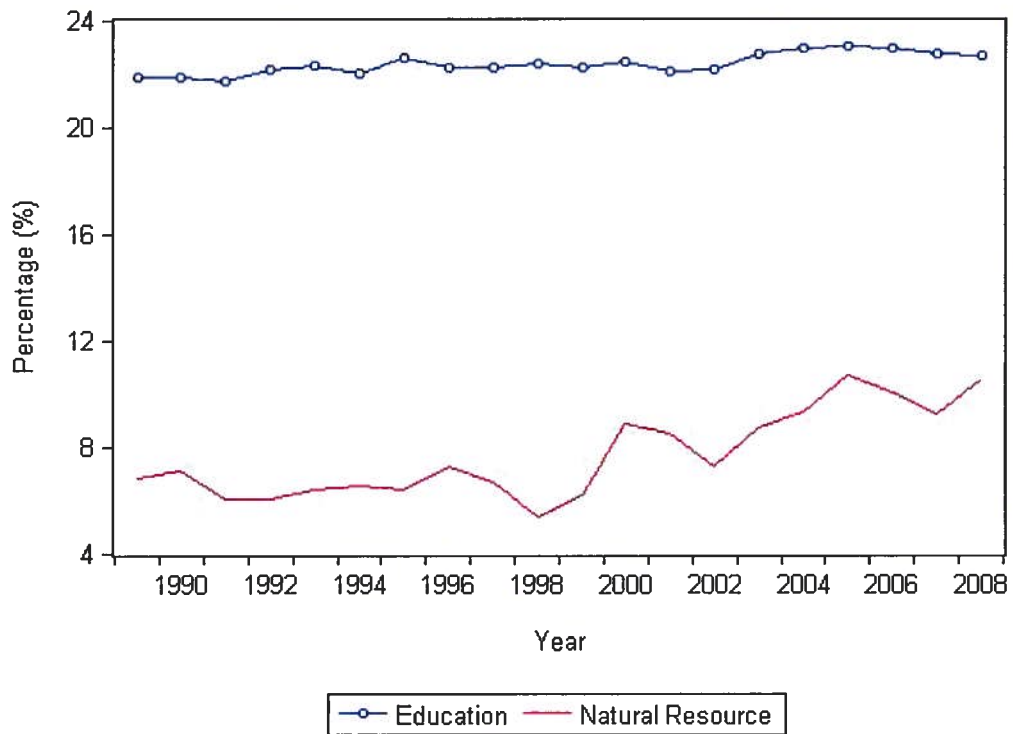


Figure 17. Natural Resource Share and Share of Gov't Expenditure on Education for Pooled Data



**Table 12: Summary Statistics for Method 1**

<b>Variables</b>	<b>Pooled</b>	<b>Ontario</b>	<b>Quebec</b>	<b>Alberta</b>	<b>British Columbia</b>
Enrolment Rate	40.10 (1.76)	38.43 (4.22)	52.72 (2.33)	32.54 (1.92)	36.72 (3.17)
Education Expenditure per Capita	7.59 (.15)	7.62 (.13)	7.59 (.14)	7.66 (.21)	7.49 (.15)
Share of Natural Resource	8.23 (1.76)	1.09 (.20)	1.30 (.14)	24.35 (5.81)	6.20 (1.26)
Share of Trade	70.08 (3.57)	76.33 (4.61)	69.78 (4.35)	72.39 (3.36)	61.81 (2.60)
Working Population Rate	85.71 (.54)	85.12 (.41)	85.27 (.98)	88.00 (.30)	84.45 (.56)
Urbanization Rate	81.33 (1.20)	83.71 (1.31)	78.35 (.79)	80.35 (1.11)	82.94 (2.14)
Ln (GDP per Capita)	10.50 (.10)	10.51 (.11)	10.32 (.11)	10.75 (.10)	10.41 (.09)
Observation Size	68	17	17	17	17

**Table 13: Summary Statistics for Method 2**

<b>Variables</b>	<b>Pooled</b>	<b>Ontario</b>	<b>Quebec</b>	<b>Alberta</b>	<b>British Columbia</b>
Income per Capita	36141.29 (3802.78)	36353.89 (3863.32)	29913.90 (3568.89)	45309.11 (5307.31)	32988.25 (2898.69)
Natural Resource Price	1.07 (.22)	1.07 (.22)	1.07 (.22)	1.07 (.22)	1.07 (.22)
Share of Employment in Natural Resource Sector	.03 (.00)	.01 (.00)	.01 (.00)	0.06 (.01)	.02 (.01)
Population	6412289 (550944.70)	11479136 (1080039)	7328278 (.145)	2975536 (398921.90)	3866208 (436775.50)
Observation Size	64	17	17	17	17

**Note: Natural Resource Price is a price of natural resource relative to finished goods.**

Table 14: OLS Regression Results Using Enrolment Rate

Variable	Pooled	Ontario	Quebec	Alberta	British Columbia
Constant	235.58 (246.07)	58.07 (559.00)	207.55 (573.42)	-513.11 (856.90)	2238.89** (986.83)
Share of Natural Resource	-.311 (.20)	3.71 (5.67)	-3.28 (5.17)	-.05 (.17)	.34 (.82)
Share of Trade	-.36 (.32)	-.35 (.22)	-.18 (.15)	.35 (.27)	.36 (.29)
Working Pop Rate	1.70 (1.66)	-2.18 (4.66)	-1.38 (3.09)	4.60 (7.19)	-13.85 (6.48)
Urbanization Rate	.29 (.48)	.93 (1.46)	2.08 (1.39)	1.26 (.87)	1.80*** (.53)
Ln GDP per Capita	-32.08* (16.70)	10.52 (21.10)	-17.70 (25.86)	1.42 (23.60)	-115.93*** (44.93)
Observation Size	64	17	17	17	17
R <sup>2</sup>	.94	0.74	.61	.23	.73

Note: \*, \*\*, \*\*\* represents 90%, 95%, 99% significance level, respectively.

**Table 15: OLS Regression Results using Government Education Expenditure per Capita**

Variable	Pooled	Ontario	Quebec	Alberta	British Columbia
Constant	17.97*** (3.26)	17.33*** (5.19)	.98 (10.75)	-8.85 (19.32)	27.31* (16.29)
Share of Natural Resource	.01*** (.00)	.14*** (.05)	.07 (.10)	.00** (.00)	.01 (.01)
Share of Trade	-.00 (.00)	-.01*** (.00)	-.01*** (.00)	-.01 (.01)	.00 (.00)
Working Pop Rate	-.01 (.02)	-.16*** (.04)	-.04 (.06)	.00 (.16)	-.23** (.11)
Urbanization Rate	-.02*** (.01)	-.00 (.01)	-.01 (.03)	.08*** (.02)	.00 (.01)
Ln GDP per Capita	-.74*** (.22)	.44*** (.20)	1.20** (.49)	.92* (.53)	-.05 (.74)
Observation Size	68	17	17	17	17
R <sup>2</sup>	.98	0.98	.96	.97	.96

Note: \*, \*\*, \*\*\* represents 90%, 95%, 99% significance level, respectively.

**Table 16: Regression Result for Income Level Effect**

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	Fixed Effect	Fixed Effect	Random Effect	Random Effect
$\alpha_1$ : Mining, Forestry, Logging Employment Share	5.45*** (.66)	5.71*** (.49)	-4.14* (.49)	.92 (.82)	.17 (1.81)	1.33* (.79)
$\alpha_0$ : Constant	10.33*** (.02)	10.33*** (.02)	10.59*** (.02)	10.45*** (.02)	10.47*** (.08)	10.44*** (.02)
Period Effect	No	Yes	No	Yes	No	Yes
Observation	96	96	96	96	96	96
$R^2$	.42	.76	.68	.98	.00	.93

**Table 17: Regression Result for Income Growth Effect**

	(1)	(2)	(3)	(4)
	OLS	OLS	Fixed Effect	Fixed Effect
$\beta_1$ : Mining, Forestry, Logging Employment Share	.79 <sup>***</sup> (.26)	.49 <sup>***</sup> (.17)	.16 (.77)	-.10 (.52)
$\beta_2$ : Mining, Forestry, Logging Employment Share x Real Price Growth of Natural Resource	.65 <sup>*</sup> (.40)	.68 <sup>**</sup> (.33)	.68 <sup>*</sup> (.41)	.73 <sup>**</sup> (.34)
$B_3$ : Mining, Forestry, Logging Employment Share x Pop. Growth	-43.36 <sup>***</sup> (11.77)	-25.26 <sup>***</sup> (7.50)	-37.97 <sup>***</sup> (13.98)	-18.91 <sup>**</sup> (9.19)
$B_4$ : Mining, Forestry, Logging Employment Share x Mining, Forestry and Logging Employment Growth	2.43 <sup>**</sup> (1.00)	1.23 <sup>*</sup> (.67)	2.61 <sup>**</sup> (1.03)	1.36 <sup>*</sup> (.69)
$\beta_0$ : Constant	.01 <sup>**</sup> (.00)	.01 (.00)	.02 (.02)	.02 <sup>*</sup> (.01)
Period Effects	No	Yes	No	Yes
Observation	92	92	92	92
$R^2$	.25	.81	.26	.81

**Table 18: Correlation Test for Method 1 Variables**

## Ontario

	Share of Natural Resource	Share of Trade	Urbanization Rate	Working Population Rate	GDP per Capita
Share of Natural Resource	1.00	-0.58	-0.02	-0.28	0.01
Share of Trade	-0.58	1.00	0.07	-0.13	0.23
Urbanization Rate	-0.02	0.07	1.00	<b>-0.81</b>	<b>0.92</b>
Working Population Rate	-0.28	-0.13	<b>-0.81</b>	1.00	<b>-0.89</b>
GDP per Capita	0.01	0.23	<b>0.92</b>	<b>-0.89</b>	1.00

## Quebec

	Share of Natural Resource	Share of Trade	Urbanization Rate	Working Population Rate	GDP per Capita
Share of Natural Resource	1.00	-0.24	0.61	-0.16	-0.04
Share of Trade	-0.24	1.00	-0.03	-0.43	0.57
Urbanization Rate	0.61	-0.03	1.00	-0.73	0.56
Working Population Rate	-0.16	-0.43	-0.73	1.00	<b>-0.96</b>
GDP per Capita	-0.04	0.57	0.56	<b>-0.96</b>	1.00

## Alberta

	Share of Natural Resource	Share of Trade	Urbanization Rate	Working Population Rate	GDP per Capita
Share of Natural Resource	1.00	0.41	0.72	-0.74	0.81
Share of Trade	0.41	1.00	-0.03	-0.70	0.60
Urbanization Rate	0.72	-0.03	1.00	-0.49	0.61
Working Population Rate	-0.74	-0.70	-0.49	1.00	-0.96
GDP per Capita	0.81	0.60	0.61	-0.96	1.00

## British Columbia

	Share of Natural Resource	Share of Trade	Urbanization Rate	Working Population Rate	GDP per Capita
Share of Natural Resource	1.00	0.15	0.76	-0.84	0.87
Share of Trade	0.15	1.00	0.33	0.05	0.07
Urbanization Rate	0.76	0.33	1.00	-0.81	0.86
Working Population Rate	-0.84	0.05	-0.81	1.00	-0.98
GDP per Capita	0.87	0.07	0.86	-0.98	1.00

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