An Empirical Analysis of a Regional Dutch Disease: The Case of Canada

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ABSTRACT

While there has been extensive research conducted on the *Dutch Disease* (DD), very little attention, if any, has been devoted to the regional mechanisms through which it may manifest itself. This is the first empirical attempt to research a 'regional *DD*' by looking at the macroeconomic impacts of resource windfalls across Canadian provinces. In addition, this study presents a first attempt at quantifying the relative importance of the two DD intermediate channels; namely, the *Spending Effect* (SE) and *Resource Movement Effect* (RME). Our panel data reveal that some of the standard DD mechanisms are also relevant at the regional level to a certain extent; specifically, there is a strong SE, yet a weak RME. We find that resource-rich provinces (and territories) experience on average higher inflation but only weak to none capital flight. The quantification exercise shows that the SE accounts for approximately 70% of the overall DD effects, with the RME accounting for the rest; in the absence of these two effects the positive impact of mineral abundance on exports increases by 61%. While this holds for the region-specific exports to the rest of the world, intra-federal trade across Canadian provinces is less responsive to DD effects.

Keywords: Regional Dutch Disease, Inflation, Exports.

JEL classification: F10, N92, O18

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1. INTRODUCTION

In recent years there has been a fast expanding literature researching the impacts of resource abundance on several measures of economic performance. Recent empirical evidence and theoretical work provide strong support to a negative link between resource abundance and long-term growth (Auty 1994, 2001, 2007, Baggio and Papyrakis 2010, Bulte et al. 2005, Caselli and Cunningham 2009, Papyrakis and Gerlagh 2004, 2007, Sachs and Warner 1995, 1997, 1999a, 1999b, 2001, Rodriguez and Sachs 1999, Leite and Weidmann 1999, Gylfason 2000, 2001a, 2001b). However, this so called *Resource Curse* hypothesis has not been accepted without reservations. In recent years a number of papers have raised concerns about the magnitude of the resource impact, with much of the debate concentrating on alternative definitions of resource abundance (see Brunnschweiler 2008, Brunnschweiler and Bulte 2008, Stijns 2005, Van der Ploeg 2011). In general, resource abundance expressed as share of economic activity (GDP or exports) rather than per capita terms is often more strongly and negatively correlated with economic performance.

Several explanations of the underperformance of resource rich economies have been provided in the literature. A first stream of research has focused on political economy explanations and linked natural resource abundance with inferior institutional quality leading to rent-seeking behaviour and weak property rights (Bulte et al. 2005, Dalmazzo and De Blasio 2003, Sachs and Warner 1999a, 2001, Torvik 2002, Wick and Bulte 2006). Governments in resource rich countries abuse their access to resource revenues, via increased spending on patronage or reduced taxation, to prolong their stay in power (Robinson and Torvik 2005, Ross 1999, 2001). Individuals, on the other hand, engage in rent-seeking competition in an effort to extract rents from the common pool of resource revenues (Bjorvatn and Selvik 2008, Mehlum et al. 2006, Olsson 2007).

A second branch of the literature focuses on *Dutch Disease* (DD) explanations of the negative economic side-effects of resource abundance (Corden 1984, Corden and Neary 1982, Sachs and Warner 2001, Torvik 2002). In their basic DD model, Corden and Neary (1982) divide the DD mechanism to two effects, arising by a resource shock. The first, called the *Resource Movement Effect* (RME), describes the movement of production factors from various sectors towards the resource one due to higher marginal productivities. The second, called the *Spending Effect* (SE), describes the inflationary outcome of an income shock which, in turn, decreases the competitiveness of commodities outside the primary sector. The basic idea is that both effects cause non-primary tradable sectors to contract. Although not exclusively (e.g. see Torvik 2001), much of the literature has focused on the potential crowding-out of the manufacturing sector specifically, given the 'learning-by-doing' externalities of the sector (Aizenman and Lee 2010, Krugman 1987, Matsuyama 1992, Sachs and Warner 1997).

There are a few more empirical studies that attempt to test the DD hypothesis. Most of the studies make use of case-study analyses to verify DD impacts, which limits the extent of cross-country comparison (see Forysth 1985, McMahon 1997, Larsen 2006). Many of the studies that provide cross-country econometric estimates of the DD focus on positive income shocks that arise either from remittances (Amuedo-Dorantes and Pozo 2004, See Lartey et al. 2008), or aid transfers (Adenauer and Vagassky 1998, Rajan and Subramanian 2009), rather than resource income. Furthermore, empirical analyses (e.g. see Harding and Venables 2011) often confine themselves to researching the correlation between resource abundance and share of tradable sectors in the overall economy, without empirically exploring the intermediate mechanisms that lead to the DD, i.e. RME and SE – a focal point of our subsequent empirical study.

Very little attention, if any, has been devoted to the regional mechanisms through which the DD may manifest itself. Do resource-dependent regions experience higher inflation rates and as a result a skewed composition of exports, in favour of primary commodities rather than manufacturing or other tradable commodities? Is there a difference with respect to how resource abundant regions trade with other resource-scarce regions of the same country or the rest of the world? There is no reason why the DD should be confined to a national level or currency-related issues. There is evidence, for instance, that the Faroes and Greenland suffered from reduced competitiveness in their exporting sectors in the past, as a result of their booming fishing industry (Paldam 1997). Both countries use the Danish krona for their international transaction and the loss of competitiveness of their domestic economies arose from inflationary pressures and a corresponding appreciation of the real domestic exchange rate, rather than changes in the nominal exchange rate which is mainly determined by changes in the Danish economy. There is also some tentative evidence pointing to a positive impact of mineral abundance on average prices across Chinese provinces (Zhang et al. 2008). Additionally, it is well documented that price differentials across regions of the same country are often of similar magnitude to the ones observed across sovereign nations (McMahon 1991, Slesnick 2002, Walden 1998), as well as that regional price differentials can persist over time (Cecchetti et al. 2002, Culver and Papell 2006, Roos 2006). This suggests that DD can materialize at the regional level despite the use of a common currency.

In this paper, we contribute to this strand of the literature by studying both the SE and RME of the DD hypothesis at a regional level. This is the first empirical attempt to research a 'regional DD' by looking at the macroeconomic impacts of resource windfalls across Canadian provinces and territories. The intra-federal case of Canada is of particular appeal to this study, given the provincial heterogeneity in resource abundance,[1] and the availability of data at the provincial level. We make use of cross-provincial panel data between 1984 and 2007 to investigate the existence of regional DD effects of resource income. We examine the DD by focussing both on the mineral and non-mineral resource sectors, and we analyse impacts on overall province-specific exports, as well as on disaggregated province-specific exports to the rest of the world (international exports) and to other Canadian provinces (domestic exports). Our panel data reveal that some of the standard DD mechanisms are also relevant at the regional level to a certain extent. Specifically, we find there is a strong SE, yet a weak RME, as resource rich provinces (and territories) experience on average higher inflation and weak to none (and even opposite, under certain specifications) capital movement from non-primary tradable sectors. More generally, our results indicate that mineral abundance has, on the whole, a rather weak positive impact on export growth, contrary to what DD theory predicts; moreover, once controlling for SE and RME, we find a stronger positive effect of mineral abundance on exports. At the disaggregated export level, we find that international exports are more vulnerable to DD effects, whereas domestic exports are less responsive to them.

We further contribute to the DD literature by quantifying the relative importance of SE and RME in the overall DD effects. To our knowledge, this is the first empirical paper that attempts to quantify the relative contribution of these indirect mechanisms to the overall impact of resource abundance on export growth. Our analysis follows the methodology set out by Mo (2000, 2001) and Papyrakis and Gerlagh (2004, 2007) who explore the intermediate channels through which inequality, corruption and resource dependence affect income growth. We find that on average the SE and RME account for approximately 70% and 30% of DD effects, respectively; moreover, through this quantification exercise we note that in case these two channels are controlled for, mineral abundance would potentially increase its positive impact by 61%.

An additional merit of our analysis is its regional orientation. While countries often differ in several dimensions – such as language, the quality of institutions, cultural characteristics, and monetary or fiscal policies – that are difficult to control for in cross-country empirical research, regions within a country are likely to present little variation in them (Barro and Sala-i-Martin 1995). For this reason, cross-regional estimates of DD mechanisms can potentially allow for a better identification of econometric models in comparison to similar cross-country based empirical results. We realize that our analysis is confined to Canada and its institutional environment; however, we argue that the inter-regional analysis can nevertheless reflect more general inferences similar to

[1] For instance, the average GDP share of mineral output of Quebec and Prince Edward Island is less than 1%, while that of Alberta and Saskatchewan is more than 20%.

cross-country studies, to the extent that these two frameworks are similar. The Canadian economy is highly decentralized by its federal constitution; specifically, provincial ownership and control over local resources are constitutionally entrenched, making them largely equivalent to those of independent countries. In addition, the DD is a market mechanism that is to some extent independent of institutional arrangements, so that the specific institutional settings of Canada should not necessarily inhibit the generalization of results. Nonetheless, as discussed by Raveh (2012), an intra-federal environment provides higher factor mobility compared to a cross-country one, which can in turn mitigate or even reverse the expected magnitude of the RME. Our results are consistent with this, showing that the RME is practically non-applicable at the provincial level.

The paper is structured as follows – Section 2 presents the main empirical evidence of a regional DD for Canada; we first look at differences in inflation and capital movement across Canadian provinces and whether these are correlated with dependence on resource income, then we investigate whether these DD channels influence overall exports. Section 3 investigates DD effects on exports at the international and domestic disaggregation levels. Section 4 undertakes various robust checks. Section 5 summarizes our main results and offers concluding remarks.

2. EMPIRICAL EVIDENCE OF A REGIONAL CANADIAN 'DUTCH DISEASE'

In this section we start with empirically exploring the historical experience of resource-rich Canadian provinces in terms of inflation rates and composition of exports. According to the DD theory, resource rich economies experience a SE according to which a resource windfall produces an income shock which subsequently increases the prices of non-traded goods (i.e. of those goods whose prices are determined domestically rather than in international markets). This resource-induced inflationary pressure causes the real exchange rate to appreciate and results in loss of competitiveness for the exporting sectors (Magud and Sosa 2010). In addition, these economies are also expected to experience a RME according to which factors are drawn to the resource sector from other sectors, given the high factor returns that sector potentially exhibits; this effect also results in loss of competitiveness for the exporting sectors (Matsuyama 1992). Whether the manufacturing sector will be negatively affected in a disproportionate manner (as often assumed in the DD literature, see Larsen 2006 and Torvik 2001) will largely depend on the relative export orientation of the sector.

As a first step, we explore whether there is empirical evidence to the DD mechanisms (transmission channels), through which resource abundance may influence export growth (i.e. the

SE and RME). We estimate cross-provincial regressions for the 13 Canadian provinces and territories using panel data for the 1984-2007 period,[2] to identify whether resource rich Canadian provinces experience on average higher inflation rates (i.e. SE), as well as a declining share of the non-primary tradable sectors in total capital (i.e. RME).[3] Equations (1) and (2) investigate these two DD mechanisms, for Canadian province 'i' at time 't'.[4] Equation (1) explores whether the inflation rate (*Inflation*) tends to be substantially higher across the more resource rich Canadian provinces. Inflation is measured as the annual percentage change in regional price levels. We use two alternative measures of resource abundance (*RA*) which correspondingly capture the relative share in national income of a. the mineral sector (minerals, quarrying) and b. the non-mineral resource sector (agriculture, fishing, hunting, forestry). This is done to better understand how each type of resource-windfall affects the economy, and in what magnitude. All data are provided by Statistics Canada (Canada's national statistical agency).[5] We use the mineral abundance measures with a one-year time lag, since it is unlikely that any resource windfalls will have an immediate impact on prices through increased aggregate demand. We also include the price level in the previous year ($Prices_{t-1}$) as an additional regressor, to test whether a high level of prices may constrain further price increases in the subsequent year (meaning, that there might be more room for price increases in provinces where prices stand at a lower level, other thing equal). Equation (2) explores whether percentage changes in the share of capital in the non-primary tradable sectors (*Capital Movement*) correlate with resource abundance in the previous period. We also include the share of capital in the non-primary tradable sectors in the previous year ($Capital_{t-1}$) as an additional regressor, since an initial high level of capital share in the manufacturing sector is likely to constrain further increases of that share in the subsequent year. Columns (1) and (2) of Table 1 present results of estimates of both equations with regional fixed effects (φ_i, χ_i) for the case of mineral resources, i.e. the type of natural resource abundance which has received most attention in the DD literature.

$$Inflation_{i,t} = \alpha_0 + \alpha_1 RA_{i,t-1} + \alpha_2 Prices_{i,t-1} + \varphi_i + \varepsilon_{i,t} \quad (1)$$

$$Capital\ Movement_{i,t} = \beta_0 + \beta_1 RA_{i,t-1} + \beta_2 Capital_{i,t-1} + \chi_i + \upsilon_{i,t} \quad (2)$$

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[2] This is a maximized panel that covers all years for which data is available. Note that data is available for Northwest Territories and Nunavut separately only for 1999-2008; pre-1999 data is available for the two territories together. Therefore, in our sample they appear as one territory in all pre-1999 years and as two distinct territories in all post-1999 years (1999 included).

[3] We focus on capital rather than labour shares, since the mineral sector employs very small shares of the labour force, while it is one of the most capital-intensive sectors. This is suggested by the University of Groningen's cross-country database on 'Industry Factor Intensity' which ranks 'Mining and Quarrying' as the third most capital intensive industry across 32 industries and 30 countries in 1997.

[4] Note that all models in this paper are annual-based.

[5] Appendices 1 and 2 present descriptive statistics, definitions, and data sources for all variables.

Regression (1) reveals that mineral dependent Canadian provinces experience higher inflation, as the SE mechanism would predict (for example, a difference in the share of minerals in GDP of 50%, i.e. of the magnitude found between New Brunswick and Newfoundland, would correspond to a larger inflation rate by approximately 1%). There is also some evidence, as observed in Regression (2), that mineral dependent provinces experience a fall in the share of total capital employed in the non-primary tradable sectors, although the effect is much weaker.

Insert Table 1

We now turn to the possible crowding-out effects of natural resource abundance on exports, as predicted by DD theory via the SE and RME. Our measures of exports relate to the province-specific value of exports, expressed as a share of GDP. Equation (3) explores whether growth in the share of exports in GDP (*Growth in Overall Exports*) tends to be substantially lower across the more resource-rich Canadian provinces. We include the share of exports in GDP in the previous year ($Overall\ Exports_{t-1}$) as an additional regressor, to test whether past high exports shares may negatively influence increases in export growth in the subsequent year (which would suggest that provinces with a previously high share of exports in GDP may find it more difficult to further increase the share, other things equal). Ideally, one should focus on non-resource exports rather than total exports, but this measure does not exist at the Canadian province level. Thus, the annual growth in exports as a share of GDP from period t_0=1984 to t_T=2007 depends on the export share in the previous year ($Exports_{t-1}$), our measure of resource abundance in the previous year (RA_{t-1}) and the two DD intermediate variables (i.e., *Inflation* and *Capital Movement*):

$$Export\ Growth_{i,t} = \gamma_0 + \gamma_1 Exports_{i,t-1} + \gamma_2\, RA_{i,t-1} + \gamma_3 Inflation_{i,t} + \gamma_4 Capital\ Movement_{i,t} + \zeta_i + u_{i,t} \quad (3)$$

We estimate export growth in Equation (3), with regional fixed effects (ζ_i) and we first focus on the effects of mineral resources – results are presented in Regressions (3) and (4) of Table 1. In Regression (3) we only include lagged exports and mineral resources as regressors and we find that mineral abundance has a weak positive impact on export growth, contrary to what DD theory would predict. The DD theory predicts that mineral resources affect export growth indirectly via their effect on other export-related variables (in our case, these are the impacts on *Inflation* and

Capital Movement of Table 1). We, hence, expect that mineral resources may even have a stronger beneficial impact on export growth once we control for their effects on inflation and changes in capital share (i.e. the SE and RME). In other words, a statistical correlation between RA and the DD transmission variables (i.e. *Inflation* or *Capital Movement*) is likely to cancel out the potential beneficial impact that RA could otherwise have on export growth. If mineral resources positively (negatively) correlate with variables of a vector *Z*' that hamper (promote) export growth, then when vector *Z* is sufficiently rich to capture most of these indirect effects of minerals on export growth, we expect that its inclusion in the empirical analysis would significantly increase the coefficient of mineral abundance on export growth. In Regression (4) we thus include *Inflation* and *Capital Movement* as the transmission variables commonly referred to in the DD literature as the intermediate channels linking mineral abundance and export growth. We find that inflation hinders export growth, while a large share of overall capital in the non-primary tradable sectors has the opposite, although non-significant, effect. As expected, the coefficient of our mineral abundance proxy has increased significantly both in magnitude (almost by a factor of 5.5) as well as in statistical significance (at the 1% level). This suggests that mineral resources could have a potentially beneficial effect on export growth once their indirect effects on inflation and capital movement are controlled for. The rather feeble relationship between export growth and minerals of Regression (3) is hence likely to be explained by these indirect DD impacts of minerals on other export-related activities.

Since natural resource abundance explains part of the variation in the DD related variables (*Inflation*, *Capital Movement*), by substitution of Equations (1) and (2) into (3) we can calculate the overall (direct and indirect) impact of resource abundance on export growth – i.e. both the indirect impact attributed to DD effects, as well as any other direct impact of resources on exports:

$$Export\ Growth_{i,t} = (\gamma_0 + \gamma_3\alpha_0 + \gamma_4\beta_0) + \gamma_1 Exports_{i,t-1} + (\gamma_2 + \gamma_3\alpha_1 + \gamma_4\beta_1)RA_{i,t-1} + \gamma_3\alpha_2 Prices_{i,t-1} + \gamma_4\beta_2 Capital_{i,t-1} + \gamma_3(\varepsilon_{i,t} + \varphi_i) + \gamma_4(\upsilon_{i,t} + \chi_i) + u_{i,t} + \zeta_i \quad (4)$$

where $\gamma_2 RA_{t-1}$ and $(\gamma_3\alpha_1 + \gamma_4\beta_1)RA_{t-1}$ capture the direct and indirect (DD) effects of resource abundance on export growth respectively. Regression (5) of Table 1 presents the estimated values for all coefficients of Equation (4) for the case of mineral abundance. The coefficient of mineral abundance now includes both direct and indirect effects and points to a 0.052% increase in export growth for any additional percentage of mineral resources in GDP.

Our next step is to quantify the relative importance of each DD transmission channel in explaining the overall impact of mineral abundance on export growth. The direct effect is given by

γ_2, while $\gamma_3\alpha_1$ and $\gamma_4\beta_1$ capture the channel-specific effect for each of the intermediate DD mechanisms (i.e. for *Inflation* and *Capital Movement*) (see Equation (4)). Results are presented in Table 2. The fifth column (Relative Contribution to $\gamma_2 + \gamma_3\alpha_1 + \gamma_4\beta_1$) provides the relative contribution of each DD channel with respect to the overall impact of minerals on export growth. From this column, we can see that if there were no SE (impact of minerals on inflation), there would be an additional increase in the positive impact of minerals on export growth of 44%; similarly, there would be an additional 17% if there was no RME (impact of minerals on capital movement). In the absence of a DD, mineral rich Canadian provinces would have experienced a 61% larger increase in export growth; meaning, any additional percentage of mineral resources in GDP would have corresponded to an increase of export growth by 0.084 compared to 0.052. Thus, while we find that minerals appear to stimulate, rather than frustrate, export growth as a whole (see Regression (4)), the potential of mineral abundance in terms of supporting export growth could have increased by 61% in the absence of DD effects. The last column (relative contribution to $\gamma_3\alpha_1 + \gamma_4\beta_1$) provides the contribution of the *Inflation* and *Capital Movement* effects to their joint DD impact. From this column, we can see that the SE constitutes the majority (72%) of the overall negative DD effect of minerals on export growth.

Insert Table 2

Non-Mineral Resources

We now move to empirically examine whether our findings also hold for the case of the non-mineral resource sector (agriculture, fishing, hunting, forestry). We replicate Regressions (1) and (2) for the case of non-mineral resources. Results are presented in Regressions (6) and (7) of Table 1. For the non-mineral resource we do not find any significant DD impact, either on inflation or capital movements. Replicating Regressions (3) to (5) for the case of non-mineral resources also reveals that non-mineral resource abundance is not significantly correlated with export growth (not shown, results available upon request). These results are constituent with those of previous studies showing that *Resource Curse* and DD effects are most acute when considering point-source resources (mining and quarrying).[6]

3. DOMESTIC VS. INTERNATIONAL EXPORTS

In addition to investigating total exports, we also wish to examine how resource-rich provinces trade both with other Canadian provinces (domestic exports) as well as with the rest of the world (international exports). Thus, we disaggregate our measure of total exports into its domestic and international components to investigate whether our key findings hold. Table 3 presents the main results for both cases. Regressions (8)-(10) and (11)-(13) of Table 3 replicate Regressions (3)-(5) of Table 1 for the cases of domestic and international exports, respectively. As can be seen by comparing Regressions (8)-(10) to (11)-(13), results on domestic and international export growth are qualitatively different. Domestic exports do not seem to be responsive to DD effects, as indicated through the non-significant results presented in Regressions (8)-(10). Conversely, growth in international exports is reduced for mineral-rich provinces (column (11)), although this is largely driven by the two DD channels (*Inflation*, *Capital Movement*) – once the latter are included in column (12), the coefficient of mineral resources loses significance and almost halves in size.

Insert Table 3

An intuitive explanation for the different response levels of domestic and international exports to DD effects may rest in the different demand elasticities they present. Domestic markets may be less responsive to price changes or factor movements, given that they operate under reduced mobility costs (so that for instance even if the price of exportable good *X* increases in Alberta due to a resource boom, Quebec may still find it less costly to import that good from Alberta than from Germany). Conversely, international markets may be far more responsive, based on similar reasoning. This, in turn, helps to explain the differences we observe between the two cases. In addition, albeit being in opposition to DD theory, the reversed RME result in Regressions (12) and (13) is rather consistent with the link between higher factor mobility and the RME pointed by Raveh (2012), who showed that reduced mobility costs may lead to an *Alberta Effect,*[7] under which the RME is expected to be mitigated or even reversed.

One can also replicate Table 2 for the case of growth in international export and quantify the importance of the SE and RME channels repeating the steps followed in Section 2. Results are presented in Table 4. From the fifth column of Table 4 (Relative Contribution to $\gamma_2 + \gamma_3\alpha_1 + \gamma_4\beta_1$)

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[6] See Isham et al. 2005, Ross 2001, and Sala-i-Martin and Subramanian 2003.

[7] The *Alberta Effect* mechanism refers to the regional factor attraction process that may follow a resource boom (as a result of shifting the tax burden away from production factors); this process can potentially mitigate or even overturn the accompanied RME. See Raveh (2012) for further details.

we can see that almost half of the overall negative correlation between mineral abundance and international export growth can be attributed to the two DD channels (27% and 16% for the SE and RME respectively). The last column (Relative Contribution to $\gamma_3\alpha_1 + \gamma_4\beta_1$) provides the contribution of the Inflation and Capital Movement effects to their joint DD impact. From this column, we can see that the SE (*Inflation*) constitutes the majority (63%) of the overall negative DD effect of minerals on international export growth.

Insert Table 4

4. Robustness Checks

We apply two robustness tests to our main results. First, we employ a different resource abundance measure. Second, we undertake estimations using the Arellano-Bond estimator.

4.1 Natural Mineral Capital

In our analysis thus far we used the GDP share of resource output to measure resource abundance. Previous studies criticized this measure for being associated with unobserved development characteristics (Brunnschweiler and Bulte 2008, van der Ploeg 2011); in our case, this implies that our measure of resource abundance can potentially be endogenous to exports, and, as a result, our estimates may suffer from an endogeneity bias. We expect this to be less of a concern at the intra-federal Canadian level, given that there is little variation in development and technology levels across Canadian provinces and territories; nevertheless, we attempt to address this concern by constructing and employing an additional regional resource abundance measure of *Mineral Capital*. This measure is the GDP share of proven, probable and established reserves (in Canadian Dollars terms) of all types of minerals for which data is available, including: crude oil, natural gas, coal, lignite, copper, gold, lead, nickel, silver, zinc, and sulphur. The *Mineral Capital* variable is a *stock* measure, as opposed to the previously used *flow* measures of output shares, hence making it less vulnerable to endogeneity concerns. In effect, this is an equivalent measure of the World Bank's Natural Capital measure employed by Brunnschweiler and Bulte (2008), only constructed at the regional level, and specifically confined to minerals. Data for this measure is not available for the province of Prince Edward Island, as well as for the territories of Yukon, Northwest Territories, and Nunavut; therefore, it limits our sample to the remaining nine provinces (albeit for the period investigated previously of 1984-2007) and decreases it to 180 observations. This forms the reason for employing output-based measures in the main specifications of the previous sections.

Results appear in Table 5. Regressions (14)-(18) replicate Regressions (1)-(5), only using the *Mineral Capital* variable, in lieu of the previously used output-based proxy. The main results still hold. Namely, we observe a positive effect of resources on inflation, and a non-significant relation to capital movement. Through Regressions (17) and (18) we note that it is once again the SE channel that dominates, whereas, if anything, there is rather an opposite but weak RME. The main difference to previous results lies in Regression (18), where we see that in the absence of SE and RME, minerals have virtually no effect on resources; nevertheless, this is still consistent with the main findings, as it shows that any negative effects of resource on exports mainly occur through the inflation (SE) channel.

Insert Table 5

4.2 Estimations using the Arellano-Bond Estimator

The dynamic panel framework we employ gives rise to various potential concerns; namely, endogeneity bias, serial autocorrelation, and omitted variable bias. The latter concern is treated to some extent through the fixed effects, yet the first two remain applicable nonetheless. Therefore, we employ the commonly used Arellano-Bond estimator (Arellano and Bond 1991). This estimator addresses the abovementioned concerns by taking first differences, instrumenting variables with all of their lagged values (assuming them to be pre-determined), and using a GMM estimator.

Regressions (19)-(23) replicate Regressions (1)-(5), using the Arellano-Bond estimator. Results are presented in Table 6, and are similar in sign, magnitude and significance, to those presented in Table 1. In other words, even when using this estimator we observe the existence and strong domination of the SE over a weakly and statistically non-significant opposite RME; in addition, we also note that once the SE and RME are held constant, mineral abundance affects exports positively.

Insert Table 6

5. CONCLUSION

Very little attention has been devoted to the regional mechanisms through which the DD manifests itself. In this paper, we make use of cross-province panel data analysis for Canada to show that the DD, through its intermediate channels of the SE and RME, can be applicable at the regional level, but to a limited extent. Resource-rich provinces are strongly affected by a SE, yet are only weakly affected by a RME. Through a quantification exercise on the effects of minerals on exports, we show that the SE accounts for the vast majority of the DD impact (approximately 70%), whereas RME accounts for the rest (30%). We find that the direct impact of minerals on exports is weakly positive, contrary to DD predictions; moreover, once the two intermediate channels (SE, and RME) are controlled for, the effect becomes significantly positive. Results indicate that in the absence of a SE and RME, the positive impact of minerals on exports increases by approximately 61%. By disaggregating region-specific exports to a. international exports and b. domestic exports, we find that it is rather international exports that are vulnerable to DD effects, while domestic exports are relatively less responsive to them. Finally, we find that unlike point-source resources (mining and quarrying), diffuse-source ones (agriculture, fishing, hunting, forestry) create marginal to practically non-existent DD effects.

These are important findings for regional policy-making. Our analysis demonstrates that the DD can also hold at the regional level, allowing resource-scarce provinces to become relatively more export-oriented over time. For instance, we find that even in a relatively homogenous sample (such as that consisting of Canadian provinces), one can observe substantial variation in inflation rates that correlates with measures of resource richness. A better understanding of these regional DD mechanisms is hence essential for adopting policy measures that support export performance, particularly in mineral-rich regions.

We envisage various extensions of our analysis in the near future. First, one could attempt to empirically estimate regional DD effects for countries with different levels of economic development. Regions in developing economies, for example, may experience inflationary pressure due to additional income arising through remittances (Acosta et al. 2009) or aid (Rajan and Subramanian 2011), rather than through mineral-dependent economic activities. Second, a follow-up study could try to extend the analysis on DD effects looking beyond impacts on exports and assess subsequent indirect consequences in terms of unemployment and poverty levels.

Appendix 1: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Mineral Resources (223)	0.089	0.14	0.00009	0.71
Non-Mineral Resources (223)	0.04	0.03	0.0005	0.14
Mineral Capital (223)	0.56	0.69	0.002	3.95
Inflation (223)	0.024	0.01	-0.01	0.07
Capital Movement (223)	0.008	0.05	-0.09	0.25
Prices (223)	90.93	11.5	66.3	112.3
Capital (223)	0.16	0.07	0.02	0.28
Growth of overall exports (223)	0.01	0.05	-0.15	0.21
Overall exports (223)	0.53	0.12	0.15	0.77
Growth of international exports (223)	0.02	0.09	-0.4	6.54
International exports (223)	0.31	0.1	0.03	0.51
Growth of domestic exports (223)	0.003	0.06	-0.17	0.44
Domestic exports (223)	0.22	0.06	0.09	0.33

Appendix 2: List of Variables Used in the Regressions

All variables cover the period of 1984-2007, and are annually and regionally based; all data retrieved from Statistics Canada (www.statcan.gc.ca/start-debut-eng.html).

Mineral Resources	GDP share of mineral (oil, gas, minerals) output.
Non-Mineral Resources	GDP share of non mineral resources (agriculture, fishing, forestry, hunting) output.
Mineral Capital	GDP share of the value of proven, probable and established reserves of crude oil, natural gas, coal, lignite, copper, gold, lead, nickel, silver, zinc, and sulphur.
Inflation	Regional inflation rates per annum. Computed as the change in regional price levels.
Capital Movement	The annual percentage change in the share of capital in non-primary tradable sectors (out of total capital). The non-primary tradable sectors include (based on NAICS): Wholesale trade, retail trade, and manufacturing.
Prices	Regional price levels (consumer price index based).
Capital	The share of capital in non-primary tradable sectors out of total capital. The non-primary tradable sectors include (based on NAICS): Wholesale trade, retail trade, and manufacturing.
Growth of Overall Exports	The annual percentage change in the GDP share of total region-specific exports.
Overall Exports	GDP share of total region-specific exports.
Growth of International Exports	The annual percentage change in the GDP share of region-specific exports to other countries.
International Exports	GDP share of region-specific exports to other countries..
Growth of Domestic Exports	The annual percentage change in the GDP share of region-specific exports to other Canadian provinces and territories.
Domestic Exports	GDP share of region-specific exports to other Canadian provinces and territories.

TABLE 1. Testing for Cross-Regional Dutch Disease Effects in Canada (Panel, 1984-2007, 1-year intervals)

Dependent variable:	(1) Inflation	(2) Capital Movement	(3) Growth in Overall Exports	(4) Growth in Overall Exports	(5) Growth in Overall Exports	(6) Inflation	(7) Capital Movement
Mineral Resources (t-1)	0.022***	–0.065	0.015	0.084***	0.052*		
	(0.006)	(0.121)	(0.055)	(0.029)	(0.029)		
Non-Mineral Resources (t-1)						0.221	0.273
						(0.145)	(0.559)
Inflation				–1.081***			
				(0.250)			
Capital movement				0.142			
				(0.123)			
Inflation ($\varphi + \varepsilon$)					–1.082***		
					(0.250)		
Capital movement ($\chi + \upsilon$)					0.142		
					(0.123)		
Overall exports (t-1)			–0.198***	–0.395***	–0.395***		
			(0.038)	(0.073)	(0.073)		
Prices (t-1)	–0.0005***			0.0009**	0.002***	–0.0005***	
	(0.0001)			(0.0004)	(0.0004)	(0.0001)	
Capital (t-1)		–0.812**		0.29	0.177		–0.808***
		(0.322)		(0.18)	(0.214)		(0.243)
R^2 adjusted - within	0.16	0.07	0.07	0.20	0.20	0.17	0.07
R^2 adjusted - between	0.03	0.14	0.10	0.17	0.17	0.27	0.10
N	223	223	223	223	223	223	223

Standard errors are robust, clustered by province/territory, and appear in parentheses. Superscripts *, ** and *** correspond to a 10, 5 and 1% level of significance. All regressions include regional fixed effects and an intercept. Descriptive statistics descriptions of all variables appear in Appendices 1 and 2, respectively.

TABLE 2. Relative Importance of Dutch Disease Channels

Dutch Disease Channels	$\gamma_3;\gamma_4$ (Table 2)	$\alpha_1;\beta_1$ (Table 1)	Contribution to $\gamma_2 + \gamma_3\alpha_1 + \gamma_4\beta_1$	Relative Contribution to $\gamma_2 + \gamma_3\alpha_1 + \gamma_4\beta_1$	Contribution to $\gamma_3\alpha_1 + \gamma_4\beta_1$	Relative Contribution to $\gamma_3\alpha_1 + \gamma_4\beta_1$
GDP share of Mineral output (t-1)			(Column 4) 0.084	161%		
Inflation	–1.081	0.022	–0.023	–44%	–0.023	72%
Capital Movement	0.142	–0.065	–0.009	–17%	–0.009	28%
Total			(Column 5) **0.052**	**100%**	**–0.032**	**100%**

TABLE 3. Testing for Cross-Regional Dutch Disease Effects in Canada – Domestic vs. International Exports (Panel, 1984-2007, 1-year intervals)

Dependent variable:	(8) Growth in Domestic Exports	(9) Growth in Domestic Exports	(10) Growth in Domestic Exports	(11) Growth in International Exports	(12) Growth in International Exports	(13) Growth in International Exports
Mineral Resources (t-1)	0.281 (0.192)	0.224 (0.168)	0.226 (0.175)	–0.124* (0.065)	–0.073 (0.057)	–0.129** (0.057)
Inflation		–0.355 (0.382)			–1.611*** (0.489)	
Capital Movement		–0.150 (0.202)			0.329*** (0.101)	
Inflation (φ +ε)			–0.355 (0.382)			–1.611*** (0.489)
Capital Movement (χ + υ)			–0.150 (0.202)			0.329*** (0.101)
Domestic exports (t-1)	–0.599* (0.339)	–0.550 (0.325)	–0.550 (0.325)			
International exports (t-1)				–0.430*** (0.080)	–0.774*** (0.117)	–0.774*** (0.117)
Prices (t-1)		0.000001 (0.0003)	0.0002 (0.0005)		0.002*** (0.0005)	0.003*** (0.0005)
Capital (t-1)		-0.640 (0.410)	–0.518 (0.430)		0.85** (0.31)	0.588* (0.308)
R^2 adjusted - within	0.07	0.11	0.11	0.11	0.21	0.21
R^2 adjusted - between	0.01	0.02	0.02	0.14	0.14	0.14
N	223	223	223	223	223	223

Standard errors are robust, clustered by province/territory, and appear in parentheses. Superscripts *, ** and *** correspond to a 10, 5 and 1% level of significance. All regressions include regional fixed effects and an intercept. Descriptive statistics descriptions of all variables appear in Appendices 1 and 2, respectively.

TABLE 4. Relative importance of Dutch Disease channels (Int. Exports)

Dutch Disease Channels	$\gamma_3;\gamma_4$ (Table 3)	$\alpha_1;\beta_1$ (Table 1)	Contribution to $\gamma_2 + \gamma_3\alpha_1 + \gamma_4\beta_1$	Relative Contribution to $\gamma_2 + \gamma_3\alpha_1 + \gamma_4\beta_1$	Contribution to $\gamma_3\alpha_1 + \gamma_4\beta_1$	Relative Contribution to $\gamma_3\alpha_1 + \gamma_4\beta_1$
Mineral Resources			(Table 3) –0.073	57%		
Inflation	–1.611	0.022	–0.035	27%	–0.035	63%
Capital Movement	0.329	–0.065	–0.021	16%	–0.021	37%
Total			**–0.129**	**100%**	**–0.056**	**100%**

TABLE 5. Cross-Regional Dutch Disease Effects in Canada, Natural Mineral Capital Measure (Panel, 1984-2007, 1-year intervals)

Dependent variable:	(14) Inflation	(15) Capital Movement	(16) Growth in Overall Exports	(17) Growth in Overall Exports	(18) Growth in Overall Exports
Mineral Capital (t-1)	0.005** (0.002)	0.009 (0.008)	-0.003 (0.01)	0.005 (0.007)	0.00005 (0.006)
Inflation				–1.23*** (0.31)	
Capital movement				0.16 (0.09)	
Inflation (φ +ε)					–1.23*** (0.31)
Capital movement (χ + υ)					0.16 (0.09)
Overall exports (t-1)			–0.15*** (0.02)	–0.26*** (0.04)	–0.26*** (0.04)
Prices (t-1)	–0.0005*** (0.0001)			0.0003 (0.0003)	0.001** (0.0003)
Capital (t-1)		-0.58 (0.39)		0.18 (0.22)	0.09 (0.27)
R^2 adjusted - within	0.20	0.08	0.06	0.21	0.21
R^2 adjusted - between	0.43	0.0032	0.0003	0.02	0.01
N	180	180	180	180	180

Standard errors are robust, clustered by province/territory, and appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. All regressions include regional fixed effects and an intercept. Descriptive statistics descriptions of all variables appear in Appendices 1 and 2, respectively. Due to data limitations, analysis does not include Prince Edward Island, Yukon, Northwest Territories, and Nunavut.

TABLE 6. Testing for Cross-Regional Dutch Disease Effects in Canada, Using the Arellano-Bond Estimator (Panel, 1984-2007, 1-year intervals)

Dependent variable:	(19) Inflation	(20) Capital Movement	(21) Growth in Overall Exports	(22) Growth in Overall Exports	(23) Growth in Overall Exports
Mineral Resources (t-1)	0.01*** (0.005)	-0.08 (0.08)	0.06 (0.06)	0.11*** (0.03)	0.07* (0.04)
Inflation				–1.04*** (0.21)	
Capital movement				0.14 (0.1)	
Inflation ($\varphi + \varepsilon$)					–0.91*** (0.21)
Capital movement ($\chi + \upsilon$)					0.11 (0.15)
Overall exports (t-1)			–0.26*** (0.04)	–0.45*** (0.06)	–0.43*** (0.08)
Prices (t-1)	–0.0004*** (0.00005)			0.001*** (0.0004)	0.001*** (0.0004)
Capital (t-1)		-0.92*** (0.25)		0.18 (0.18)	0.03 (0.21)
N	223	223	223	223	223

Standard errors are robust, clustered by province/territory, and appear in parentheses. Superscripts *, ** and *** correspond to a 10, 5 and 1% level of significance. All regressions include regional fixed effects and an intercept. Descriptive statistics descriptions of all variables appear in Appendices 1 and 2, respectively.

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