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# Dutch Disease, Factor Mobility, and the Alberta Effect: The case of federations

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# Dutch Disease, Factor Mobility, and the Alberta Effect – The Case of Federations [a]

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## Abstract

Do reduced costs of factor mobility mitigate *Dutch Disease* effects, to the extent that they are reversed? The case of federations provides an indication they do. We observe *Resource Blessing* effects at the federal-state level (within federations) yet rather *Resource Curse* ones at the federal level (between federations), and argue the difference in outcomes stems from the difference in factor mobility costs. Through a two-region tax competition model we show that with sufficiently low factor mobility costs a resource-boom triggers an *Alberta Effect* –where resource abundant regions exploit the fiscal advantage, provided by resource rents, to compete more aggressively in the inter-regional competition over capital, and as a result attract vast amounts of capital– that mitigates, and possibly reverses, *Dutch Disease* symptoms, so that *Resource Curse* effects do not apply. Thus, this paper emphasizes the significance of the mitigating role of factor mobility in *Dutch Disease* theory, and presents a novel mechanism (*Alberta Effect*) through which this mitigation, and possible reversion, process occurs. The paper concludes with empirical evidence for the main implications of the model.

*Keywords*: Natural Resources, Factor Mobility, Dutch Disease, Resource Curse, Tax Competition

JEL *classification*: O13, O18, O57, Q33

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## 1. INTRODUCTION

Can reduced costs of factor mobility mitigate *Dutch Disease* symptoms, to the extent that they are reversed? Classic *Dutch Disease* theory overlooks this potentially critical point.[1] Corden (1984) briefly considers the mitigation effects of immigration; Wahba (1998) does so formally, yet she points at the increased marginal productivities, in the form of higher wages, as the triggering mechanism which can at best mitigate the *Dutch Disease* effects. Through the case of federations, this paper demonstrates that reduced costs of factor mobility not only mitigate *Dutch Disease* effects but can in fact reverse them, and presents the *Alberta Effect* mechanism through which this mitigation, and possible reversion, process occurs.

In an influential set of papers, Sachs and Warner (1997, 1999, 2001) presented the so-called growth curse of natural resources, showing a counterintuitive negative relationship between resource abundance and economic growth. Albeit facing criticism (Brunnschweiler and Bulte 2008), several additional empirical studies further confirmed this finding;[2] however, the vast majority of them (Sachs and Warner's included) investigated cross-country variations, thus questioning its robustness for variations in more local settings. Indeed, historical accounts, such as the 19th century *California Gold Rush*,[3] show that resource abundance can be a blessing at the local level; recent studies support this story as well.[4]

We start with a further investigation of this insight by looking into the case of federations.[5] We employ all federal-states that have available data to re-examine Sachs and Warner's hypothesis within and between federations, and compare between outcomes.[6] Results show that resource abundance is a blessing at the federal-state level, yet similar to findings of previous cross-country studies remains a curse at the federal level. These opposite, yet significant, results are robust to controlling for standard growth-explaining variables, as well as to different resource wealth measures, estimation techniques, and periods investigated.

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[1] See Corden and Neary 1982, Krugman 1987, van Wijnbergen 1984. Considering a resource boom (being the focus of this paper), *Dutch Disease* is divided to a *Spending Effect* and a *Resource Movement Effect*. The former describes the inflationary outcome of an income shock which, in turn, causes an appreciation of the local currency, while the latter describes the movement of production factors from various sectors to the resource one due to higher marginal productivities. The main idea is that both effects cause tradable sectors (specifically, manufacturing) to contract. However, this literature does not consider the impact of factor mobility costs on these effects, as they assume capital is internationally immobile and labor supply is fixed.

[2] See Van der Ploeg (2011) for a survey.

[3] Discovery of gold caused mass population movement to the west of the United States which had an immense positive effect on the development of the area. Other similar events, such as 19th century gold rushes in Canada, South Africa, and Australia, presented similar outcomes.

[4] Aragon and Rud (2011) show how a Peruvian goldmine increase welfare at the localized level, Michaels (2011) shows that resource abundance levers development in the long run at the US county level, and lastly, Caselli and Michaels (2009) show that *Dutch Disease* does not apply in Brazilian municipalities.

[5] A federation is a state characterized by a union of partially self-governing *federal-states* united by a central government. Throughout the paper we use the term *federal-state* to refer to a state within a federation (such as, for instance, New York and California in the United States, or Quebec and Alberta in Canada).

[6] Our intra-federal sample includes 234 federal-states of the federations of: Australia, Belgium, Brazil, Canada, Germany, India, Malaysia, Russia, United Arab Emirates, and the United States, whereas the cross-federal one includes these 10 federations (examined for the same timeframes, as will be outlined in-detail in section 2).

This comparison exercise, and its result, let us focus specifically on the effects of factor mobility costs on *Dutch Disease* effects. On one hand federal-states are largely comparable to sovereign countries in terms of determination of fiscal policy, resource ownership, availability of data, and price level differentials, yet on the other hand they present an environment with both reduced mobility costs (as it is less costly to relocate physical capital or labor within a federation than across countries) as well as relatively little variance in institutional quality. By assuming intra-federal level of institutional quality is held constant, we argue the differences in outcomes may be attributed to differences in *Dutch Disease* effects.[7] In turn, through the theoretical analysis we show these differences in *Dutch Disease* effects can potentially stem from the mentioned differences in factor mobility costs, implying for the relative importance of factor mobility considerations in *Dutch Disease* theory.

By extending Zodrow and Mieszkowski's (1986) basic capital tax competition model,[8] we connect between factor mobility costs and the *Dutch Disease* in an attempt to explain the opposite outcomes observed initially. Motivated by the case of Alberta and focused on the *Resource Movement Effect*,[9] the model analyzes a two-region capital tax competition, and shows that with sufficiently low factor (specifically, capital) mobility costs a resource boom triggers an *Alberta Effect* –where resource abundant regions exploit the fiscal advantage, provided by the resource rents, to compete more aggressively in the inter-regional competition over capital, and as a result attract vast amounts of capital– which in turn mitigates and even reverses *Dutch Disease* symptoms (and, following Wahba's (1998) model, transmits them to factor exporting regions) so that eventually *Resource Blessing* effects are observed within federations.[10] Ultimately, resource booms lead to *Dutch Disease* symptoms in resource abundant federal-states, similar to those observed in sovereign countries; however, because federal-states operate in an environment with reduced factor mobility costs they can initiate an *Alberta Effect* and consequently attract enough capital to maintain or even expand the size of their manufacturing sectors, and by that mitigate or reverse the effects of the *Dutch Disease*. The model shows there exists a threshold cost of factor mobility below which an *Alberta Effect* materializes and above which it does not. In case it is assumed that within federations factor mobility costs are below that threshold while between federations (or more generally, between countries) they are above it, then this model provides an explanation for the difference in outcomes presented initially.

[7] The literature considers two main explanations for the *Resource Curse:* the political explanation of institutional quality, and the market mechanism one of *Dutch Disease* (Van der Ploeg 2011). By holding institutional quality constant we are left with *Dutch Disease* considerations. See section 2 for an elaborated discussion.
[8] The model considers an endowment asymmetry framework, which has not been analyzed previously in tax competition models. This is discussed in greater detail in section 3.
[9] See sections 2 and 3 for elaborated discussions.
[10] Thus, the *Alberta Effect* mechanism refers specifically to the successful factor attraction process followed by exploitation of the fiscal advantage provided by resource rents. This mechanism was mentioned in the context of the *Dutch Disease* by Corden (1984), who termed it the *Alberta Effect.*

We validate the suggested mechanism through an intra-federal analysis of the United States, and find that: a. resource abundant US states present a more competitive business environment (in the form of more competitive taxes, greater investment in infrastructure, and greater public good provision) and attract more physical capital, b. the business environment channel accounts for approximately 60% of the resource-induced inflows of physical capital, and c. contrary to predictions of *Dutch Disease* theory resource abundant states have their manufacturing sector grow faster – as the model predicts.

The paper is structured as follows – Section 2 goes through the initial empirical exercise, investigating *Resource Curse* effects within and between federations. Section 3 presents the model and goes through the theoretical analysis. Section 4 presents empirical evidence for the main implications of the model, through the case of the United States. Section 5 concludes.

## 2. THE EFFECTS OF RESOURCE WEALTH ON LONG TERM GROWTH - WITHIN AND BETWEEN FEDERATIONS

Let us undertake *Resource Curse* analyses, in the spirit of Sachs and Warner (1997), within and between federations. For that we employ two samples, intra-federal and cross-federal ones. The intra-federal sample includes 234 federal-states of the federations of Australia, Belgium, Brazil, Canada, Germany, India, Malaysia, Russia, United Arab Emirates, and United States; this is a maximized sample that includes all federal-states that have complete data available, for the maximum time period available. Thus, the time period investigated for federal-states of each federation is as follows: Australia: 1990-2008, Belgium: 1999-2008, Brazil: 1995-2008, Canada: 1984-2008, Germany: 1991-2008, India: 1980-2008, Malaysia: 2004-2008, Russia: 2004-2008, United Arab Emirates: 2000-2008, and United States: 1977-2008. The cross-federal sample includes the 10 federations to which the federal-states correspond, each covering the exact corresponding time period as in the intra-federal sample (so that, for instance, in the intra-federal sample the federal-states of Australia cover the period of 1990-2008, and in the cross-federal sample Australia covers the same time period). These corresponding time periods, bounded by the availability of data at the federal-state level, are critical for comparing results under each of the samples. Description of the data, and periods investigated for each federation and federal-state, is presented in appendix 1.

As a first take we plot in figure 1 average annual growth in real per capita GDP versus the share of primary output in GDP in initial year –conditional on a vector 'Z' of controls that includes initial income, education, institutional quality, investment, population growth, and openness (all of which described in-detail in the regression analyses to

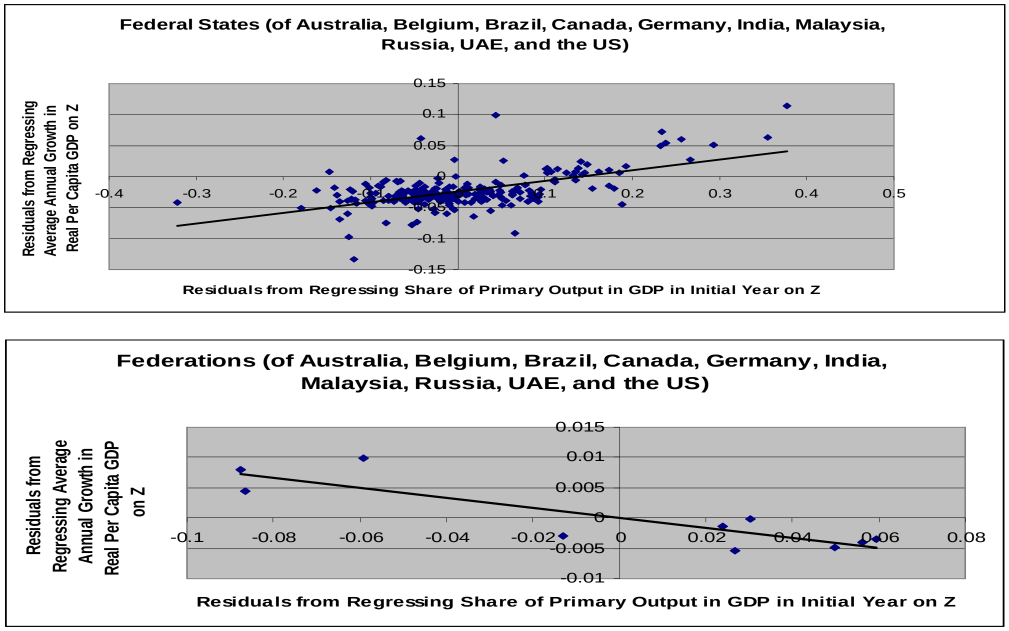


**FIGURE 1**. *Resource abundance and economic growth within and between federations*

follow)– for each of the two samples.[11] The top figure of the intra-federal sample shows a positive association between resources and long term growth at the federal-state level;[12] conversely, the bottom figure of the cross-federal sample shows a negative association between these two factors at the federal level for the same federations, time periods, and controls. This, in fact, presents the basic result under cross-sectional framework; we show this holds under a more elaborated panel framework having federal-state, federal, and time fixed effects, as well as additional controls.

Let us first investigate the intra-federal sample, under panel framework covering the time periods mentioned previously in five year intervals.[13] Thus, for federal-state *'i'*, and time *'t'*, we test the following model:

$$G^{it} = \alpha_0 + \alpha_1 R^{it} + \alpha_2 Z^{it} + \chi^t + \mu^i + \varepsilon^{it} \qquad (1)$$

In terms of notation: *'G'* is average annual real per capita GDP growth, *'R'* is the proxy for resource share, *'Z'* is a vector of control variables that includes initial income, education, institutional quality at the federal-state and federal levels, investment, openness, population

[11] As described in the regression analyses to follow, in the intra-federal case we control for institutional quality at both the federal-state and federal levels.

[12] Similar graphs for each federation separately are presented in appendix 2, each showing a similar positive association as observed in the top graph of figure 1. Papyrakis and Gerlagh (2007) undertake a similar exercise at the US state level for the period of 1986-2000, and find a negative association. In this paper the intra-federal sample extends beyond the United States (includes nine additional federations); in addition, the specific sample on the United States covers an extended period (1977-2008).

[13] These represent the longest time intervals under which the sample size is kept at maximum; longer time intervals decrease the sample size significantly. Nonetheless, realizing that the *Resource Curse* usually refers to long term phenomena, we show results hold under a pooled cross-sectional framework, where time-intervals are maximized for each federation (and its federal-states) separately. See appendix 1 for further details on the time intervals covered, and any corresponding adjustments made per federation.

growth, and an interaction term of federal institutional quality and resource share (following Mehlum et al. (2006)), '$\chi$' is a time fixed effect, and '$\mu$' is a federal-state fixed effect.[14]

Variables in '*Z*' are measured as follows[15] – Initial income: logarithm of real per capita GDP;[16] Education: share of the education industry in GDP; Federal institutional quality: the Political Rights Index (Freedom House 2010);[17] Federal-state institutional quality: share of the public administration sector in GDP; Investment: share of gross capital formation in GDP; Openness: net international migration rate; Population growth: average annual rate of population growth over the time interval. Resource wealth is measured by the share of primary (agriculture, hunting, fishing, forestry, and mining) output in GDP. To mitigate endogeneity concerns all variables are measured at the beginning of each time interval; in addition, all variables are expressed as deviation from period means with first difference to cancel time and federal-state fixed effects (following Caselli et al. 1996).[18]

Note that all proxies in '*Z*' have been commonly used in previous studies;[19] however, our measures of institutional quality and openness require further elaboration. Starting with the former, given the essential nature of institutional quality in *Resource Curse* analyses (Mehlum et al. 2006) we control for variation in both federal-state and federal levels, especially as these are time variant and not captured through the fixed effects. In addition, unlike country level measures no objective measure exists uniformly for all federal-states; the size of the public administration industry in GDP gives a unified objective measure across federal-states, and despite its imperfect measure of institutional quality it was found to be a key determining factor of it (La Porta et al. 1999). One concern is that federal districts, which are considered independent federal-subjects yet host most of the federal administrative units,[20] may introduce biased measures due to their relatively high administrative share in GDP. However, when dropped from the sample results do not change in direction or significance; thus, they are included in the analyses to follow. As for our measure of openness, we realize it is not obvious. A potentially more accurate proxy would involve some measure of exports and imports; however, this data is scarcely available at the federal-state level, and would have decreased our sample significantly. Therefore, we follow Papyrakis and Gerlagh (2007) and

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[14] Given the length of time intervals, the federal-states of Malaysia and Russia have one observation so that they carry no federal-state level fixed effects; instead, we add federal level dummies for these two federations. Note that results do not change in case these two federations are otherwise dropped from the sample.

[15] Unless specified otherwise, data was retrieved from the statistics bureau of each federation; see appendix 1.

[16] Data expressed in constant 2000 US$ prices.

[17] As defined by *Freedom House (2010): "*The *Political Rights Index* measures the degree of freedom in the electoral process, political pluralism and participation, and functioning of government. Numerically, Freedom House rates political rights on a scale of 1 to 7, with 1 representing the most free and 7 representing the least free."

[18] With the exception of Malaysia and Russia which are not time differenced, for the reasons mentioned earlier.

[19] See Sachs and Warner (1997) and Papayrakis and Gerlagh (2004), among others.

[20] These include the District of Columbia (US), Federal District (Brazil), and the Capital Territory (Australia).

estimate this using the net international migration rate; following their argument, open economies tend be more welcoming to immigrants (Ethier 1985).[21]

Since our objective is investigating *Resource Curse* phenomena (effects of resources on long term growth) we focus on the sign and significance of $\alpha_1$; thus, albeit being potentially interesting, we abstract from discussing results of other coefficients, or more generally economic impacts, magnitudes, or welfare implications of results. Note that all results for this section are summarized in table 1. Specifically, the main result using this sample is presented in regression 1. The coefficient on the resource share proxy is positive and significant, providing an indication for *Resource Blessing* effects at the federal-state level. To mitigate omitted variable bias the main result is presented with all variables in *'Z'* included; nonetheless, we observe *Resource Blessing* effects even when variables in *'Z'* are added gradually.[22] To test for robustness, in regression 2 we use the GDP share of the mineral sector (mining and quarrying) as the resource share proxy, in lieu of the previously used one; results remain to hold. Finally, in regression 3 we add the GDP share of the primary sector at the federal level; this lets us observe the federal-state's own effect of resources vis-à-vis the effect of resources of other states in the federation. The coefficient on the federal-state resource measure remains positive and significant with increased magnitude, yet interestingly the coefficient on the federal resource measure is negative and significant implying that federal-states are negatively affected by resource booms in other parts of the federation.

Let us now investigate the cross-federal sample, under panel framework covering the same time periods mentioned previously in five year intervals. Thus, for time *'t'*, and federation *'f'*, we test the following model:

$$G^{tf} = \alpha_0 + \alpha_1 R^{tf} + \alpha_2 Z^{tf} + \chi^t + \eta^f + \varepsilon^{tf} \qquad (2)$$

Apart from excluding the federal-state fixed effects and federal-state institutional quality, this model is identical to the intra-federal equation in terms of notation, and variables included. The resource share proxy as well as all variables in *'Z'* are measured similarly to those in the intra-federal sample, with the exception of – Education: average years of schooling for population aged 15 and over (Barro and Lee 2010), and Openness: share of total trade in GDP (World Development Indicators 2010). Again, all variables are measured at the beginning of each time interval and are expressed as deviations from period means with first difference.

The main result is presented in regression 5; the negative and significant coefficient on the resource share proxy provides an indication for *Resource Curse* effects at the federal level. In regression 6 we test for robustness by using the GDP share of the mineral sector

[21] Note this has no bearing on the factor attraction mechanism (*Alberta Effect*) presented in the theoretical part; as will be evident, the mechanism suggested evolves strictly around capital and, for reasons outlined in a later section, abstracts from issues of labor movement. Nonetheless, we note that results do not change qualitatively in case this variable is altogether not included in the estimations (results available from author).

[22] Results available from the author.

instead of the primary-based one. Results remain to hold in sign and significance under this measure; we continue to observe *Resource Curse* effects at the federal level.

When comparing between the outcomes under the intra and cross federal scenarios, we observe that in both cases coefficients of all independent variables are identical in sign and significance, with the exception of the one on resources which has an opposite –yet significant– sign in each case, implying that resources affect federal-states and federations (or rather sovereign countries more generally) in an opposite manner.

One concern is that previous *Resource Curse* results at the cross-country level (Gylfason 2001, Papyrakis and Gerlagh 2004, Sachs and Warner 1997) may not hold for the 1977-2008 range investigated in this case given the surge in oil prices, implying that the observed federal-level *Resource Curse* results may in fact be specific to our 10 federations. To alleviate this concern, we extend Sachs and Warner's (1997) exercise to the period of 1977-2008. In effect, we retest regression 1.5 from their 1997 study (representing their main result) for our extended period; this regression is a cross-sectional version of specification (2) with the exclusion of fixed effects, population growth and the interaction term of institutional quality and resource share, and the inclusion of a terms of trade measure. To further maintain consistency with the original exercise, we adopt an exports-based resource measure (GDP share of primary exports). This cross-country sample includes 76 countries.[23] Results appear in regression 7. The negative and significant coefficient on the resource share proxy implies there exists a *Resource Curse* under Sachs and Warner's specification for our investigated period. As observed in regression 8, this result remains to hold when we use the share of mineral output in GDP as the resource share proxy, in lieu of the exports-based one.

Another concern relates to a possible sample selection bias. The intra-federal sample includes all federal-states that have available data; however, this availability depends on the federal institutional quality, and is biased towards the relatively stronger ones (so that, for instance, data is available for the federal-states of the United States, yet not for those of Sudan). This implies that the intra-federal *Resource Blessing* effects may in fact be driven by good institutions. To address this we add an interaction term of federal institutional quality with the resource share proxy. While results for the cross-federal sample are similar to those of Mehlum et al. (2006) as we observe a negative coefficient on the interaction term in regressions 5 and 6, the intra-federal sample once again presents an opposite outcome as we observe a positive and significant coefficient on the interaction term in regressions 1-3, implying that intra-federal *Resource Blessing* effects amplify as the federal institutional quality deteriorates. This, in turn, indicates that, if anything, there is a downward sample selection bias, so that true estimators are actually more positive than those presented. An

[23] See appendix 1 for description and sources of variables used in this exercise, as well as a list of countries included in the sample.

intuitive explanation for this interesting result relates to federal equalization schemes, which are possibly more effective in regimes with stronger institutions. This implies that in federations with stronger institutions resource rents are redistributed across the federation more effectively, so that intra-federal variability is lower compared to that of federations with weaker institutions. Greater intra-federal variability and less effective redistribution of resource rents favor resource abundant federal-states, which consequently experience amplified *Resource Blessing* effects, as the above result suggests.

A final concern relates to the potential endogeneity of the resource share proxy to the growth or income levels, as discussed by Brunnschweiler and Bulte (2008) and Van der Ploeg (2011). Usually, this is addressed through an IV approach; however, under panel framework with fixed effects it is challenging to adopt a suitable instrument which presents sufficient time variation. Therefore, we exploit the cross-sectional versions of our panels, and take an IV approach under this setting. We follow Sachs and Warner (1997) and use land per capita as an instrument for the resource share proxy. We find land per capita to be a valid instrument as on one hand it correlates highly with the various resource share measures, since higher land per capita provides greater potential for primary output, yet on the other hand it is relatively exogenous to growth since it is largely based on geographic factors. Given its mobility, we realize population remains vulnerable to endogeneity, yet we measure it at the beginning of the period, assuming it to be pre-determined.

For the intra-federal case, we estimate equation (1) in its cross-sectional version; thus, the specification now includes federal fixed effects, and excludes federal-state and time dummies.[24] In addition, since this is in effect a pooled cross-section, we adjust initial income to provide comparable convergence effects.[25] Results appear in regression 4. First stage estimation confirms the validity of the instrument through the results of its coefficient and the accompanying F-Statistic; second stage estimation indicates that the main results hold, as we continue to observe *Resource Blessing* effects. As for the cross-federal case, the limited sample size prevents us from undertaking a comparable meaningful exercise;[26] therefore, we turn to the extended cross-country sample, used previously in regressions 7 and 8, and take a similar estimation using the same IV. Results appear in regression 9. Again, first stage results validate the instrument through the F-Statistic and the coefficient on land per capita; second stage results show *Resource Curse* continue to apply at the country level. Thus, the opposite outcome of the two scenarios is observed even under this specification.

[24] Federal institutional quality and its interaction term with resources are not included in this specification, given the federal fixed effects.
[25] See appendix 1 for further details on the computation of this adjustment.
[26] Nonetheless, figure 1 indicates the opposite outcomes between the intra and cross federal scenarios remains to hold under the simple cross-sectional framework.

### *2.1 Discussion*

The results of this section indicate that at the federal-state level resource abundance is a blessing, yet at the federal (or more generally, sovereign country) level it is rather a curse. Naturally, we ask what is the reason for these completely opposite outcomes? We argue the reason lies in the difference in factor mobility costs which, in turn, affect the magnitude and direction of *Dutch Disease* symptoms; specifically, those of the *Resource Movement Effect*. The literature suggests various explanations for the *Resource Curse*; these, however, can be largely grouped into either political explanations that relate to institutional quality, or to market mechanism explanations that relate to the *Dutch Disease* (Van der Ploeg 2011). Let us discuss each in the context of an intra-federal environment to realize why the focus should indeed be on factor mobility and the *Resource Movement Effect*.

Firstly, we address the issue of institutional quality. In previous cross-country studies variability in institutional quality was quite substantial and thus relevant; however, despite controlling for it in the current analyses, this is not the case in an intra-federal environment which is relatively homogenous in that respect. In our exercise, the main variability in institutional quality is rather between federations, and as was shown earlier, if anything worse federal institutional quality only amplifies intra-federal *Resource Blessing* effects. Thus, the difference between the intra and cross federal scenarios is not expected to stem from differences in the effects of institutions.

Secondly, we address the issue of *Dutch Disease*. As opposed to cross-federal settings an intra-federal one presents a unified monetary system. This difference may imply that the *Spending Effect*, which is driven by the appreciation of the local currency, would be mitigated at the federal-state level. However, as outlined by Sachs and Warner (1999), since it is the real change in prices that affects local currency, then it is rather price level differentials that determine the magnitude of the *Spending Effect*. It is well documented that price levels differentiate at the regional level at least as much as they do across countries;[27] additional studies show these prices converge more slowly at the regional level than at the country level.[28] This means that the *Spending Effect* at the federal-state level is expected to be at least as large as it is in sovereign countries, despite the homogenous monetary systems.[29]

This leaves us with the *Resource Movement Effect*; we argue it is the difference in factor mobility costs between the two cases that affects the magnitude and sign of it. Thus, we focus on mobility costs; in case these are viewed as transportation (Krugman, 1991) or transaction (Coase, 1937) costs so that they vary with distance, then once they are low enough a resource boom can trigger an Alberta *Effect* that potentially overturns the accompanying

[27] See McMahon (1991), Slesnick (2002), and Walden (1998).
[28] See Cecchetti et al. (2002), Culver and Papell (2006), and Roos (2006).
[29] Indeed, taking the case of China, Zhang et al. (2008) show that provincial resource booms increase provincial inflation, confirming this mechanism is applicable at the local level.

*Dutch Disease* (*Resource Movement Effect)* symptoms. To better understand the suggested mechanism, let us firstly consider the case of Alberta – owning the second largest petroleum reserves in the world, Alberta exploits its resource wealth to compete aggressively in the inter-provincial competition over production factors; indeed, it presents one of the most competitive business tax environments in North America,[30] which significantly contributes to it having one of the highest investment per capita levels in Canada for the past several decades. These attracted factors prevent the manufacturing and other growth-enhancing sectors from contracting so that *Dutch Disease* and de-industrialization processes are mitigated and even reversed; indeed, Alberta's manufacturing sector grew by approximately 50% in the period of 1999-2009, being well above growth rates of both manufacturing sectors of other Canadian provinces and Alberta's total economy – contrary to *Dutch Disease* predictions. This, in turn, leads to *Resource Blessing* effects, as Alberta's real per capita growth rates have been amongst the highest in Canada, for the past 20 years.

Nonetheless, exploiting the fiscal advantage of resource rents to compete for production factors can, basically, be done by any sovereign resource rich country, so that this mechanism should not necessarily be unique to intra-federal cases in-general, nor to Alberta specifically; however, due to the relatively higher factor mobility costs between countries the factor attraction process does not materialize in the same magnitude that it does in Alberta, or in other intra-federal and localized settings, so that *Dutch Disease* symptoms are not mitigated, and *Resource Curse* outcomes are observed. That being said, the case of Alberta serves as a main motivator for the model presented in the following section which, to the best of our knowledge, undertakes a first attempt at presenting the potential mitigating effects of factor mobility on *Dutch Disease* symptoms, through the *Alberta Effect* mechanism.

## 3. THE MODEL

In this section we introduce the model and theoretical analysis; the main objective is to present the suggested mechanism through the simplest framework. As will be outlined through the introduction of the setup, various simplifying assumptions are taken in all aspects of the model. However, there are in addition five critical ones.

Firstly, we assume the main mechanism through which the resource attraction process occurs is a tax competition (which can also be interpreted as a subsidy competition). We realize this can be undertaken through other channels as well, such as competition in infrastructure. This is accounted for in the empirical part, where competition in infrastructure and public goods are also considered; nevertheless, the tax mechanism is emphasized in the model because despite its relative importance,[31] it has not been considered previously under

[30] For instance, Alberta presents no provincial retail sales, capital, payroll, or machinery and equipment taxes.
[31] See Newman and Sullivan (1988) for a survey; specifically, Bartik (1985) finds that a ten percent decrease in corporate tax increases the number of new plants by to two to three percent. Hines (1997) presents a similar

an endowment asymmetry framework,[32] as opposed to the case of infrastructure competition under such asymmetry which has been analyzed by Cai and Treisman (2005).

Secondly, we assume having an inter-regional tax competition is independent of the economy's level of institutional quality, so that such a competition may arise regardless of whether the economy possesses strong or weak institutions. Scholars contend that inter-regional competition punishes wasteful or corrupt governments with capital flight, incentivizing them to guarantee secure property rights and provide a hospitable environment for factors.[33] Indeed, two key examples arise in this context – Russia and China; inter-regional competition over factors is observed in each, despite their relative weak institutions.[34]

Thirdly, we assume the resource endowment is capital intensive. Previous studies found that *Resource Curse* effects are most acute when considering point-source resources (mining and quarrying);[35] in addition, University of Groningen's cross-country database on 'Industry Factor Intensity' ranks 'Mining and Quarrying' third most capital intensive industry among 32 industries across 30 countries in 1997. Thus, the emphasis in the model is on capital-based resources. This is a key assumption, because it forms the basis for considering competition over capital and concentrating on capital rather than labor mobility.[36] In addition, this is consistent with previous studies showing that labor is attracted to urbanized and agglomerative areas.[37] Since resources tend to locate in non-agglomerative and remote areas, we argue that a factor attraction process should indeed emphasize capital over labor.[38]

Fourthly, the analysis focuses specifically on the *Resource Movement Effect* and abstracts from considering any *Spending Effects*, for the reasons outlined in the previous section. In a sense, this follows Matsuyama's (1992) model that also focuses on the *Resource Movement Effect*; however, his model omits the feature of capital mobility and allocation. Our model extends his work by allowing for that and by considering the regional fiscal advantage that resource abundance provides; our model shows the addition of these features reverses his main result.[39]

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finding for FDI. Other research shows that tax competition over production factors is a viable mechanism at the regional level (see Brueckner 2003, for a survey).

[32] Bucovetsky (1991), Kanbur and Keen (1993), and Wilson (1991) present models of asymmetric tax competition; however, the asymmetry is in population sizes rather than endowment shocks, as it is in this model.

[33] See Qian and Roland (1998), and Montinola, Qian, and Weingast (1995).

[34] See Cai and Treisman (2005) for the case of Russia, and Li et al. (2000) for that of China. Remarks on the institutional quality of each were based on the Political Rights Index of Freedom House (2010).

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

[36] A slightly modified setting with a labor intensive resource, labor movements, and no capital drain, would have been more suitable for explaining historical phenomena such as the *California Gold Rush* or the Canadian *National Policy*; however, since such a setting would be less relevant for explaining the results in the initial empirical exercise (as it would bear only marginal capital involvement), we focus on the current framework.

[37] See Williamson (1988) for a survey.

[38] While one can find several definitions for capital in the literature, in the context of this paper 'capital' is mostly related to physical capital (such as machinery, plants, etc.). This definition plays a key role in the empirical part.

[39] Yet as opposed to Matsuyama (1992), we neither consider dynamics nor do we assume learning-by-doing technology in the manufacturing sector.

Finally, we consider a static, one-period model. The *Resource Curse* refers to the long term effects of resource wealth; thus, transitional effects are not considered, making the usage of a multi-period model less relevant. That being said, in the context of this paper, once we assume the one period of the model represents the entire transitional period from one steady-state to another, adopting a multi-period model does not present further insights beyond those of the static one, yet it presents unnecessary analytical complications, and divert the focus to issues that are of less relevance to the main theme. In a sense, using a static model is in fact merely a simplifying feature, as results do not change under either version of the model. Nonetheless, this relates to the results of the previous section. One concern is that the model does not fully explain the initial results as it does not consider convergence issues. However, as will be evident in the theoretical analysis, the resource boom is initiated once the economy is in a symmetric equilibrium; this means that convergence is in fact held constant and thus accounted for. To address that further, we could present level regressions instead of the Barro-type growth ones presented in the previous section; however, following the reasoning of Mehlum et al. (2006), having income at the end of the period as the dependent variable while controlling for initial income is basically equivalent to undertaking a growth regression.

### *3.1 Benchmark Setting*

There exists an economy with two symmetric regions;[40] each having a manufacturing sector. Production in each region is undertaken by capital (K) and labor (L), employed through a neoclassical production function (F(K,L)); it takes place in the manufacturing sector, to produce a final good (Y) that is either consumed (X) or converted to a pure public good (G). The starting population size of each region is $L_i$ (where $L_1 + L_2 = N$);[41] labor market is inelastic so that each resident is employed and provides one unit of labor. There is a fixed supply of capital in the economy (where $K_1 + K_2 = K^*$), that is equally owned by its residents (so that each owns: $K^* / N = k^*$). Capital and labor are perfectly and costlessly mobile across the economy. Each region has a government that levies a per-unit, source-based, capital tax to finance a pure public good, so that:[42]

$$G_i = T_i K_i \qquad (3)$$

The after-tax rate of return on capital is $\rho$; although determined endogenously, $\rho$ is taken as given by each region. Following that, the pre-tax rate of return on capital would be $\rho + T_i$.

[40] We take the simplifying assumption of having a closed economy; analyzing an open one neither changes results nor adds further insights.
[41] Note that *'i'* represents the region, where $i \in (1,2)$. Also in terms of notation, subscripts, superscripts, capital letters, and small letters, represent regions, sectors, level variables, and per capita variables, respectively.
[42] An alternative interpretation for this could be a subsidy; meaning, taxes are levied as described, yet decreasing them may be equivalent to giving subsidies, so that a subsidy-competition arises.

There are many firms operating in each of the regions, and there is free entry to the market. Capital markets are competitive so that profit maximization by each firm yields:

$$f_{k_i}(k_i) = \rho + T_i \qquad (4)$$

Residents of this economy have identical preferences, represented by a strictly quasi-concave utility function, U(X,G), where *X* and *G* are normal goods with diminishing returns;[43] in addition, they own equal shares of the firms, in their respective regions. Therefore, given that residents spend all their income on private consumption, a representative resident's budget constraint would be:

$$x_i = f(k_i) - (\rho + T_i)k_i + \rho k^* \qquad (5)$$

Each region competes for the economy's capital stock, by means of tax competition; thus, a capital tax competition arises, modeled along Cournot-Nash lines. This is a static model where the order of events is as follows – each region sets its capital tax level, based on which capital is reallocated across the economy; this determines the regional wage and public goods levels, which in turn determines labor allocation. That said, by equation (4) each region derives $k_i(T_i)$ so that it can vary $k_i$ by its choice of $T_i$; totally differentiating it with respect to $k_i$ and $T_i$ yields:

$$\frac{dk_i}{dT_i} = \frac{1}{f_{k_i k_i}} < 0 \qquad (6)$$

By equation (3), we get:

$$\frac{dG_i}{dT_i} = L_i k_i + T_i L_i \frac{dk_i}{dT_i} \qquad (7)$$

Also, by differentiating equation (5) with respect to $T_i$ and substituting equation (6), we get:

$$\frac{dx_i}{dT_i} = -k_i \qquad (8)$$

Each region aims to set the tax level that would maximize the welfare of its residents; each would, thus, maximize the utility of a representative resident, subject to the budget constraints of the region and the resident.[44] Therefore, in its simplest form the problem of each of the regions would be as follows:

$$\underset{\{T_i\}}{Max}\, U(x_i, G_i)$$

Let us denote $U_{G_i}/U_{X_i}$ by $m(x_i, G_i)$; thus, we get:

[43] We assume marginal utilities of *X* and *G* go to infinity as each approaches zero, and vice versa.

[44] In the tax competition literature the government objective can be expressed in several forms (Wilson 1999). The standard way is adopted in this model; however, other models consider different routes such as having a leviathan government (Brennan and Buchanan 1980) or a semi self-interest one (Cai and Treisman 2005). While this distinction is critical for understanding whether tax competition can discipline governments, it does not play a role in the current context.

$$\frac{dx_i}{dT_i} + m(x_i, G_i)\frac{dG_i}{dT_i} = 0 \tag{9}$$

Substituting equations (7) and (8) to equation (9) and rearranging, we get:

$$L_i m(x_i, G_i) = \frac{1}{1 + \frac{T_i}{k_i}\frac{dk_i}{dT_i}} > 1 \tag{10}$$

In equilibrium, equation (10) must hold for each of the regions, together with the following capital mobility condition:

$$f_{k_1} - T_1 = f_{k_2} - T_2 \tag{11}$$

Under this symmetric setting, a symmetric equilibrium arises, where factors are allocated equally between regions, and the size of the respective manufacturing sectors is thus the same.[45] Let us now consider the case of a resource boom in region 2.

### *3.2 The Introduction of a Resource Sector*

Following Corden (1984), resource booms can be viewed as one of three cases: a technology shock in the primary sector, an increase in commodity prices, or a discovery of resources. Although our analysis is applicable to each of these, we focus on the latter. Starting at the symmetric equilibrium, we introduce a resource sector to region 2.[46] We assume this sector is capital intensive, so that, as a simplification, it only employs capital and an exogenous and immobile resource endowment (Q), to produce the final good.[47] Capital in the resource sector is taxed similarly to that in the manufacturing sector (as was modeled previously); in addition, a lump-sum tax (z) is imposed on the resource rents. Employing such a tax acts as a simplifying feature; imposing distortionary taxes instead will not change results, yet complicate the analysis needlessly.[48] We assume that at least some of the resource rents accrue to the regional government. Indeed, this depends on the level of fiscal decentralization; however, merely having regional governments means the level of fiscal decentralization is positive,[49] so that the region has at least some fiscal benefit from the resource.[50] In addition,

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[45] See an elaborated discussion and proof in appendix 3.

[46] More generally, this sector can be regarded as any sector that may significantly enlarge the fiscal capacity of the region; indeed, this is not restrictive to resources, but is regarded as such in the current context due to the specific observation this model aims to explain.

[47] In terms of notation, since now region 2 has two sectors (manufacturing and resource), a superscript *'m'* refers to the manufacturing sector, while a superscript *'r'* refers to the resource one (region 1 remains to have one sector, as before, so that this notation does not apply to it).

[48] Despite its unrealistic characteristics, a lump sum tax is often used in related models as a simplifying mechanism that attains a first best outcome; this is in fact how it should be regarded in this case. We, thus, use it mainly because it does not change the main results yet is convenient in terms of tractability. Considering a different case where all taxable factors (including capital) are levied a lump sum tax instead of a distortionary one would change the outcome. Therefore, since having a distortionary tax is more realistic, and since this distortion is critical for the outcome, we keep it with the capital, yet change it for a lump sum one with the resource rents.

[49] This is especially applicable in the context of federal-states, specifically those included in the initial intra-federal analysis, where the fiscal benefit from resources located in their territories (albeit being in varying degrees) is constitutionally entrenched, within the federal framework.

as previously discussed in the introduction of the critical assumptions, we assume the region uses this fiscal advantage towards the inter-regional competition over capital, regardless of its institutional quality. Therefore, in this case the regional budget constraint is:

$$G_2 = T_2^{\ m} K_2^{\ m} + T_2^{\ r} K_2^{\ r} + z \quad (12)$$

The technology used in the resource sector differs from that adopted by the manufacturing sector; nevertheless, production is modeled also by a neoclassical production function (H(K,Q)). The resource is equally owned by residents of region 2 (so that: $q^* = Q / L_2$) and it provides an endogenously-determined rate of return of $\alpha$.[51] Therefore, the budget constraint of a representative resident in region 2 would be:

$$x_2 = f(k_2^{\ m}) - f_{k_2^m} k_2^{\ m} - z / L_2 + \rho k^* + \alpha q^* \quad (13)$$

Also, in addition to equation (4) profit maximization by firms yields:

$$h_{k_2^r}(k_2^{\ r}, q) = \rho + T_2^{\ r} \quad (14)$$

$$h_q(k_2^{\ r}, q) = \alpha \quad (15)$$

Once again, the regions engage in a capital tax competition. Note that region 1 behaves according to the analysis presented previously; therefore, let us see how the situation changes in region 2:

$$\underset{\{T_2^r, T_2^m, z\}}{Max}\ U(x_2, G_2)$$

Substituting equations (12) and (13) to the above, yields the following first order conditions:

$$U_{X_2} = U_{G_2} L_2 \quad (16)$$

$$U_{X_2} \frac{dx_2}{dT_2^{\ r}} + U_{G_2} \frac{dG_2}{dT_2^{\ r}} = 0 \quad (17)$$

$$U_{X_2} \frac{dx_2}{dT_2^{\ m}} + U_{G_2} \frac{dG_2}{dT_2^{\ m}} = 0 \quad (18)$$

Note that $\frac{dx_2}{dT_2^{\ r}}, \frac{dG_2}{dT_2^{\ r}}, \frac{dx_2}{dT_2^{\ m}}, \frac{dG_2}{dT_2^{\ m}}$ are identical in computation to equations (7) and (8), only with the corresponding notation. Thus, if we substitute these to the first order conditions and solve, we get the following:

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[50] We realize a federal government may play a role in this, especially in terms of redistributing resource rents to other regions through an equalization payments scheme. However, since even in the most equalized federations the fiscal imbalance remains regardless of such schemes (see Boadway 2006 for the case of Canada), we choose to abstract from adding this feature to the model, and to focus on maintaining the simplest possible framework that will nevertheless present a fiscal imbalance.

[51] The endogeneity assumption is required for consistency with the closed-economy and capital mobility assumptions, and is undertaken for simplicity purposes. Assuming for an exogenous rate of return, determined in international markets, would arguably be more realistic; however, it would have no effect on results and would present no further insights, yet would require an open economy framework, complicating the analysis needlessly.

$$T_2^{\ r} = T_2^{\ m} = 0 \qquad (19)$$

This means that if the lump sum tax on the resource rents is unrestricted or that otherwise the discovered resource is substantial enough (in the sense that sufficient taxes can be levied on the resource rents so that the efficient level of public good is supplied) then region 2 can, in fact, efficiently lower its capital taxes to zero, while as was seen in the previous analysis, the tax rate of region 1 remains positive.[52] This emphasizes the fiscal advantage the resource gives to the region in which it was found.

**Proposition 1.** *When factors of production are completely mobile the Nash Equilibrium outcome dictates having* $k_2^{\ m} > k_1, K_2^{\ m} > K_1, L_2 > L_1, G_1 = T_1 K_1, G_2 = z,$ *so that the manufacturing sector of region 2 is larger than that of region 1's (in per capita terms, as well as in absolute size).*
*Proof.* See appendix 5.

Therefore, we see that in the extreme case of perfectly mobile factors, an *Alberta Effect* is initiated and as a result *Dutch Disease* symptoms are mitigated in the resource abundant region, to the point where its manufacturing sector actually grows, and are in turn transmitted to the resource poor region, where the opposite occurs.

Let us now consider the case where labor is completely immobile between regions (yet capital is still freely mobile as before). This case illustrates how the extent to which labor is mobile does not affect the mitigation outcome.

**Proposition 2.** *When capital is mobile and labor is inter-regionally immobile the Nash Equilibrium outcome dictates having* $k_2^{\ m} > k_1, K_2^{\ m} > K_1, L_2 = L_1, G_1 = T_1 K_{1,} G_2 = z,$ *so that the manufacturing sector of region 2 is larger than that of region 1's (in per capita terms, as well as in absolute size).*
*Proof.* See appendix 5.

Next, we consider the extreme case, where both factors are completely immobile between the regions (yet are still perfectly mobile within them). Following the analysis of the benchmark case, once the resource is discovered the economy is in a symmetric equilibrium. The analysis that follows is identical to that which has been presented previously (in both regions 1 and 2), so that in equilibrium $T_2^{\ r} = T_2^{\ m} = 0$ and $T_1 > 0$; nonetheless, the main result is reversed.

**Proposition 3.** *When factors are completely immobile between regions (yet are mobile within them) the Nash Equilibrium outcome dictates having*
$k_1 > k_2^{\ m}, K_1 > K_2^{\ m}, L_2 = L_1, G_1 = T_1 K_{1,} G_2 = z,$ *so that the manufacturing sector of region 1 is larger than that of region 2 (in both per capita and absolute terms).*
*Proof.* See appendix 5.

[52] The cases of a restricted 'z' or a relatively small resource discovery are not analyzed, since they would present identical mechanisms (to the one presented) only in smaller magnitudes, deeming them uninteresting in terms of providing additional theoretical insights.

Thus, when factors are immobile across regions an *Alberta Effect* does not materialize and the usual *Dutch Disease* result is derived in the sense that the manufacturing sector of the resource abundant region contracts.[53] The opposite results of the two extreme cases provide some intuition for the mechanics this model tries to emphasize. When factors are immobile there is a *Resource Movement Effect* towards the resource sector, and the manufacturing sector contracts, yet it stays that way because it can not attract the 'missing' factors from other regions. When factors are mobile, the same happens, yet due to the fiscal advantage that the resource provides the manufacturing sector can attract the 'missing' factors (by presenting a competitive tax environment) so that it maintains its size, or even grows.

The opposite results of the two extreme cases (together with proposition 2) show there exists a threshold level of capital mobility below which the manufacturing sector of the resource abundant region contracts, while above which it does not.[54] Theoretically, in case it is assumed that the cost of factor mobility within federations is equal to or below the given threshold, while that across federations is above it, then the model provides an explanation to the empirical observation made initially, as it shows how reduced mobility costs can potentially initiate an *Alberta Effect* that mitigates and possibly overturns the *Resource Movement Effect* at the local level so that manufacturing sectors of resource abundant federal-states are not contracted and so, in turn, *Resource Blessing* effects are eventually observed.[55]

## 4. EMPIRICAL TESTING

Let us take the United States as a case study, and through an intra-federal analysis, covering the 50 US states and the District of Columbia, undertake two tests; the first to realize whether the *Alberta Effect* applies, and the second to investigate whether *Dutch Disease* symptoms are indeed mitigated (or even reversed) in resource abundant states, as theory suggests.

A US state level analysis is relevant for our purposes for four main reasons. Firstly, there is considerable variation in resource abundance amongst federal-subjects within the US.[56] Secondly, following the initial empirical analysis, it provides an environment with factor mobility levels that are expected to be sufficiently high to test the given theory. Thirdly, it presents a relatively homogenous environment compared to cross-country cases, thus mitigating requirements for having multiple controls, and in turn potentially presenting better identification. Finally, connecting this to the initial intra-federal empirical exercise, US

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[53] To further emphasize how labor mobility does not affect the outcome in this case, in case labor is completely mobile in proposition 3's setting, the manufacturing sector of region 2 would only further contract, so that not only outcome does not change but it, in fact, amplifies.

[54] In appendix 4 we add mobility costs to the model, and derive that threshold mobility.

[55] Note that the model abstracts from looking into the aggregation of the sub-national effects; through the national level result (capital immobility case) we implicitly assume that such a sub-national aggregation results in a negative outcome (i.e. the manufacturing sector in region 1 contracts by more than the expansion of that sector in region 2); yet, explaining the mechanics behind this is beyond the scope of this paper, and is left for future work.

[56] For instance, in 1997 (being one of the investigated years in our sample) mineral output accounted for approximately third of Alaska's or Wyoming's total output, yet it was practically non-existent in the District of Columbia or Delaware.

federal-subjects exhibit *Resource Blessing* effects; specifically, repeating regression 1 for the US only we get a coefficient of 0.1, significant at the two percent level, on the resource share proxy.[57] This makes the US a valid case study.

***4.1 Does the Alberta Effect apply in resource abundant states?***

The previous section implies that in case the *Alberta Effect* applies, resource abundance is expected to affect the inflow of physical capital through the business environment; therefore, motivated by the model and theoretical analysis, let us test the following model, using a cross-sectional sample, for US federal-subject *'i'*:[58]

$$FDI^i = \alpha_0 + \alpha_1 B^i + \alpha_2 R^i + \alpha_3 \ln Y_0{}^i + L^i + \varepsilon^i \tag{20}$$

$$B^i = \beta_0 + \beta_1 R^i + \beta_2 \ln Y_0{}^i + L^i + \upsilon^i \tag{21}$$

$$R^i = \gamma_0 + \gamma_1 R_*{}^i + \phi^i \tag{22}$$

In terms of notation, *'FDI'* represents the inflow of physical capital measured by average per capita Foreign Direct Investment in physical capital in 1997-2006.[59] *'B'* represents the business environment, measured in three ways to capture the different competition mechanisms; firstly, by the average *State Business Tax Climate Index* for 2006-2011,[60] secondly by average per capita expenditure on infrastructure in 1997-2006, and thirdly by average per capita public good provision in 1997-2006.[61] *'R'* represents resource wealth in 1997, measured in two ways: share of primary output in GDP, and share of mineral output in GDP. $'R_*'$ represents exogenous resource wealth measured by the corresponding variables in 'R' reported for 1977, being the earliest year for which complete data is available at the state-level.[62] $'LnY_0'$ is the logarithm of real per capita GDP in 1997. *'L'* is a dummy variable for landlocked states.

This analysis carries two key underlying assumptions. Firstly, consistent with the model we assume that moving physical capital has substantial transportation and transaction costs, giving any such flows a spatial dimension so that they decrease with distance. This forms the reason for adopting FDI in physical capital for measuring capital inflow; albeit

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[57] See the US graph in appendix 2 for the cross-sectional version of this exercise (presenting the same outcome).

[58] Wherever possible, variables are expressed in per capita terms, due to the analysis made in the theoretical section; nonetheless, note that results do not change in case these are otherwise expressed as share of GDP (results available from the author). All data are expressed in millions of US$, constant 2000 prices, wherever applicable. Unless specified otherwise, all data was retrieved from the US Bureau of Economic Analysis; see Appendix 1 for description and sources of all variables.

[59] Investigated period is the maximum available. Due to data limitations, District of Columbia, Montana, North and South Dakota, Nevada, and Wyoming are excluded from the sample.

[60] The 'State Business Tax Climate Index' is an index that ranks US states by their 'tax-friendliness' to business. The index, published by the US Tax Foundation, is a number from 1 to 10, where 10 is friendliest. 2006 is the earliest year for which this index is available. Unlike other possible measures, such as for instance per capita tax payment, which do not hold key factors (as the size of the tax base) constant, this index is an objective one that directly compares between the competitiveness of the tax environment of the various states.

[61] Period investigated corresponds to (and is limited by) that of the capital inflow.

[62] Meaning we assume, for instance, that an exogenous measure of the share of primary output in GDP in 1997 is that same measure in 1977.

being an imperfect measure of spatially-oriented capital inflows,[63] employing a different measure, such as general capital formation, would have also included forms of capital that exhibit less substantial mobility costs, making it less applicable to the theoretical analysis. Also, based on this assumption we abstract from adding an explicit mobility measure to our analysis. Secondly, we assume the intra-federal US environment is homogenous enough so that cross-state differences are largely captured by differences in income level; we note that results do not change qualitatively in case all controls from vector 'Z' of equation (1) are included, yet due to the small variation in them we prefer to follow the given specification.

We start by estimating the effects of resources on the business environment.[64] Thus, we substitute out 'R' in equation (21) using equation (22), and estimate its modified version, for each of our business environment and resource measures. Results appear in the top panel of table 2; the coefficient on the resource measure is positive and significant in all the relevant regressions, indicating that on average resource abundant US states present a more competitive business environment in terms of taxation, investment in infrastructure, and public good provision. In terms of the suggested theory, this implies that resource abundant states indeed exploit the fiscal advantage provided by resource rents to compete more aggressively in the inter-regional competition over factors.

Next, we estimate the magnitude of the indirect effect of resources on the inflow of physical capital, through the business environment channel. Hence, we estimate two reduced form versions of the given system. In the first version, we initially substitute out 'R' in equations (20) and (21) using equation (22), and then substitute out 'B' in equation (20) using equation (21). Thereafter, we estimate the updated equation (20). This version does not account for the business environment, so that it gives the total effect of resources on capital inflow. In the second version, we simply substitute out 'R' in equation (20) using equation (22), and then estimate the modified equation (20) which now includes both the business environment and resources. This version presents the direct effect of resources on the capital inflow, with the business environment channel excluded. Comparing the outcomes of these two cases provides an indication for the magnitude of the *Alberta Effect* (i.e. how much do resources affect capital inflow through the business environment channel).

The results for both versions appear in the bottom panel of table 2. Specifically, results for the first version, estimating the total effect of resources, appear in regressions 16-17, using primary and mineral based resource measures, respectively. Results for the second

[63] FDI in physical capital includes, by definition, all formatted physical capital that has foreign ownership greater than 10 percent. Primarily, it presents some measure of foreign investment (which is not spatially oriented), yet since this investment is in formatted physical capital within the region, then indirectly it does provide a measure of spatially-oriented capital inflows. Nonetheless, we realize it measures these inflows imperfectly in that it only covers physical capital with the required amount of foreign ownership, limiting our results to that type of capital.
[64] In this exercise the District of Columbia is not included in the sample due to data limitations. In addition, we note that results remain to hold even if the more limited sample used in the following exercise is employed.

version, estimating the direct effect of resources, appear in regressions 18-19, again for each of the two previously mentioned resource measures, respectively; note that in this version we include both the tax and infrastructure measures to account for the full effect of the business environment.[65] Comparing the results of regressions 16 to 18, and 17 to 19, we observe that in both cases approximately 60% of the resource-induced capital inflows are due to the business environment channel, which is quite substantial. In regressions 20-21 we take robustness tests. In regression 20 we use our measure of public good provision in lieu of the infrastructure-based one, whereas in regression 21 we use the average *Corporate Tax Climate Index* for 2006-2011 instead of the general index used previously.[66] Results remain to hold in both cases. In the former, 60% of the resource-induced capital inflows are due to the business environment channel, whereas in the latter the estimate is 50%.

These results provide some indication that at least at the US state level the *Alberta Effect* mechanism is indeed applicable to some extent. Moreover, to the extent that resource sectors are capital intensive, these results further imply that some substantial portion of resource-induced capital inflows are directed to non-resource capital-intensive sectors, such as manufacturing.

### *4.2 Are Dutch Disease symptoms mitigated, or even reversed, in resource abundant states?*

As explained initially, according to *Dutch Disease* theory resource abundance leads to contraction of the manufacturing sector. Thus, let us test the following model using a maximized panel covering the period of 1977-2008 in five year intervals, for US federal-subject $'i'$, in time $'t'$:[67]

$$Man^{it} = \alpha_0 + \alpha_1 R^{it} + \alpha_2 \ln Man_0^{\ it} + \alpha_3 \ln Y_0^{\ it} + \beta^i + \tau^t + \varepsilon^{it} \qquad (23)$$

This model is similar to that presented in specification (1) in that it is in effect a growth regression, only instead of investigating total growth we look specifically into the growth of the manufacturing sector. Thus, *'Man'* is the growth rate of the manufacturing sector. The manufacturing sector itself, however, is measured in two ways; the first is its product as share of GDP, and the second is its employment as share of total employment. $'\ln Man_0'$ is the logarithm of the manufacturing-level in the beginning of the time interval (capturing convergence phenomena). $'\ln Y_0'$ is the logarithm of real per capita GDP in the beginning of the time interval. As in section 4.1, here also we employ the same homogeneity assumption through which we aim to capture state heterogeneity using variation in income levels; once

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[65] Since the infrastructure measure is a subset of the public good provision one (so that the two highly correlate), we prefer using the latter for robustness rather than including both in the same specification. Note that results are largely similar under either measure.

[66] The *Corporate Tax Climate Index* is a component of the more general index used in the previous specification, and is measured and interpreted in the same manner. We adopt this component specifically for the robustness test given its relevance to the notion of capital tax competition.

[67] All data retrieved from the US Bureau of Economic Analysis, and is expressed in millions of US$, constant 2000 prices, wherever applicable. For complete description of variables and sources see appendix 1.

again, results do not change qualitatively in case all controls from vector *'Z'* of model (1) are included, and it is merely due to the small variation in them that we prefer to follow the given specification. We measure *'R'* (resource wealth) as either share of primary output in GDP or share of mineral output in GDP. Finally, $\beta^i$ is a state fixed effect and $\tau^t$ is a time fixed effect. As in the sample employed in model (1), here also all variables are expressed in deviations from period means with first difference.

As before, we are mostly interested in realizing the sign and significance of $\alpha_1$. Results appear in table 3. Regressions 22-25, show that using either resource wealth and manufacturing measures $\alpha_1$ is positive and significant, indicating that on average resource rich states have a faster-growing manufacturing sector so that *Dutch Disease* symptoms are indeed reversed in them and are transmitted to the resource poor (factor exporters) states, consistent with Wahba's (1998) theory and our model. Since *Dutch Disease* theory often refers to structural shifts, and to be consistent with our static model, we undertake similar estimations using 10-years and 15-years intervals, as robustness tests. The former case is presented in regressions 26-27, and the latter one in regressions 28-29; results do not change in sign, significance, or magnitude.

Similar tests provide an opposite result once employed under a cross-county framework (where factor mobility costs are higher); investigating oil exporting countries, Ismail (2010) shows that resource booms lead to a contraction of the manufacturing sector, as *Dutch Disease* theory predicts; Sachs and Warner (1997) show similar results for a cross-section of 52 countries. This contrast in results emphasizes further the importance of factor mobility costs in *Dutch Disease* theory.

## 5. CONCLUDING REMARKS

The paper starts with an intriguing empirical observation – at the federal-state level (within federations) resource abundance is a blessing, while at the federal level (between federations) it is rather a curse, consistent with findings of previous cross-country studies. We point at the differences in factor mobility costs as the potential trigger for the different outcomes. Motivated by the case of Alberta, we extend the basic capital tax competition model of Zodrow and Mieszkowski (1986) to present the *Alberta Effect* mechanism through which the mitigation and possible reversion process of *Dutch Disease* effects can potentially occur. The model shows there exists a threshold cost of factor mobility below which resource abundant regions initiate an *Alberta Effect* –where they exploit the fiscal advantage provided by their resources to compete more aggressively in the inter-regional competition over production factors, and as a result attract vast amounts of capital– which mitigates and potentially overturns the usual *Dutch Disease* effects (specifically, the ones related to the *Resource Movement Effect*), and in turn transmits them to resource poor regions, as Wahba (1998) suggests. In case we assume factor mobility costs within federations are below that threshold, while those across federations are above it, then the model provides a potential explanation for the initial empirical observation.

In the last section we undertake an intra-federal analysis of the United States to provide some empirical validation for the suggested mechanism. Results confirm the main implications of the model: firstly, resource abundant states have a more competitive business environment and attract greater amounts of physical capital; secondly, the business environment channel accounts for approximately 60% of resource-induced inflows of physical capital; finally, manufacturing sectors of resource abundant states grow relatively faster, so that *Dutch Disease* effects are reversed and transmitted to the resource poor states.

Thus, through the case of federations this paper demonstrates the importance of factor mobility in *Dutch Disease* theory. Results may carry certain policy implications for fiscally decentralized economies, where resource booms can potentially lead to regional fiscal imbalances. Nonetheless, in this paper we focus on distributional effects, and abstract from investigating aggregative ones. Thus, an interesting extension to this work would be to investigate national-level effects of such regional mechanisms, and the role that an equalization payments scheme may have in this; this is left for future work.

**References**


Aragon, S., and Rud J., 2011, Natural resources and local communities: Evidence from a Peruvian goldmine, *mimeo.*

Barro, R., and Lee, J., 2010, A New Data Set of Education Attainment in the World, 1950-2010, NBER Working Paper No. 15902.

Bartik, J. T., 1985, Business Location Decisions in the United States: Estimates of the Effects of Unionization, Taxes, and Other Characteristics of States, Journal of Business and Economic Statistics, Vol. 3(1).

Boadway, R., 2006, Natural Resource Shocks and the Federal System: Boon and Curse?, Fiscal Federalism and the Future of Canada Conference Proceedings, Institute of Intergovernmental Relations.

Brennan, G., and Buchanan, J., 1980. The Power to Tax: Analytical Foundations of a Fiscal Constitution. Cambridge University Press, New York.

Brueckner, J. K., 2003, Strategic Interaction Among Governments: An Overview of Empirical Studies, International Regional Science Review, Vol. 26(2), pp. 175-188.

Brunnschweiler, C., and H., Bulte, 2008, The resource curse revisited: A tale of paradoxes and red herrings. Journal of Environmental Economics and Management, 55, 3, pp. 248-264 .

Bucovetsky, S., 1991, Asymmetric Tax Competition, Journal of Urban Economics, Vol. 30(2), pp. 167-181.

Cai, T., and Treisman, D., 2005, Does Competition for Capital Discipline Governments? Decentralization, Globalization, and Public Policy, American Economic Review, Vol. 95(3).

Caselli, F., Esquivel, G., and Lefort, F., 1996, Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics, Journal of Economic Growth, Vol. 1 (3), pp. 363-389.

Caselli, F. and Michaels, G., 2009, Do oil windfalls improve living standards? Evidence from Brazil. NBER Working Paper No. 15550.

Cecchetti, S. G., Mark, C. N., Sonora, R. J., 2002, Price Index Convergence Among United States Cities, International Economic Review, Vol. 43(4).
Coase, R., 1937, The nature of the firm, Economica, Volume 4, Issue 16, pp. 386-405.
Corden, W.M, 1984, Booming sector and Dutch disease economics: survey and consolidation, Oxford Economic Papers, Vol. 36, No. 3, pp. 359-380.
Corden, W.M., and J.P. Neary, 1982, Booming sector and de-industrialization in a small open economy, The Economic Journal 92, 825-848.
Culver, S. and D. Papell, 2006, Panel evidence of purchasing power parity using intranational and international data. International macroeconomics: Recent developments. Nova Scotia Publishers.
Ethier, W.J., 1985. International trade and labor migration. American Economic Review 75, 691–707.
Freedom House. 2010. Freedom in the World 2010: The Annual Survey of Political Rights and Civil Liberties. Available online at: http://www.freedomhouse.org/template.cfm?page=363&year=2006
Gylfason, T., 2001, Natural resources, education, and economic development, European Economic Review 45, 847-859.
Hines, J., 1997, Altered States: Taxes and the Location of Foreign Direct Investment in America, American Economic Review, Vol. 86(5), pp. 1076-1094.
Isham, J., Woolcock, M., Pritchett, L. and Busby, G., 2005, The varieties of rentier experience: How natural resource export structures affect the political economy of economic growth, The World Bank Economic Review, Vol. 2, No. 2, pp. 141-174.
Ismail, K., 2010, The structural manifestation of the 'Dutch Disease': The Case of Oil Exporting Countries, Working Paper 10/103, IMF, Washington D.C.
Kanbur, R., and Keen, M., 1993, Jeux Sans Frontieres: Tax Competition and Tax Coordination When Countries Differ in Size, American Economic Review, 83(4), pp.877-92.
Krugman, P., 1987, The narrow moving band, the Dutch Disease, and the competitive consequences of Mrs. Thatcher, Journal of Development Economics, Vol. 27 pp. 41-55.
Krugman, P., 1991, Increasing returns and economic geography, Journal of Political Economy, Vol. 99, no. 3.
La Porta, R., Lopez-de-Silanes, F., Shleifer, A., and Vishny, R., 1999, The Quality of Government, The Journal of Law, Economics, and Organization, 15 (1), pp. 222-279.
Li, S., Li, S., and Zhang, W., 2000, The Road to Capitalism: Competition and Institutional Change in China, Journal of Comparative Economics, Vol. 28(2), pp. 269-292.
Matsuyama K., 1992, Agricultural productivity, comparative advantage, and economic growth. Journal of Economic Theory, 58, 317-334.
McMahon, W.W., 1991, Geographical cost of living differences: An update. Journal of American Real Estate and Urban Economics Association 19: 426-450.
Mehlum, H., Moene, K., and Torvik, R., 2006, Institutions and the resource curse, The Economic Journal, 116, pp. 1-20
Michaels, G., 2011, The long term consequences of resource based specialization. The Economic Journal, Vol. 121(551), pp. 31-57.
Montinola, G., Yingyi Q., and Barry R. W., 1996, Federalism, Chinese Style: The Political Basis for Economic Success, World Politics, Vol. 48(1), pp.50-81.
Newman, J. R., Sullivan, H. D., 1988, Econometric analysis of business tax impacts on industrial location: what do we know and how do we know it?, Journal of Urban Economics, Vol. 23(2), pp. 215-234.
Papyrakis, E. and R. Gerlagh, 2004, The resource curse hypothesis and its transmission channels, Journal of Comparative Economics, 32, 181-193.
Papyrakis, E., and Gerlagh, R., 2007, Resource abundance and economic growth in the United States. European Economic Review 51, 1011-1039
Qian, Y., and Roland, G., 1998, Federalism and the Soft Budget Constraint, American

Economic Review, December, Vol. 88(5), pp.1143-62.
Ross, M., 2001, Does oil hinder democracy?, World Politics, Vol. 53, pp. 297–322.
Roos, M., 2006, Regional price levels in Germany. Applied Economics 38(13), 1553-1566.
Sachs, J.D. and A.M. Warner, 1997, Fundamental sources of long-run growth, Journal of African Economics, pp. 335-376.
Sachs, J.D. and A.M. Warner, 1999, The big push, natural resource booms and growth, Journal of Development Economics 59, 43-76.
Sachs, J.D. and A.M. Warner, 2001, Natural resources and economic development: The curse of natural resources, European Economic Review 45, 827-838.
Sala-i-Martin, X. and Subramanian, A., 2003, Addressing the natural resource curse: An illustration from Nigeria, NBER Working Paper No. 9804.
Slesnick, D.T., 2002, Prices and regional variation in welfare. Journal of Urban Economics 51: 446-468.
Van der ploeg, F., 2011, Natural Resource: Curse or Blessing?, Journal of Economic Literature, Vol. 49(2), pp. 366-420.
Van Wijnbergeb, S., 1984, The 'Dutch Disease': A Disease after all? The Economic Journal, Vol. 94 (373), pp. 41-55.
Wahba, J., 1998, The transmission of dutch disease and labour immigration, Journal of International Trade & Economic Development, Vol. 7, Issue 3, pp. 355-365.
Walden, M.L., 1998, Geographic variation in consumer prices: Implications for local price indices. Journal of Consumer Affairs 32: 204-226.
Williamson, G. J., Migration and Urbanization, Handbook of Development Economics, Vol. 1 pp. 425-465.
Wilson, D. J., 1991, Tax Competition With Interregional Differences in Factor Endowments, Regional Science and Urban Economics, Vol. 21(3), pp. 423-451.
Wilson, D. J., 1999, Theories of tax competition, National Tax Journal, Vol. 52, pp. 269-304.
Wooldridge, J.M., 2002, Econometric Analysis of Cross Section and Panel Data. MIT Press.
World Bank, 2010, World Development Indicators, International Bank for Reconstruction and Development/World Bank, Washington.
Zhang, x., L. Xing, S. Fan, and X. Luo, 2008, Resource abundance and regional development in China, Economics in Transition, 16, 1, pp. 7-29.
Zodrow, G., and Mieszkowski, Z., 1986, Pigou, tiebout, property taxation, and the Underprovision of local public goods, Journal of Urban Economics, 19, pp. 356-370.

**Appendix 1** – Description of Data and Samples

**(I) Intra Federal Sample (regressions 1-4)**

List of economies covered: Australia: New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, Northern Territory, Capital Territory. Belgium: Brussels, Flemish, Walloon. Brazil: Acre, Alagoas, Amapa, Amazonas, Bahia, Ceara, Distrito Federal, Espirito Santo, Goias, Maranhao, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Parana, Paraiba, Para, Pernambuco, Piaui, Rio Grande do Norte, Rio Grande do Sul, Rio de Janeiro, Rondonia, Roraima, Santa Catarina, Sergipe, Sao Paulo, Tocantins. Canada: Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Northwest Territories, Nunavut, Northwest Territories and Nunavut combined, Ontario, Prince Edward Island, Quebec, Saskatchewan, Yukon. Germany: Baden-Württemberg, Bayern, Berlin, Branden-burg, Bremen, Hamburg, Hessen, Mecklenburg-Vorpommern, Nieder-Sachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, Sachsen, Sachsen-Anhalt, Schleswig-Holstein, Thüringen. India: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chattisgarh, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Manipur, Meghalaya, Mizoram, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal. Malaysia: Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Pulau Pinang, Sabah, Sarawak, Selangor, Terengganu, WPKL. Russia: Republic of Adygea, Altai Republic, Amur Oblast, Arkhangelsk Oblast, Astrakhan Oblast, Republic of Bashkortostan, Belgorod Oblast, Bryansk Oblast, Republic of Buryat, Chelyabinsk Oblast, Chukotka Autonomous Okrug, Chuvash Republic, Republic of Dagestan, Republic of Ingushetia, Irkutsk Oblast, Ivanovo Oblast, Kabardino-Balkar Republic, Kaliningrad Oblast, Republic of Kalmykia, Kaluga Oblast, Kamchatka Krai, Karachay-Cherkess

Republic, Republic of Karelia, Kemerovo Oblast, Khabarovsk Krai, Republic of Khakassia, Kirov Oblast, Komi Republic, Kostroma Oblast, Krasnodar Krai, Krasnoyarsk Krai, Kurgan Oblast, Kursk Oblast, Leningrad Oblast, Lipetsk Oblast, Magadan Oblast, Mari El Republic, Republic of Mordovia, Moscow Oblast, Murmansk Oblast, Nizhni Novgorod Oblast, Novgorod Oblast, Novosibirsk Oblast, Omsk Oblast, Oryol Oblast, Orenburg Oblast, Republic of North Ossetia-Alania, Penza Oblast, Perm Krai, Primorsky Krai, Pskov Oblast, Rostov Oblast, Ryazan Oblast, Sakha Republic, Sakhalin Oblast, Samara Oblast, Saratov Oblast, Smolensk Oblast, Stavropol Krai, Sverdlovsk Oblast, Tambov Oblast, Republic of Tatarstan, Tomsk Oblast, Tula Oblast, Tuva Republic, Tver Oblast, Tyumen Oblast, Udmurt Republic, Ulyanovsk Oblast, Vladimir Oblast, Volgograd Oblast, Vologda Oblast, Voronezh Oblast, Yaroslavl Oblast. United Arab Emirates: Abu-Dhabi, Ajman, Amm Al-Qiwain, Dubai, Fujeira, Ras Al-Khaima, Sharjah. United States: Alaska, Alabama, Arkansas, Arizona, California, Colorado, Connecticut, District of Columbia, Delaware, Florida, Georgia, Hawaii, Indiana, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, Missouri, Mississippi, Montana, North Carolina, North Dakota, Nebraska, New Hampshire, New Jersey, New Mexico, Nevada, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Vermont, Washington, Wisconsin, West Virginia, Wyoming.

Data Sources and periods investigated:

Australia – Period investigated is 1990-2008. All data retrieved from the Australian Bureau of Statistics. Belgium – Period investigated is 1999-2008. All data retrieved from the Institute of National Accounts of Belgium. Brazil – Period investigated is 1995-2008. All data retrieved from the Statistical Institute of Brazil. Canada – Period investigated is 1984-2008 for the 10 provinces, and Yukon. Nunavut and Northwest Territories are sampled separately from 1999-2008, whereas from 1984-1999 they are considered a single territory (under the name 'Nunavut and Northwest Territories'). All data retrieved from Statistics Canada. Germany – Period investigated is 1991-2008 All data retrieved from the Federal Statistics Office of Germany. India – Period investigated is 1980-2008. All data retrieved from the Ministry of Statistics of India. Malaysia – Period investigated is 2004-2008. All data retrieved from the Department of Statistics of Malaysia. Russia – Period investigated is 2004-2008. All data retrieved from the Federal Statistics Service of Russia. United Arab Emirates – Period investigated is 2000-2008. All data retrieved from the Ministry of Economy of the United Arab Emirates. United States – Period investigated is 1977-2008. All data retrieved from the US Bureau of Economic Analysis.

Description of Variables: All variables are measured in initial year (for each time interval), unless stated otherwise. All data retrieved from the respective statistics bureau of each federation, unless stated otherwise. In the panel analyses, periods start at 1974 in five year intervals up to 2008 (included); to include all available observations, the first period of each federation is adjusted in case it is not available for the entire time interval (note this involves no more than two missing years, which is why a five year interval is adopted instead of a longer one which would necessarily carry a greater number of missing years). Adjustments are made to the initial income (to present comparable convergence effects), as described below. For example in the case of Germany data is available from 1991, so that in the corresponding time interval (1989-1993), data on initial income is adjusted for all federations with available data. Note that results do not change qualitatively (with marginal quantitative differences) in case observations are dropped so that no adjustments are required (i.e. in the above example, Germany's data prior to 1994 are dropped from the sample); however, we preferred exploiting the full set of data.

*Growth:* Average annual real per capita growth.

*Share of Primary Sector in GDP:* Share of primary (agriculture, fishing, hunting, forestry, and mining) output in GDP.

*Share of Mineral Sector in GDP:* Share of mineral (mining and quarrying) output in GDP.

*Land per capita:* Logarithm of land area (in square kilometres) per capita.

*Initial Income:* Logarithm of real per capita GDP (in constant 2000 US$ prices). In the cross-sectional versions (regression 4 and figure 1) and in periods with incomplete data in the panel cases (regressions 1-3), we adjust this measure as follows: for each region real per capita GDP is normalized by the corresponding real per capita GDP of the US (such that if the converted income measure is from 1990, then it is divided by the real per capita GDP of the US in 1990). This normalized measurement is used as initial income, and can be compared across federations and years.
*Education:* Share of the education sector in GDP.

*Institutional quality (federal level):* The Political Rights Index (Freedom House). The index is a number between one and seven, where one represents an economy with the strongest institutional quality and seven represents one with the worst.

*Investment:* Share of gross capital formation in GDP.

*Openness:* Net international migration rate.

*Population Growth:* Average annual population growth rate over the time interval.

*Institutional quality (federal-state level):* Share of public administration sector in GDP.

**(II) Cross Federal Sample (regressions 5-6)**

List of economies and periods covered: Australia (1990-2008), Belgium (1999-2008), Brazil (1995-2008), Canada (1984-2008), Germany (1990-2008), India (1980-2008), Malaysia (2005-2008), Russia (2004-2008), United Arab Emirates (2000-2008), United States (1977-2008).
Description of Variables: All variables are measured in initial year (for each time interval), unless stated otherwise. All data retrieved from the World Bank's World Development Indicators, unless stated otherwise.

*Growth:* Average annual real per capita growth.

*Share of Primary Sector in GDP:* Share of primary (agriculture, fishing, hunting, forestry, and mining) output in GDP.

*Share of Mineral Sector in GDP:* Share of mineral (mining and quarrying) output in GDP.

*Initial Income:* Logarithm of real per capita GDP (in constant 2000 US$ prices).

*Education:* Years of schooling for population aged over 15 (Barro and Lee 2010).

*Institutional quality:* The Political Rights Index (Freedom House). The index is a number between one and seven, where one represents an economy with the strongest Institutional quality and seven represents one with the worst.

*Investment:* Share of gross capital formation in GDP.

*Openness:* Share of total trade (exports and imports) in GDP.

*Population Growth:* Average annual population growth rate over the time interval.

**(III) Cross Country Sample (regressions 7-9)**

List of economies covered (period investigated: 1977-2008, for all economies): Algeria, Argentina, Australia, Austria, Bangladesh, Belize, Bolivia, Brazil, Cameroon, Canada, Chile, Colombia, Congo Republic, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Guatemala, Guyana, Honduras, China, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea Republic, Liberia, Malawi, Malaysia, Mali, Mauritius, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Niger, Norway, Pakistan, Panama, Peru, Philippines, Portugal, Saudi Arabia, Senegal, Singapore, Spain, Sri Lanka, Sweden, Switzerland, Syria, Thailand, Togo, Trinidad and Tobago, Tunisia, United Kingdom, United States, Uruguay, Venezuela, Zambia.

Description of Variables: All variables are measured in initial year, unless stated otherwise. All data retrieved from the World Bank's World Development Indicators, unless stated otherwise.

*Growth:* Average annual real per capita growth.

*Share of Primary Exports in GDP:* Share of primary (agriculture, fishing, hunting, forestry, and mining) exports in GDP.

*Share of Mineral Sector in GDP:* Share of mineral (mining and quarrying) output in GDP.

*Land per capita:* Logarithm of land area (in square kilometres) per capita.

*Initial Income:* Logarithm of real per capita GDP (in constant 2000 US$ prices).

*Education:* Years of schooling for population aged over 15 (Barro and Lee 2010).

*Institutional quality:* The Political Rights Index (Freedom House). The index is a number between one and seven, where one represents an economy with the strongest Institutional quality and seven represents one with the worst.

*Investment:* Share of gross capital formation in GDP.

*Openness:* Share of total trade (exports and imports) in GDP.

*Terms of Trade:* Change in the log of the external terms of trade between 1977 and 2008. The external term of trade is the ratio of a US dollar export price index to an import price index in similar units.

**<u>(IV) Intra US Sample</u> (regressions 10-29)**

Regressions 10-21 investigate the period of 1997-2006; regressions 22-29 investigate the period of 1977-2008.

<u>List of economies covered:</u> Alaska, Alabama, Arkansas, Arizona, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Hawaii, Indiana, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, Missouri, Mississippi, Montana, North Carolina, North Dakota, Nebraska, New Hampshire, New Jersey, New Mexico, Nevada, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Vermont, Washington, Wisconsin, West Virginia, Wyoming.

- In regressions 10-15 District of Columbia is not included in the sample.
- In regressions 16-21 District of Columbia, Montana, North Dakota, Nevada, South Dakota, and Wyoming are not included in the sample.

<u>Description of Variables:</u> All variables are measured in initial year (for each time interval) in constant 2000 US$ prices, unless stated otherwise. All data retrieved from the US Bureau of Economic Analysis, unless stated otherwise.

*FDI in Physical Capital:* Average per Capita Foreign Direct Investment in Physical Capital, 1997-2006.

*Business Tax Climate:* Average Business Tax Climate Index 2006-2011 (US Tax Foundation). The index is a number between one and ten, where one represents an economy with the least competitive tax environment and ten represents one with the most competitive tax environment.

*Corporate Tax Climate:* Average Corporate Tax Climate Index 2006-2011 (US Tax Foundation). This represents one of the components of the abovementioned *Business Tax Climate*, and thus is measured similarly.

*Expenditure on Infrastructure:* Average per capita expenditure on infrastructure, 1997-2006 (US Census Bureau).

*Expenditure on Public Goods:* Average per capita expenditure on public goods, 1997-2006 (US Census Bureau).

*Share of Primary Sector in GDP:* Share of primary (agriculture, fishing, hunting, forestry, and mining) output in GDP (measured in 1977 in regressions 10-21).

*Share of Mineral Sector in GDP:* Share of mineral (mining and quarrying) output in GDP (measured in 1977 in regressions 10-21).

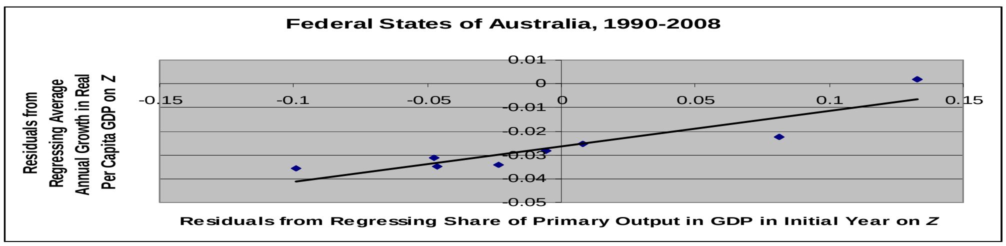
*Initial Income:* Logarithm of real per capita GDP (measured in 1977 in regressions 10-21).

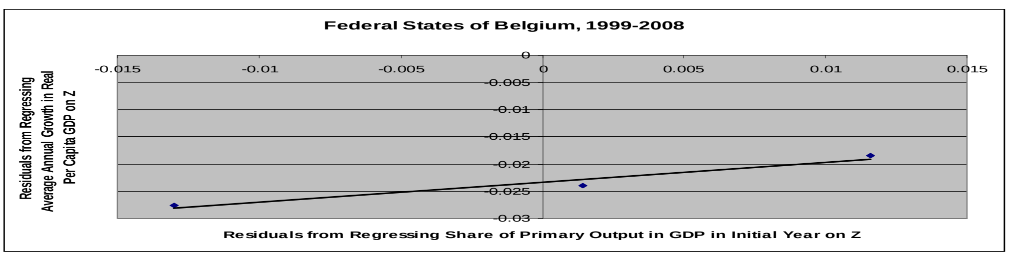
*Landlocked:* Dummy variable for landlocked states.

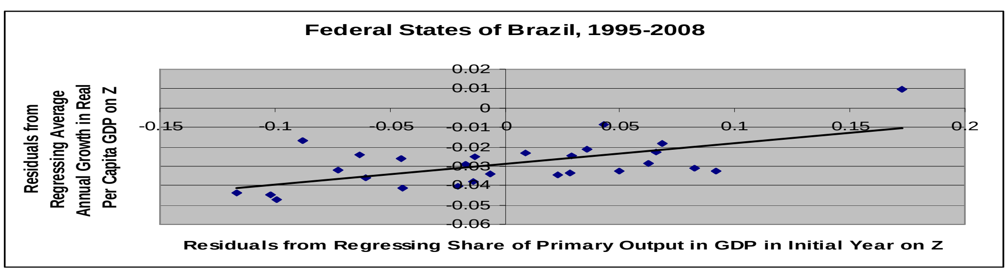
*Growth of Manufacturing Sector:* Average annual growth of the manufacturing (measured as share out of total GDP or share of its employment out of total employment).

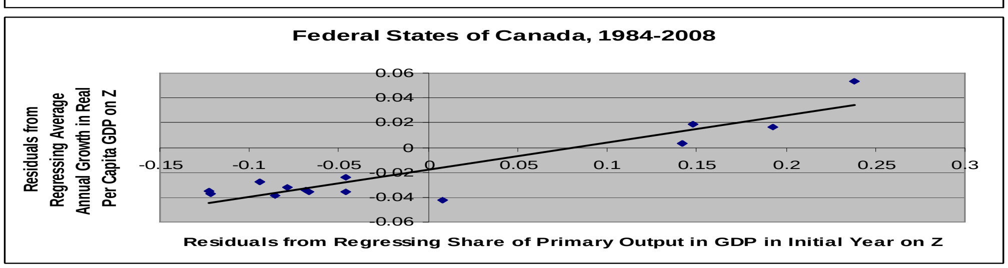
*Initial Level of Manufacturing Sector:* The level of the manufacturing sector (measured as share out of total GDP or share of its employment out of total employment) at the beginning of the period (in each time interval).

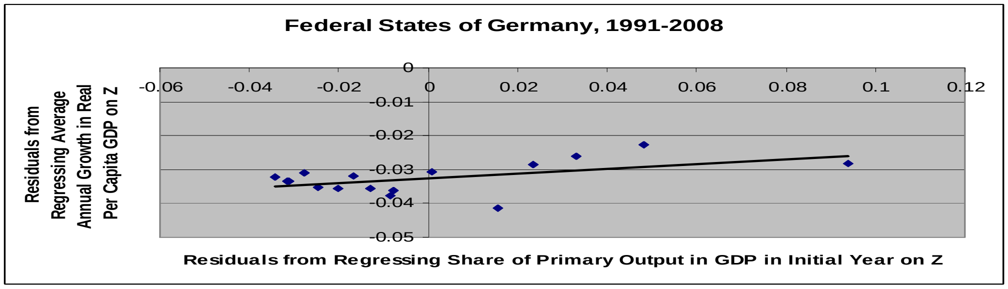
**Appendix 2** – Resources and Growth for the Separate Federations




Federal States of Germany, 1991-2008
Residuals from Regressing Average Annual Growth in Real Per Capita GDP on Z
Residuals from Regressing Share of Primary Output in GDP in Initial Year on Z
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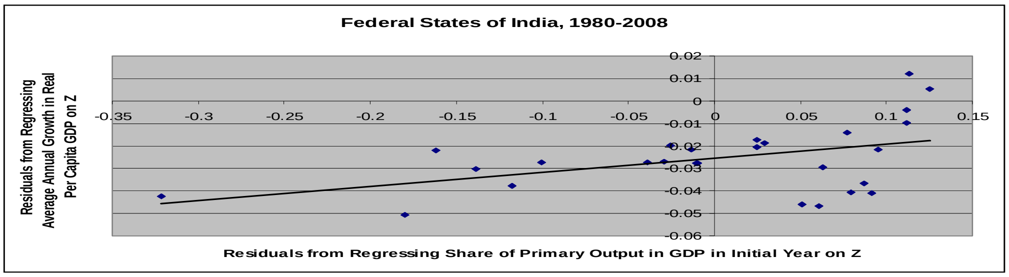
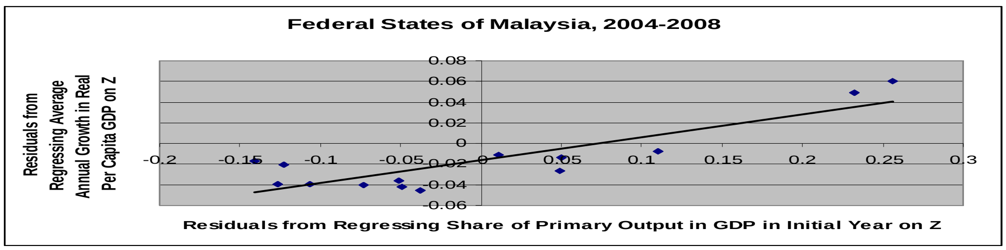
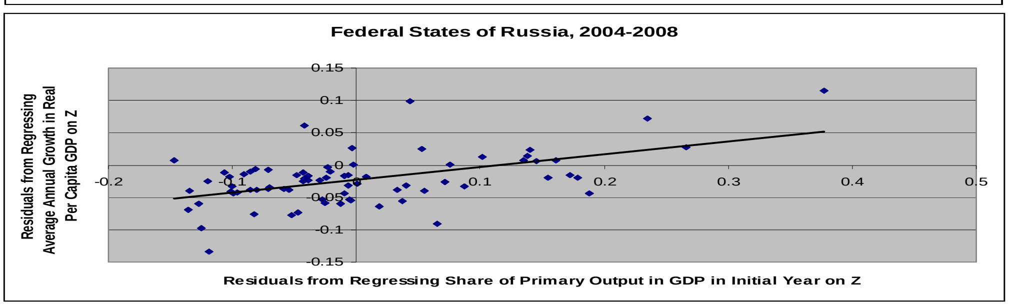
0 -0.01 -0.02 -0.03 -0.04 -0.05


Federal States of India, 1980-2008
Residuals from Regressing Average Annual Growth in Real Per Capita GDP on Z
Residuals from Regressing Share of Primary Output in GDP in Initial Year on Z
-0.35 -0.3 -0.25 -0.2 -0.15 -0.1 -0.05 0 0.05 0.1 0.15
0.02 0.01 0 -0.01 -0.02 -0.03 -0.04 -0.05 -0.06


Federal States of Malaysia, 2004-2008
Residuals from Regressing Average Annual Growth in Real Per Capita GDP on Z
Residuals from Regressing Share of Primary Output in GDP in Initial Year on Z
-0.2 -0.15 -0.1 -0.05 0 0.05 0.1 0.15 0.2 0.25 0.3
0.08 0.06 0.04 0.02 0 -0.02 -0.04 -0.06


Federal States of Russia, 2004-2008
Residuals from Regressing Average Annual Growth in Real Per Capita GDP on Z
Residuals from Regressing Share of Primary Output in GDP in Initial Year on Z
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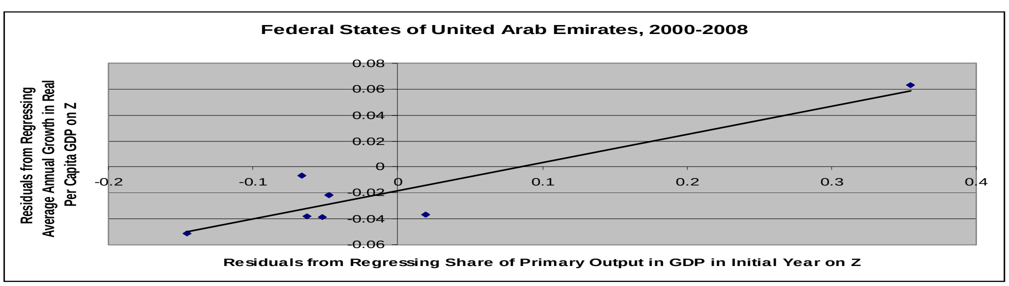
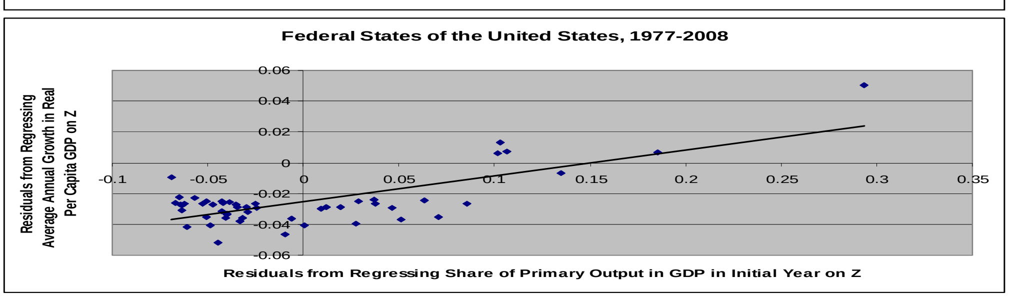
0.15 0.1 0.05 0 -0.05 -0.1 -0.15


Federal States of United Arab Emirates, 2000-2008
Residuals from Regressing Average Annual Growth in Real Per Capita GDP on Z
Residuals from Regressing Share of Primary Output in GDP in Initial Year on Z
-0.2 -0.1 0 0.1 0.2 0.3 0.4
0.08 0.06 0.04 0.02 0 -0.02 -0.04 -0.06


Federal States of the United States, 1977-2008
Residuals from Regressing Average Annual Growth in Real Per Capita GDP on Z
Residuals from Regressing Share of Primary Output in GDP in Initial Year on Z
-0.1 -0.05 0 0.05 0.1 0.15 0.2 0.25 0.3 0.35
0.06 0.04 0.02 0 -0.02 -0.04 -0.06

**Appendix 3** – <u>The Symmetric Case</u>

Under the benchmark case, there exists a unique and symmetric Nash Equilibrium outcome, in which $K_1 = K_2, T_1 = T_2, L_1 = L_2, G_1 = G_2$.

Proof

The symmetric outcome, where the regions choose an equal tax rate (and so other indicators are equal as well) follows equations (10) and (11), and so it is a viable option. Interestingly, it is also a unique option – In a first scenario, let us assume that $T_1 > T_2$ and $G_2 \geq G_1$. By (11) we get that $k_2 > k_1$, which means that $x_2 > x_1$; since the level of public good in region 2 is at least as high as that in region 1, then labor will move to region 2 down to at least where $k_1 = k_2$; once that occurs (11) does not hold. Thus, rate of return of capital and the regional wage rates cannot be equal at the same time, so that equilibrium does not arise. What will happen, in fact, is that capital and labor will continue to move to region 2 so that in the limit region 1 vanishes.[68] In a second scenario, let us assume that $T_1 > T_2$ yet also $G_1 > G_2$. The higher tax rate in region 1 means that there would be more capital in region 2, making its tax base larger than that of region 1. Taking the first scenario into account, region 2 knows that once its public good level is at least as high as that of region 1 it will make region 1 vanish in the limit; thus, given its higher tax base region 2 would be able to raise its tax to a point where it is still below that of region 1 yet it equalizes the levels of public goods between the regions (causing that which was described in the previous scenario, where region 1 vanishes in the limit). The two above scenarios work both ways (meaning, not only when region 1 presents higher taxes, but also vice versa), which means that no region can allow itself to present lower taxes than its neighbour or otherwise it will vanish in the limit. Thus, the only viable option is when tax rates are equal and a completely symmetric outcome arises. □

**Appendix 4** – <u>The Threshold Cost of Factor-Mobility</u>

Let us now assume that capital does not flow freely between regions, yet is still completely mobile within them.[69] Specifically, there is an exogenously-determined per-unit cost, which may be regarded as a transport cost along Krugman's (1991) lines or transaction costs following Coase (1937), of $\tau$ for moving capital from one region to the other. This cost, through which we model mobility levels, is higher the farther apart the two regions are (meaning higher distance presents higher $\tau$) and is paid by firms in the region to which capital is exported to firms of the region from which capital is imported. Let us denote the total amount of capital in each region $(K_i)$ as follows:[70]

$$K_i = K_i^{\sim} + K^{im} - K^{ex} \tag{24}$$

Given positive trade, having two regions means one would be a net importer, while the other a net exporter, of capital; thus, we define $K^T$ such that $K^T = K^{im} = K^{ex}$. Further, we define β as the per-unit cost firms in the net importer region pay on all of the capital employed in that region, and γ as the per-unit sum firms in the net exporter region receive on all of the capital employed in that region; therefore, we have:

$$\beta = \frac{\tau K^T}{K_i} \tag{25}$$

[68] Nonetheless, note that the concept of the limit in this context represents the long term, and is only mentioned here under purely theoretical terms.

[69] As was mentioned at an earlier point, a cost is put on mobility of capital specifically, due to the result of proposition 3; this is largely driven by having a capital intensive resource.

[70] Where superscript '~' denotes the initial level of capital in the region, superscript 'im' denotes the level of capital imported to the region, and superscript 'ex' denotes the level of capital exported from the region.

$$\gamma = \frac{\tau K^T}{K_i} \quad (26)$$

This means that the rate of return on capital changes in each of the regions, so that in the net importer region it is:

$$f_{k_i} = \rho + \beta + T_i \quad (27)$$

While in the net exporter region it is:

$$f_{k_i} = \rho - \gamma + T_i \quad (28)$$

Since this is a one period model, the resource sector (once introduced) will only be attracting capital up to when capital (in that sector) earns its marginal product; furthermore, since capital still moves freely within regions it will only attract capital from the manufacturing sector of region 2 (since it is less costly to do so), so that in effect the movement of capital occurs only between the two manufacturing sectors. That said, let us assume we are at the stage where the resource sector is introduced, so that the economy is in a symmetric equilibrium, as was shown initially in the benchmark case. As before, each region solves its maximization problem, and we get $T_1 > 0$ and $T_2{}^r = T_2{}^m = 0$. This means that in case no capital moves between regions then the following capital mobility condition holds:

$$f_{k_1} - T_1 = f_{k_2{}^m} = h_{k_2{}^r} \quad (29)$$

Condition (29) implies that rate of return on capital is higher in region 2 (due to the low taxes) as was seen in the previous section, so that capital will be imported there. Once that happens, the capital mobility condition changes to:

$$f_{k_1} - T_1 + \gamma_2 = f_{k_2{}^m} - \beta_1 = h_{k_2{}^r} \quad (30)$$

At this point it is possible to derive the threshold cost $(\tau^*)$ above which the *Resource Movement Effect* applies as in proposition 3, while below which it is mitigated as in propositions 1 and 2 since an *Alberta Effect* is triggered. From condition (30) we see that $\tau^*$ is determined by the following condition: $\gamma_2 + \beta_1 = T_1$, since at that point rates of return are equated between the two manufacturing sectors. Therefore, by substituting equations (25), (26), and (13) to the above condition, and solving for $\tau^*$, we get:

$$\tau^* = \frac{K_2{}^m (K_1)^2 f_{k_1 k_1}}{K^T (K_2{}^m + K_1) U_{G_1}} (1 - L_1 m(x_1, G_1)) > 0 \quad (31)$$

As can be seen $\tau^*$ is endogenous to the amount of relocated capital; however, since both the elasticity of substitution between private consumption and the public good and the technology employed in the manufacturing sectors are not explicitly specified it can not be determined how movement of capital between the regions affects the threshold cost. Nevertheless, it is possible to make the following inference:[71]

**Proposition 4.** If $\tau > \tau^*$ then Dutch Disease symptoms apply (through the Resource Movement Effect) so that (on per capita terms) the manufacturing sector of region 2 contracts compared to that of region 1 (such that $k_1 > k_2{}^m$); otherwise, if $\tau \leq \tau^*$ then Dutch Disease symptoms are mitigated (by triggering an Alberta Effect) so that (on per capita terms) the manufacturing sector of region 2 maintains its size or expands compared to that of region 1 (such that $k_1 \leq k_2{}^m$).

---

[71] Since the initial empirical observations were made on per capita basis, the comparisons to follow (between the two manufacturing sectors) are also made on per capita terms.

Proof

When $\tau > \tau^*$ then regional rates of return dictate that it is not efficient for region 1 to export capital to the manufacturing sector of region 2 (established by condition (30)); on the other hand, for the same reason region 1 will not import from region 2 (established by condition (29)). Thus, once the resource sector is introduced in region 2 it attracts capital from the manufacturing sector of the same region, causing for its contraction; this contraction remains in equilibrium since no capital is drawn from region 1 (so that $k_1 > k_2{}^m$). However – in case $\tau \leq \tau^*$ then rates of return on capital will be higher in the manufacturing sector of region 2 due to the low taxes (seen through condition (30)), and capital will flow there from region 1 (so that an *Alberta Effect* is triggered) and its contraction (caused by the introduction of the resource sector) is mitigated and potentially even reversed, such that $k_1 \leq k_2{}^m$ in equilibrium.

□

**Appendix 5** – Proofs for Propositions 1 – 3

Proof of Proposition 1

The updated free capital mobility condition would be:

$$f_{k_2{}^m} = h_{k_2{}^r} = f_{k_1} - T_1$$

This by itself means that in equilibrium capital per capita as well as capital in absolute level will be higher in the manufacturing sector of region 2. When it comes to labor, in case $z \geq T_1 K_1$ then labor will move to region 2 so that $L_2 > L_1$ (since both wage levels and public good levels would be higher in region 2); otherwise, due to the same reasons outlined in the proof in appendix 3, by having a larger tax base than that of region 1, region 2 would be able to at least equalize its public good provision level to that of region 1, so that even in that case labor will be drawn to region 2 and we would get $L_2 > L_1$. Thus, once taxes decrease to zero in region 2 we get the suggested equilibrium outcome, where the manufacturing sector is larger in region 2.

□

Proof of Proposition 2

The proof for proposition 1 remains applicable for this case, with the slight modification of having immobile labor, which maintains the regional population sizes equal, so that the suggested outcome is reached.

□

Proof of Proposition 3

Once the resource sector is introduced, it attracts capital only from the manufacturing sector of the same region (since factors are only immobile across regions), so that the suggested result is reached.

□

TABLE 1. *Resource Abundance and Growth: Within Federations, Across Federations, and Across Countries.*

| | Intra-Federal Analyses, 1977-2008 | | | | Cross-Federal Analyses (Panel, 1977-2008, five year intervals) | | Cross-Country Analyses: Sachs and Warner Extended (Cross section, 1977-2008) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Panel, five year intervals | | | Cross Section | | | | | |
| Dependent variable: Average annual real per capita growth | (1) | (2) | (3) | (4) (TSLS, Second Stage Result) | (5) | (6) | (7) | (8) | (9) (TSLS, Second Stage Result) |
| Share of Primary Sector in GDP | 0.25*** | | 0.34*** | 0.07*** | -0.11*** | | | | |
| | (0.03) | | (0.05) | (0.02) | (0.02) | | | | |
| Share of Mineral Sector in GDP | | 0.18*** | | | | -0.12*** | | -0.07*** | |
| | | (0.04) | | | | (0.03) | | (0.02) | |
| Share of Primary Exports in GDP | | | | | | | -0.06*** | | -0.2*** |
| | | | | | | | (0.02) | | (0.06) |
| Federal Share of Primary Sector in Federal GDP | | | -0.12*** | | | | | | |
| | | | (0.04) | | | | | | |
| Initial Income | -0.01** | -0.03*** | -0.01** | -0.01*** | -0.01*** | -0.01*** | -0.003** | -0.003** | -0.002 |
| | (0.006) | (0.01) | (0.006) | (0.005) | (0.003) | (0.003) | (0.001) | (0.002) | (0.003) |
| Education | 0.16* | 0.15 | 0.14 | 0.16* | 0.005 | 0.005** | 0.002** | 0.002** | 0.001 |
| | (0.09) | (0.1) | (0.09) | (0.09) | (0.002) | (0.002) | (0.001) | (0.001) | (0.001) |
| Rule of Law (country level) | -0.01*** | -0.01*** | -0.02*** | | -0.01*** | -0.01*** | -0.001 | -0.001 | 0.0006 |
| | (0.002) | (0.002) | (0.004) | | (0.003) | (0.002) | (0.001) | (0.001) | (0.001) |
| Investment | 0.08** | 0.08* | 0.07* | 0.08* | 0.07 | 0.06 | 0.03* | 0.04** | 0.04* |
| | (0.04) | (0.04) | (0.04) | (0.04) | (0.07) | (0.07) | (0.02) | (0.02) | (0.02) |
| Openness | 0.15 | 0.15 | 0.19 | -0.19 | 0.03* | 0.02 | 0.01* | 0.008 | 0.03** |
| | (0.16) | (0.17) | (0.16) | (0.46) | (0.01) | (0.01) | (0.006) | (0.005) | (0.01) |
| Population Growth | -0.01*** | -0.01** | -0.01*** | -0.04 | 0.009 | -0.002 | | | |
| | (0.003) | (0.004) | (0.004) | (0.12) | (0.02) | (0.02) | | | |
| Rule of Law x Resource Share | 0.05*** | 0.03*** | 0.07*** | | -0.01 | -0.006 | | | |
| | (0.005) | (0.005) | (0.01) | | (0.01) | (0.02) | | | |
| Institutional Quality (federal-state level) | 0.005 | 0.01 | -0.0002 | 0.06 | | | | | |
| | (0.02) | (0.03) | (0.02) | (0.05) | | | | | |
| Terms of Trade | | | | | | | 0.001* | 0.002* | 0.003** |
| | | | | | | | (0.001) | (0.001) | (0.001) |
| Adjusted R-squared | 04857 | 0.4638 | 0.4947 | 0.6457 | 0.7427 | 0.7498 | 0.3945 | 0.4082 | n/a |
| Observations | 598 | 598 | 598 | 234 | 35 | 35 | 76 | 76 | 76 |
| Federal-State Fixed Effects | Yes | Yes | Yes | No | No | No | No | No | No |
| Federal Fixed Effects | No | No | No | Yes | Yes | Yes | No | No | No |
| Time Fixed Effects | Yes | Yes | Yes | No | Yes | Yes | No | No | No |
| Number of economies included | 234 | 234 | 234 | 234 | 10 | 10 | 76 | 76 | 76 |

| FIRST STAGE RESULTS | | |
|---|---|---|
| Dependent variable: Share of Primary Output (regression 4) or Exports (regression 9) in GDP | (4) | (9) |
| Land per capita | 0.09*** | 0.03*** |
| | (0.004) | (0.01) |
| Adjusted R-squared | 0.8966 | 0.4417 |
| Observations | 234 | 76 |
| F-Statistic | 179.27 | 10.91 |

Standard errors are robust and appear in parentheses for independent variables. In regressions (1)-(3) standard errors are clustered by federal-states and federations; in regressions (4)-(6) they are clustered by federations. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance, respectively. In the first stage results only the coefficient on land per capita are reported, yet regressions include all variables reported in the second stage results. All regressions include an intercept. Regressions 1-3 include dummies for Malaysia and Russia and exclude federal-state dummies for these federations. For description and sources of variables, as well as a list of economies included in each regression, see appendix 1.

TABLE 2. Validating the '*Alberta Effect*' for US states, 1997-2006 (Cross Section)

PANEL A: Resources and the Business Environment

| | Average *Business Tax Climate*, 2006-2011 | | Average per capita expenditure on infrastructure, 1997-2006 | | Average per capita expenditure on public goods, 1997-2006 | |
|---|---|---|---|---|---|---|
| Dependent variable: Business Environment | (10) | (11) | (12) | (13) | (14) | (15) |
| Share of Primary Sector in GDP, 1977 | 6.64*** | | 12923.18** | | 13041.42** | |
| | (1.14) | | (5548.1) | | (5187.51) | |
| Share of Mineral Sector in GDP, 1977 | | 6.22*** | | 14683.7** | | 14387.74*** |
| | | (1.16) | | (5598.91) | | (5340.81) |
| Adjusted R-squared | 0.3638 | 0.3209 | 0.3938 | 0.4559 | 0.409 | 0.4536 |
| Observations | 50 | 50 | 50 | 50 | 50 | 50 |

PANEL B: Capital Inflow, Resources, and the Business Environment

| | Total Effect of Resources | | Direct Effect of Resources | | Robustness Tests | |
|---|---|---|---|---|---|---|
| Dependent variable: Average Per Capita Foreign Direct Investment in Physical Capital, 1997-2006 | (16) | (17) | (18) | (19) | (20) | (21) |
| Share of Primary Sector in GDP, 1977 | 92154.1*** | | 37023.4*** | | 39377.42*** | 47779.8*** |
| | (34697.2) | | (10608.53) | | (12600.5) | (12968.99) |
| Share of Mineral Sector in GDP, 1977 | | 99645.91*** | | 41606.6*** | | |
| | | (33219.11) | | | | |
| Average *Business Tax Climate*, 2006-2011 | | | 2135.54*** | 1987.42*** | 1669.01** | |
| | | | (539.1) | (581.2) | (638.34) | |
| Average *Corporate Tax Climate*, 2006-2011 | | | | | | 1122.5** |
| | | | | | | (482.14) |
| Average per capita expenditure on infrastructure, 1997-2006 | | | 2.94*** | 2.78*** | | 2.87*** |
| | | | (0.38) | (0.43) | | (0.46) |
| Average per capita expenditure on public goods, 1997-2006 | | | | | 2.88*** | |
| | | | | | (0.51) | |
| Adjusted R-squared | 0.6305 | 0.6918 | 0.8831 | 0.8843 | 0.8445 | 0.8544 |
| Observations | 45 | 45 | 45 | 45 | 45 | 45 |

Standard errors are robust and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance, respectively. All regressions include the logarithm of per capita GDP in 1997, a dummy variable for landlocked states, and an intercept. Due to data limitations the District of Columbia is not included in the sample. Additional states for which the BEA does not report data on FDI in physical capital (limiting the sample in regressions 16 to 21): Montana, North Dakota, Nevada, South Dakota, and Wyoming. For description and sources of variables, as well as a list of economies included in each regression, see appendix 1.

TABLE 3. *Resource Abundance and Growth of the Manufacturing Sector across US States*

| | Panel, five year intervals, 1977-2008 | | | | Panel, 10 year intervals, 1977-2008 | | Panel, 15 year intervals, 1977-2008 | |
|---|---|---|---|---|---|---|---|---|
| | Share of Manufacturing Sector in GDP | | Share of Manufacturing Employment in Total Employment | | Share of Manufacturing Sector in GDP | Share of Manufacturing Employment in Total Employment | Share of Manufacturing Sector in GDP | Share of Manufacturing Employment in Total Employment |
| Dependent variable: Average annual growth of manufacturing sector | (22) | (23) | (24) | (25) | (26) | (27) | (28) | (29) |
| Share of Primary Sector in GDP | 0.21***<br>(0.03) | | 0.06***<br>(0.02) | | 0.13***<br>(0.03) | 0.05***<br>(0.02)s | 0.19***<br>(0.05) | 0.06***<br>(0.01) |
| Share of Mineral Sector in GDP | | 0.19***<br>(0.03) | | 0.03**<br>(0.01) | | | | |
| Initial Income | -0.17***<br>(0.05) | -0.17***<br>(0.05) | -0.05***<br>(0.01) | -0.05***<br>(0.01) | -0.04<br>(0.04) | -0.02<br>(0.01) | -0.04***<br>(0.01) | -0.02***<br>(0.009) |
| Initial Level of Manufacturing Sector | -0.22<br>(0.17) | -0.16<br>(0.19) | 0.2<br>(0.13) | 0.29**<br>(0.14) | 0.02<br>(0.09) | 0.1<br>(0.09) | -0.18**<br>(0.09) | 0.1<br>(0.12) |
| Adjusted R-squared | 0.2204 | 0.1843 | 0.1867 | 0.1388 | 0.2496 | 0.1903 | 0.4398 | 0.298 |
| Observations | 306 | 306 | 306 | 306 | 153 | 153 | 102 | 102 |
| State Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of economies included | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |

Standard errors are robust, clustered by states, and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance, respectively. In the first stage results only the coefficient on land per capita is reported, yet regressions include all variables reported in the second stage results. All regressions include an intercept. For description and sources of variables, as well as a list of economies included in each regression, see appendix 1.