Dutch disease, factor mobility costs, and the 'Alberta Effect' – The case of Federations

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Abstract

Do reduced costs of factor mobility mitigate 'Dutch Disease' symptoms, to the extent that they are reversed? The case of federations provides an indication they do. By investigating 'Resource Curse' effects in all federations with available state-level data, it is observed that within federations resource abundance is a blessing, while between federations it is a curse, similar to results observed in previous cross-country studies. A theory is then presented in an attempt to explain the opposite results of the intra and cross federal (and previous cross-country) analyses. It is argued that the reduced costs of factor mobility within federations trigger 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– which in turn mitigates, and even 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 (the 'Alberta Effect') through which this mitigation, and possible reversion, process occurs. The paper concludes with empirical evidence for the main implications of the model, taking the United States as a case study.

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

JEL *classification*: C21, 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; more recently Wahba (1998) and Vermeulen (2010) do so formally. These papers, however, point 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 a novel mechanism (the 'Alberta Effect') through which this mitigation, and possible reversion, process occurs.

In an influential set of papers, Sachs and Warner (1995, 1997, 1999, 2001) presented the so-called growth curse of natural resources, showing a counterintuitive negative relationship between resource abundance and economic growth.[2] Albeit facing criticism (Brunnschweiler and Bulte 2007), several additional empirical studies further confirmed this finding;[3] 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 famous 19th century California gold rush,[4] show that resource abundance can be a blessing at the local level; recent studies support this story as well.[5]

We start with a further investigation of this insight by looking into the case of federations, which is particularly interesting in our context as it lets us focus specifically on the effects of

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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 mobility costs on these effects, as they assume capital is immobile and labor supply is fixed. This paper aims to demonstrate that considering mobility costs may be critical to the extent that results change dramatically.

[2] It should nevertheless be noted that concerns over specialization on natural resource exports have been raised previously by Raol Prebisch and Hans Singer more than half a century ago; however, these were not discussed in a similar context to the recent 'Resource Curse' literature.

[3] See Auty, 2001, Gylfason 2000, 2001, Gylfason et al. 1999, Lane and Tornell 1996, Leite and Weidmann 1999, Papyrakis and Gerlagh 2004, Rodriquez and Sachs 1999.

[4] 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 gold rushes, such as 19th century gold rushes in Canada, South Africa, and Australia, present similar stories

[5] Aragon and Rud (2009) show how a Peruvian goldmine increase welfare at the localized level, Michaels (2007) shows how resource abundance levers development in the long run at the county level (investigating regions in southern United States), and lastly, Michaels and Caselli (2009) show how 'Dutch Disease' does not apply in Brazilian municipalities.

reduced mobility costs on 'Dutch Disease' symptoms. On one hand federal-states are comparable to sovereign countries in terms of determination of fiscal policy, resource ownership, availability of data, variability in institutional quality, and price level differentials,[6] yet on the other hand since it is less costly to relocate physical capital or labor within a federation than across countries they present an environment with reduced mobility costs. Thus, this makes it convenient to compare an intra-federal analysis to a cross-federal one (as well as to previous cross-country ones, in the spirit of Sachs and Warner), and attribute any differences in outcomes to differences in the costs of factor mobility. That being said, we consider all federal-states that have available data,[7] and undertake both cross-sectional and panel analyses to re-examine Sachs and Warner's hypothesis within and between federations.[8] Results show that resource abundance is a blessing at the federal-state level, yet similar to the previous cross-country studies remains a curse at the federal level. These opposite, yet significant, results are robust to holding standard growth-explaining variables constant, as well as to different resource abundance measures and estimation methods.

By extending Zodrow and Mieszkowski's (1986) basic capital tax competition model,[9] a theory is presented in an attempt to explain these different outcomes. Motivated by the case of Alberta and focused on the 'resource movement effect',[10] the model analyzes a simple two-region capital tax competition, and shows that with sufficiently low mobility costs a resource boom triggers an 'Alberta Effect'[11] –where resource abundant states 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) theory, transmits them to factor exporting regions) so that eventually 'Resource Blessing' effects are observed within

[6] See Section 3 for an elaborated discussion.

[7] Namely, 247 federal states of: Australia, Belgium, Brazil, Canada, Germany, India, Malaysia, Russia, United Arab Emirates, and the United States.

[8] Papyrakis and Gerlagh (2007) checked for 'Resource Curse' effects within the United States and found they apply. However, they investigated the period of 1986-2000 and dropped Delaware and the District of Columbia from their sample. Albeit testing a similar hypothesis, in this paper the general sample is not limited to the United States (includes nine additional federations), and in addition the specific sample on the United States includes Delaware and the District of Columbia and investigates an extended period (1977-2008). As will be evident, results change as a result.

[9] The model considers an endowment asymmetry framework, which has not been analyzed previously in tax competition models. This will be discussed in greater detail in Section 4.

[10] See Sections 3 and 4 for elaborated discussions.

[11] This mechanism was initially presented by Helliwell (1981). Corden (1984) further discussed it in the context of the 'Dutch Disease', describing how Alberta successfully attracted factors of production by following it; he referred to it as the 'Alberta Effect'. In this paper we adopt this definition, and argue its mechanics are amplified and emphasized in an environment with reduced mobility costs (such as federations, or other localized settings with sufficient fiscal autonomy).

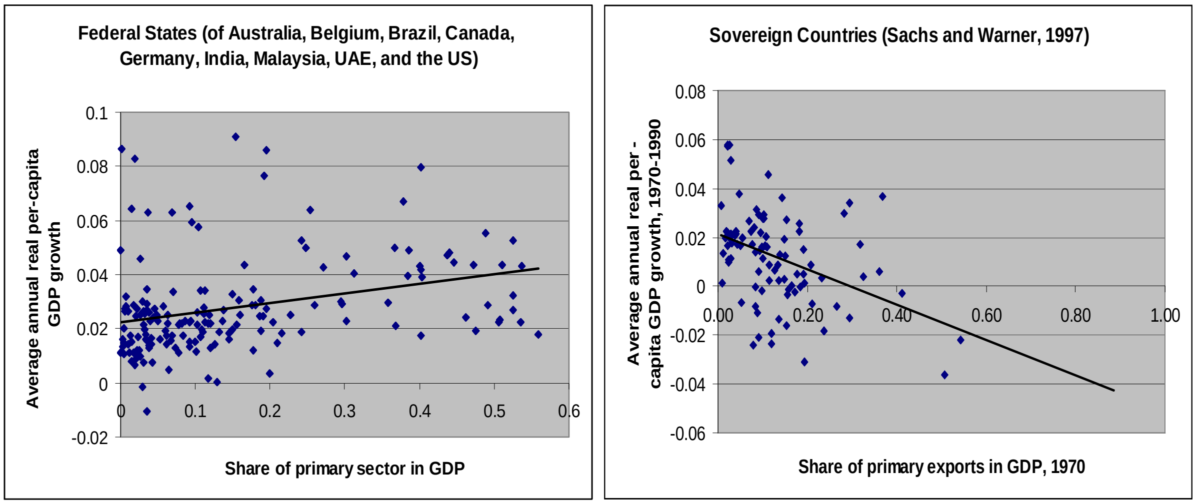
federations. In effect, similar to sovereign countries resource abundant federal-states suffer from 'Dutch Disease' symptoms; however, in contrast to sovereign countries they operate in an environment with reduced mobility costs which enables them to initiate an 'Alberta Effect' and consequently attract the necessary capital so that their manufacturing sector does not contract, and even expand. The model shows there exists a threshold mobility level below which an 'Alberta Effect' is undertaken and above which it is not. In case it is assumed that within federations mobility costs are below that threshold while between countries they are above it, then this model provides an explanation for the difference in outcomes presented initially.

We validate the suggested mechanism through an intra-federal analysis of the United States. The empirical investigation shows that resource abundant states present a more competitive business environment (in the form of more competitive taxes, greater investment in infrastructure, and greater public good provision), attract more physical capital as a result, and contrary to predictions of 'Dutch Disease' theory have their manufacturing sector grow faster in terms of both GDP and labor shares – as the model predicts.

The paper is structured as follows – Section 2 goes through the initial empirical exercise, investigating whether 'Resource Curse' occurs within and between federations. Section 3 discusses the results presented in Section 2 and explains the motivation for the model. Section 4 presents the model and goes through the theoretical analysis. Section 5 presents empirical evidence for the main implications of the model, through the case of the United States. Section 6 concludes.

2. INVESTIGATING 'RESOURCE CURSE' EFFECTS WITHIN AND BETWEEN FEDERATIONS

Out of the 25 recognized federations the minimum required state-level data is available for the following – Australia, Belgium, Brazil, Canada, Germany, India, Malaysia, Russia, United Arab Emirates, and United States. The sample used for each of the federations is the maximum available; complete description of the data, sources, and periods investigated for each federation, is presented in Appendix 1. As a first take we plot in Figure 1 the average annual real per capita growth versus resource abundance at initial period – of federal-states (left figure) and of sovereign countries (right figure).[12] Additional graphs, for each of the federations separately as well as for the similar, though non-federal, cases of China, Spain and Europe, are presented in Appendix 2.[13]



G = 0.022234 + 0.035561 R R-squared = 0.0962 , N=173 , P<0.00	G = 0.021297 - 0.0722219 R R-squared = 0.1656 , N=95 , p<0.00

FIGURE 1. *Resource-abundance and economic growth in federal states and sovereign countries*

This preliminary comparison implies that 'Resource Curse' mechanics affect federal-states and sovereign countries differently, to the extent that opposite outcomes are observed; as will be evident, these opposite outcomes also apply when the comparison is made against the cross-federal sample (instead of the one presented in the right figure) and in all cases are robust to holding standard growth-explaining variables constant, as well as to various resource abundance measures and different estimation techniques.

In their work on the 'Resource Curse', Sachs and Warner (1997) applied a simple cross-section methodology, regressing average annual real per capita growth on the logarithm of initial income, and a vector of standard growth-explaining controls that also includes a proxy for resource-share (all measured at initial year), to identify the phenomenon. We start by following their methodology, applied to the case of federations; this enables us, at least initially, to test our

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[12] The right figure is the original graph presented by Sachs and Warner (1997). As for the left figure, Russian states do not appear in the graph; results do not change in case they are included, but variability increases, making the graph less applicable. Also, the focus in this section is mainly on the comparison between the intra and cross federal scenarios, yet this initial comparison to sovereign countries in-general and to the previous seminal results of Sachs and Warner (1997) provides some intuition to what lies ahead.

[13] As was mentioned earlier, the case of federations is not restrictive; different regional settings (confederations like Europe or federations-de-facto like China and Spain) may be of interest to the given hypothesis. Nonetheless, these will not be part of the complete federations-sample, since the focus is on comparing federal-states with other federal-states of equivalent status. Nonetheless, note that results do not change qualitatively in case Europe, China, and Spain are included in the general sample.

results against theirs. Therefore, two samples are used; the first is a cross-section of 247 federal-states, and the second is a five-year-average panel of the 10 federations to which the federal-states correspond;[14] each sample covers the exact same time period for each corresponding federation. We test the following model, for each of these two samples:[15]

$$G^{it} = \alpha_0 + \alpha_1 \ln(Y_0^{\ it}) + \alpha_2 R^{it} + \alpha_3 Z^{it} + \alpha_4 Australia + ... + \alpha_{13} US + \alpha_{14} L + \chi^t + \varepsilon^{it} \qquad (1)$$

Let us keep in mind that throughout the following analyses our coefficient of interest is α_2; mostly, we are interested in realizing its direction and significance.

Starting with the intra-federal sample, time effects are dropped due to the cross-sectional estimation. As for the explanatory variables – the resource-share proxy is the share of primary sector (agriculture, forestry, fishing, and mining) in GDP;[16] the proxy for human capital is the share of the education-industry in GDP, that for investment is the share of gross capital formation in GDP, for openness it is the net international migration rate, and finally for institutional quality it is the share of the public administration sector in GDP. Note that the resource-share, human capital, investment, and openness proxies have been commonly used in previous studies;[17] the latter one (namely, institutional quality) requires further elaboration. At the country level there are several objective institutional quality indices that incorporate various aspects of the complex nature of this measure, which thus make them potentially more accurate; however, no such objective measure exists uniformly for all federal-states, whereas using each separately would significantly cut down the sample. The size of the public administration industry in GDP gives a unified objective measure across federal-states and between federations, and despite its imperfect

[14] Panel estimation is used for the cross-federal sample due to the small sample size (10 federations); estimating a cross-sectional version of this sample do not change the direction of results, yet significance drops due to the limited sample size.

[15] In terms of notation: 'G' is annualized average real per capita GDP growth,[15] 'Y_0' is per capita real GDP in the initial year, 'R' is the proxy for resource-abundance in the initial year, 'Z' is a vector of control variables that includes human capital, investment, institutional quality and openness all measured in initial year (to avoid possible endogeneity), 'Australia' through 'US' are dummy-variables for each of the 10 federations, L is a dummy for landlocked states, and χ is a time effect. Note that since the period investigated for each federation is different, initial income is normalized for all federal-states; see Appendix 1 for treatment of initial income.

[16] Sachs and Warner's initial resource-share proxy involved share of primary exports in GDP; doing the same for the intra-federal sample would decrease the sample significantly (due to limitation in data availability on exports at the state-level); therefore, primary production share in GDP is used, similar to the proxy adopted by Papyrakis and Gerlagh (2007). Note that at the cross-country level the two proxies are highly correlated (0.74636).

[17] See Sachs and Warner (1997) and Papayrakis and Gerlagh (2004), among others. More specifically, we realize the openness proxy 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 estimate this using the net international migration rate; following their justification, open economies tend be more welcoming to immigrants (Ethier 1985, Rodrik 1997).

measure of institutional quality it was found to be a key determining factor of it.[18] One concern is that federal districts, which are considered independent federal-subjects yet host most of the federal administrative units,[19] 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.[20] Results for this case are presented in Table 1; we start with having only the resource-share proxy in 'Z', and gradually increase it in the regressions that follow. We observe expected results on initial income, human capital, institutional quality, investment, and openness; while the first is constantly negative (providing evidence for convergence), the remaining ones are constantly positive, with varying significances, following results of previous growth studies.[21] More importantly, however, our coefficient of interest (α_2) is positive and significant in all regressions, indicating 'Resource Blessing' effects at the federal-state level.

For the cross-federal case, the resource-share proxy remains to be the share of primary sector in GDP; proxies for the remaining variables are as follows – for human capital: the average years of total schooling for population aged 15 and over (Barro and Lee 2010), for investment: share of gross investment in GDP (World Bank Development Indicators 2010), for openness: share of international trade in GDP (World Bank Development Indicators 2010), for institutional quality: Political Rights Index (Freedom House 2008);[22] all of which considered standard measures of these proxies in the growth literature. Results appear in Table 2. Again, we start with only having the resource-share proxy in 'Z', and then gradually increase it thereafter. As in the intra-federal scenario, here also we observe significant convergence ($\alpha_1 < 0$), and positive effects, in varying significances, of human capital, institutional quality, investment, and openness. However, in contrast to the intra-federal analysis, in this case our coefficient of interest (α_2) is rather constantly negative and significant, indicating 'Resource Curse' effects at the federal level.

The intra-federal 'Resource Blessing' result also stands in contrast to those of previous cross-country studies of this phenomenon such as Sachs and Warner (1997), Gylfason (2001), and Papyrakis and Gerlagh (2004), who investigate 'Resource Curse' effects in sovereign countries.

[18] See La Porta et al. 1999, Annett 2001.
[19] These include District of Columbia (US), Federal District (Brazil), and the Capital Territory (Australia),
[20] Results with these federal district dropped are available from the author.
[21] For cross-country settings see Barro (1991) and Mankiw et al. (1992), among others. For intra-federal settings see Papyrakis and Gerlagh (2007).

Despite undertaking a similar methodology, these previous seminal studies look into earlier periods than the one investigated in the intra-federal case. Given the sharp increase in oil prices during the past decade, one concern is that their results may change when tested under the period of the intra-federal sample, implying that the intra-federal 'Resource Blessing' effects may be period-specific.[23] To alleviate this concern, we extend Sachs and Warner's (1997b) exercise to the period tested under the intra-federal sample (1977-2008).[24] Results appear in Table 3. Columns one through five present Sachs and Warner's (1997b) original results, [25] tested for the period 1965-1990, while columns six through ten present those for the extended period of 1977-2008. Results remain similar in sign and significance in both cases;[26] specifically, the coefficient of the resource-share proxy remains negative and significant in the period of 1977-2008, as it is in the earlier one. Thus, this outcome, together with the cross-federal one (which also investigates the period of 1977-2008), shows that the intra-federal result is, in fact, not period-specific; it remains to be opposite to the cross-federal and cross-country ones even when comparable periods are tested.

Another concern is that the intra-federal results may suffer from a 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 show this is not case, we divide the intra-federal sample to two groups; the first (Group 1) includes federal-states of the federations with stronger institutions while the second

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[22] 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 right on a scale of one to seven, with seven representing the most free and one representing the least free.

[23] This concern remains valid despite showing that 'Resource Curse' effects do occur in the cross-federal case (that covers the same period as the intra-federal one), because these seminal results of the previous cross-country studies tend to be used as benchmark, and are often being compared to in other studies in this literature.

[24] An identical methodology is followed; additionally, variables are identical to the ones used in the cross-federal case. This is slightly different than Sachs and Warner's (1997) data, yet compares better with the initial intra and cross federal results. Note that a slight methodological difference between this and the cross as well as the intra federal analyses, is the exclusion of regional dummies; however, on one hand results do not change (qualitatively) when these are included, and on the other hand previous results on the intra and cross federal samples do not change (qualitatively) if these dummies are excluded from their analyses, making them equivalent to the current one. Results of either are not presented; however, they are available from the author.

[25] For variables used and sources, see Sachs and Warner (1997b). Variable names, as they appear in Sachs and Warner (1997b), are as follows – resource-share proxy: 'SXPR', human capital: 'SEC80', investment: 'LINV7089', openness: 'OPEN6590', and institutional quality: 'ICRGE80'.

[26] In both periods there is evidence for convergence, as well as for positive impact of human capital, investment, openness, and institutional quality on average annual real per capita growth.

(Group 2) includes those of the federations with weaker ones.[27] We follow the analysis made on the entire sample, and check for 'Resource Curse' effects in each of the divided sub-samples separately. Results appear in Table 4. In both groups the coefficient on the resource-share proxy is positive; however, it is insignificant in Group 1, yet highly significant in Group 2 – in all regressions. This implies that 'Resource Blessing' effects amplify as the federal institutional quality deteriorates; thus, if anything there is a downward sample selection bias, so that the true estimators are actually more positive than they already are.[28] An intuitive explanation for this relates to federal equalization schemes, which are possibly more effective in regimes with stronger institutions. This, in turn, 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.

Finally, following the criticism introduced by Brunnschweiler and Bulte (2007) and Van der Ploeg (2010) the intra-federal results may suffer from both omitted variable bias, as well as enodgeneity bias (as the resource-share proxy may in fact be endogenous to the growth or income levels). To address the former we follow Caselli et al. (1996) and undertake an intra-federal analysis of equation (1) through panel estimation, with fixed effects.[29] To address the latter we consider two additional resource-share measures – the first being mineral output as share of GDP,[30] and the second land per capita.[31] We argue that both serve as exogenous resource-share

[27] Thus, the first group includes federal-states of Australia, Belgium, Canada, Germany, and the United States, and the second group includes federal-states of Brazil, India, Malaysia, Russia, and the United Arab Emirates (division was based on the institutional quality measure used in the cross-federal sample).

[28] An alternative, and perhaps more formal, way for demonstrating the downward sample selection bias would have been to add to the complete sample a measure of federal institutional quality, and an interaction term of it with the resource-share proxy; however, given the federal dummies, such an exercise can not be undertaken. Nonetheless, we have taken a similar exercise where a new general measure, which is an interaction of the federal and state institutional qualities, was added together with its interaction with the resource-share proxy, and results (which are available from the author) confirm the above finding, as the coefficient on the interaction term is positive and significant, indicating that intra-federal 'Resource Blessing' effects increase as federal institutional quality decreases.

[29] The panel sample is identical to the cross-sectional one in terms of the variables used, yet extends it in terms of sample size as it divides the same time period (1977-2008) to sub-periods of five years. In addition, following Caselli et al. (1996), all variables in this sample are expressed as deviations from period means to account for time specific effects, and a first-difference is taken, to cancel the state-specific effects. Lastly, all variables are measured in initial year and are assumed to be pre-determined (to minimize endogeneity effects).

[30] This includes the share of oil, natural gas, and mining out of GDP. For sources (for both additional measures) for the intra-federal sample, see Appendix 1; for the cross-country sample all data was retrieved from the World Bank Development Indicators.

[31] Following Sachs and Warner's (1997) methodology, we use the logarithm of this measure in the estimations.

measures that can, therefore, replace the current proxy or otherwise instrument it. The first is such since on one hand mineral production is often lead by multinational firms that bring their own knowledge and technology, making it independent of a country's growth or income levels, while on the other hand it correlates highly with primary production, by definition. The second is such because on one hand during the period investigated the area of land is already pre-determined,[32] making it exogenous, while on the other hand it correlates highly with primary output since higher land per capita provides greater potential for primary output. Table 5 presents results for the intra-federal panel estimation; in columns one through five primary output is used as the resource-share proxy, whereas in columns six through nine the two additional measures are used either as proxies in lieu of primary output or as instruments for it. In all regressions coefficients on the non-resource variables are kept similar to the previous ones in terms of sign, magnitude, and significance; more importantly, the main result of intra-federal 'Resource Blessing' effects remain to hold under high significance, with the exception of when land per capita is used (significance drops, yet sign is kept).[33] In the relevant regressions, results of first-stage estimations indicate that both measures are well associated with primary output. To further confirm previous results using the two additional measures, we test them using the previous cross-sectional intra-federal and cross-country samples.[34] Results appear in Table 6; in columns one through four the two additional resource-share measures are tested on the cross-sectional intra-federal sample, whereas in columns five through eight they are tested on the cross-country sample, covering the period of 1977-2008. Results show that the intra-federal 'Resource Blessing' and cross-country 'Resource Curse' effects remain to hold using either of these measures (directly as a proxy in the regression or as an instrument for primary output),[35] so that the opposite outcome of the two cases is maintained even when tested under these two additional measures. Once again, for the relevant regressions, first-stage estimations indicate strong association between the two measures and primary output.

[32] In addition, we measure population size in initial period, assuming it to be pre-determined.

[33] This, at best, implies for 'Resource Blessing' effects when land per capita is used; however, more importantly it provides no evidence for 'Resource Curse' ones.

[34] In the cross-federal sample results hold in sign, yet significance drops, possibly due to the small sample size; thus, since the relevant comparison in this exercise is between federal-states and sovereign countries, we compare results to the cross-country sample given its sufficient size.

[35] For the case of land per capita, significance drops in the intra-federal sample; however, this can still be contrasted with the cross-country scenario, where the 'Resource Curse' effects remain significant.

3. DISCUSSION

The results of the previous section indicate that at the 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 mobility costs, which in turn affect the magnitude and direction of 'Dutch Disease' symptoms. Nonetheless, although federal-states and sovereign countries are comparable in many respects, there could be additional key differences between intra and cross federal environments, besides that in mobility costs, which could potentially account for the opposite results; we consider two key differences through which we emphasize why the focus should indeed be on mobility costs.

Firstly, an intra-federal environment has less variability in institutional quality compared to a cross-federal one. This relative homogeneity could potentially account for the opposite result, as a viable conjecture could be that such an environment is in fact independent of what has been found to be a key determinant of the 'Resource Curse' in the cross-country studies – variability in institutional quality (Mehlum et al 2006). However, we argue that despite this homogeneity, the intra-federal environment presents sufficient heterogeneity in institutional quality so that in terms of generating 'Resource Curse' effects it is of comparable concern to that observed in the cross-federal (or country) scenario. Indeed, several studies point at the significant variability in institutional quality and its increase with resource abundance, at the regional level.[36] Let us further illustrate this point through the case of the United States, which makes a relevant example given its relative homogenous intra-federal environment. Papyrakis and Gerlagh (2007) provide evidence for an occurrence of a 'Resource Curse' within the United States and find that corruption is a viable transmission channel of it. This implies that despite the homogenous environment, variability in corruption level within the United States is sufficiently high to make it a relevant transmission channel. To make a stronger argument, let us slightly extend their empirical analysis. Thus, we test equation (1) using Papyrakis and Gerlagh (2007) data set.[37] Results appear in Table 7. In columns one and two we have the resource-share and corruption proxies included; results indicate 'Resource Curse' effects and a negative impact of corruption. In column three we follow Mehlum et al. (2006) and add an interaction term of resource-share with corruption; the coefficient

[36] See Bobonis (2008), Desai et al. (2003), Naritomi et al. (2007), Michaels and Caselli (2009), Monteiro and Ferraz (2009), and Papyrakis and Gerlagh (2007).

[37] Refer to Papyrakis and Gerlagh (2007) for complete description of variables, and sources. Also, despite not presenting results (due to irrelevancy) note that the effect of the interaction term remains to hold even when the other variables in their dataset are also included in the regressions, albeit with varying significance.

on the interaction term is negative and significant while those on the resource-share and corruption proxies become insignificant. This indicates that similar to previous cross-country findings, corruption level can be regarded as a generating source for the 'Resource Curse', even within the relatively homogenous United States.

Secondly, as opposed to cross-federal settings an intra-federal one presents a unified monetary system. This difference may imply that the 'spending effect' of the 'Dutch Disease', 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;[38] additional studies show these prices converge more slowly at the regional level than at the country level.[39] This means that, if anything, the 'spending effect' at the federal-state level should be at least as large as it is in sovereign countries, despite the homogenous monetary systems. Indeed, Raveh and Papyrakis (2011) show that the spending effect is quite substantial at the provincial level in Canada, as resource booms increase provincial inflation, which in turn decrease provincial exports; Zhang et al. (2008) provide similar evidence for regions in China, albeit without showing the effect on the tradable sectors.

Therefore, our focus is specifically on the difference in factor 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 triggers an 'Alberta Effect' that potentially overturns the accompanying 'Dutch Disease' 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,[40] which significantly contributes to it having one of the highest investment per capita and immigration levels in Canada for the past several decades.[41] These attracted factors prevent the manufacturing and other growth-enhancing sectors from contracting so that ‘Dutch Disease’ and de-industrialization processes are mitigated

[38] See McMahon (1991), Slesnick (2002), and Walden (1998).
[39] See Cecchetti et al. (2002), Culver and Papell (2006), and Roos (2006).
[40] For instance, Alberta presents no provincial retail sales, capital, payroll, or machinery and equipment taxes.
[41] This aggressive factor competition triggered by the fiscal advantage provided by the resource-rents and the successful factor attraction process that follows forms the basis for the term ‘Alberta Effect’.

and even reversed;[42] this, in turn, leads to 'Resource Blessing' effects.[43] Nonetheless, exploiting 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 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 that present reduced mobility costs),[44] 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, presents a first attempt at connecting between the costs of factor mobility and the mitigation process of 'Dutch Disease' symptoms through the 'Alberta Effect'.

4. THE MODEL

In this section we introduce the model and theoretical analysis, in three subsections; the first presents the benchmark (symmetric) setup, the second considers a resource-boom through an introduction of a resource sector, and the third adds factor mobility costs to the analysis. The main objective is to present the suggested mechanism through the simplest framework. Thus, as will be outlined in-detail 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); however, 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,[45] it has not been considered previously under an endowment asymmetry

[42] Indeed, Alberta's manufacturing sector grew by 50% in the period of 1999-2009 -being well above the growth of Alberta's total economy- contrary to common 'Dutch Disease' predictions.

[43] Alberta's real per capita growth rates have been amongst the highest in Canada, for the past 20 years.

[44] An indication for this is given by the United States Department of Labor reports (in its publication: "Extended Mass Layoffs in the First Quarter of 2007"), which mentions that most mass job relocations are from one U.S state to another, rather than to an overseas location.

[45] See Newman and Sullivan (1988) for a survey; specifically, Bartik (1985) finds that a ten percent decrease in corporate tax increase the number of new plants by to two to three percent, which is quite substantial. Hines (1997) presents a similar finding for FDI. Other research showed that tax competition over production factors is a viable mechanism at the regional level (see Brueckner 2003, for a survey).

framework,[46] as opposed to the case of infrastructure competition under an endowment asymmetry environment 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.[47] 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.[48]

Thirdly, as will be evident in the second subsection, 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);[49] 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 mobility,[50] and thus making the entire story evolve around capital rather than labor (unlike Wahba (1998) or Vermeulen (2010)). In addition, this aligns better with previous studies showing that labor is attracted to urbanized and agglomerative areas.[51] Since resources tend to locate in non-agglomerative and remote areas, we argue that any potential factor attraction process should indeed emphasize capital over labor.[52]

Fourthly, the analysis focuses specifically on the 'resource movement effect' and abstracts from considering any 'spending effects'. As was argued in the previous section, the 'spending effect' has similar impacts at local and non-local levels, due to the similar levels of price

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[46] Bucovetsky (1991), Kanbur and Keen (1993), and Wilson (1991) presented models of asymmetric tax competition; however, the asymmetry was in terms of different population sizes rather than endowment shocks, as it is in this model.
[47] See Qian and Roland (1998), and Montinola, Qian, and Weingast (1995).
[48] See Cai and Treisman (2005) for the case of Russia, and Li et al. (2000) for that of China. Also, statements on the institutional quality of each were based on the Political Rights Index of Freedom House (2008).
[49] See De Soysa 2000, 2002, Fearon 2005, Fearon and Laitin 2003, Isham et al. 2002, Leite and Weidmann 1999, Ross 2001,2003, and Sala-i-Martin and Subramanian 2003
[50] This will be realized through the analytical analysis in the following section.
[51] See Williamson (1988) for a survey.
[52] 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.

differentials in each.[53] This leaves us with the 'resource movement effect' as the potential source of difference between the intra and cross federal cases. 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 accumulation and mobility. Our model extends his work by allowing for that and considering the regional fiscal advantage that resource abundance provides; our model shows the addition of these features (termed the 'Alberta Effect') reverses his main result.[54]

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; conversely, 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; however, the critical point 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. We address this in two ways. Firstly, as outlined in the second subsection, the resource boom is initiated once the economy is in a symmetric equilibrium, which means that convergence is in fact held constant and thus accounted for. Secondly, the main results of the previous section are re-examined using per capita income,[55] instead of growth rates. Results appear in Table 8. The main insights, which under this modification can now be better compared to the results of the model, hold in similar significance. Columns one and two look into the intra-federal case (using the cross-sectional and panel samples, respectively), column three investigates the cross-federal setting, and the last one considers the cross-country scenario (for the period of 1977-2008). Through the direction and significance of the coefficient of the resource-share proxy, we see the contrast between the intra-federal and the

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[53] This is especially so when the focus is on capital movement, rather than labor (as in our model). Immigration may affect the 'spending effect' as was described by Corden (1984), yet an inflow of physical capital is not expected to affect demand or prices, making it less relevant for 'spending effect' analysis.

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

[55] Equation (1) is retested using real per capita GDP (expressed in US$) instead of growth in the LHS. This is tested on the same samples used previously; namely, the intra-federal (cross section and panel), cross-federal, and cross-country (for 1977-2008) samples.

cross federal and country scenarios is maintained, so that 'Resource Blessing' effects are observed in the former, while 'Resource Curse' ones are observed in the two latter ones.[56]

4.1 Benchmark Setting

Let us consider the benchmark setting of the model, under the framework of the basic capital tax competition model of Zodrow and Mieszkowski (1986), in its simplest form. There exists an economy with two symmetric regions, each having a manufacturing sector.[57] 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 $L_1 + L_2 = N$);[58] labor market is inelastic so that each resident is employed and provides one unit of labor. Thus, we have:

$$Y_i = F(K_i, L_i) = X_i + G_i \tag{2}$$

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: $K^* / N = k^*$). For starters, 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:[59]

$$G_i = T_i K_i \tag{3}$$

The after-tax rate of return on capital is ρ; although determined endogenously, ρ is taken as given by each region. Following that, the pre-tax rate of return on capital would be $\rho + T_i$. 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:[60]

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[56] Despite presenting results with all variables in 'Z', the main insights remain to hold in case variables are gradually added to 'Z', as in Tables 1 and 2; in addition, despite using primary share of GDP as the resource-share proxy in all regressions, results remain to hold when this proxy is instrumented by either mineral share of GDP or land per capita (results available from the author).

[57] We take the simplifying assumption of having a closed economy; analyzing an open one neither changes results nor adds further insights.

[58] Note that throughout the paper '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.

[59] 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, rather than a tax one.

[60] Profit of a representative firm in either of the regions is: $\pi_i = L_i(f(k_i) - (\rho + T_i)k_i - w_i)$ Therefore, profit would be maximized at: $d\pi_i / dk_i = 0$.

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

Also, the free entry condition yields:[61]

$$w_i = f(k_i) - f_{k_i} k_i \tag{5}$$

Residents of this economy have identical preferences, represented by a strictly quasi-concave utility function, U(X,G), with the following properties: $U_X, U_G > 0, U_{XX}, U_{GG} < 0, U_{XG} > 0;$[62] 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:

$$x_i = f(k_i) - (\rho + T_i)k_i + \rho k^* \tag{6}$$

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, one-period 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, based on which labor is allocated across the economy. 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 equation (4) with respect to k_i and T_i, we get:

$$\frac{dk_i}{dT_i} = \frac{1}{f_{k_i k_i}} < 0 \tag{7}$$

By equation (3), we get:

$$\frac{dG_i}{dT_i} = L_i k_i + T_i L_i \frac{dk_i}{dT_i} \tag{8}$$

Also, by differentiating equation (6) with respect to T_i and substituting equation (7), we get:

$$\frac{dx_i}{dT_i} = -k_i \tag{9}$$

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

[61] The free entry condition imposes $\pi = 0$, for all firms in the nation.

[62] In effect, making X and G normal goods with diminishing returns. In addition, we assume marginal utilities of X and G go to infinity as each approaches zero, or otherwise go to zero as each approaches infinity.

region and the resident.[63] Therefore, in its simplest form the problem of each of the regions would be expressed as follows:[64]

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

Let us denote U_{G_i}/U_{X_i} by $m(x_i, G_i)$; thus, we get:[65]

$$\frac{dx_i}{dT_i} + m(x_i, G_i)\frac{dG_i}{dT_i} = 0 \qquad (10)$$

Substituting equations (8) and (9) to equation (10) and rearranging, we get:[66]

$$L_i m(x_i, G_i) = \frac{1}{1 + \frac{T_i}{k_i}\frac{dk_i}{dT_i}} > 1 \qquad (11)$$

In equilibrium, the following capital mobility condition must hold:[67]

$$f_{k_1} - T_1 = f_{k_2} - T_2 \qquad (12)$$

Therefore, in equilibrium equations (11) and (12) must hold, for each of the regions.

Proposition 1. *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. See Appendix 3.

Thus, we see that under the basic setting where the two regions are completely symmetric, resources will be allocated equally across the economy, and the manufacturing sectors will be of equal size.

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[63] 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; thus, the standard assumption of a benevolent government (or otherwise one that wishes to extend its reign by maximizing the welfare of its residents) is taken.

[64] Note that given the assumptions made on the utility function, as well as based on the setting of the problem, there would be an interior solution to the given problem, in each of the regions, such that $T_i, k_i, G_i, x_i > 0$. Therefore, corner solutions are not considered in this case.

[65] This is derived by totally differentiating $U(x_i, G_i)$ with respect to x_i and G_i.

[66] The following result replicates that which was derived by Zodrow and Mieszkowski (1986). It can be given standard *Modified Samuelson Condition* (Batina 1990) or *Marginal Cost of Public Funds* (Browning 1976) interpretations, showing how non-cooperative behavior leads to under-provision of public goods.

4.2 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.[68] Initially, 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.[69] 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.[70] We assume that at least some of the resource rents accrue to the regional government. Indeed, this depends on the level of fiscal decentralization. In case it is positive (having regional-governments means it is, especially in the context of federal-states) the region will have at least some fiscal benefit from the resource.[71] In addition, 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:

$$G_2 = T_2{}^m K_2{}^m + T_2{}^r K_2{}^r + z \qquad (13)$$

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)), so that:

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67 Capital will place where its marginal product is higher, until it is equated across regions.

68 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.

69 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).

70 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, where it does not matter for the results yet simplifies the analysis.

71 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.

$$Y_2 = X_2 + G_2 = F(K_2{}^m, L_2) + H(K_2{}^r, Q) \tag{14}$$

The resource is equally owned by residents of region 2 (so that: $q^* = Q / L_2$) and it provides an exogenously-determined rate of return of α. Therefore, the budget constraint of a representative resident in region 2 would be:

$$x_2 = f(k_2{}^m) - f_{k_2{}^m} k_2{}^m - z / L_2 + \rho k^* + \alpha q^* \tag{15}$$

Once again, the regions engage in a capital tax competition. Note that region 1 behaves according to the analysis presented previously (since nothing changed there basically); therefore, let us see how the situation changes in region 2, as its problem is analyzed as follows:[72]

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

Substituting equations (15) and (13) to the given problem, we get the following first order conditions:

$$U_{X_2} = U_{G_2} L_2 \tag{16}$$

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

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

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 (8) and (9), only with the corresponding notation. Thus, if we substitute these to the first order conditions and solve, we get the following:

$$T_2{}^r = T_2{}^m = 0 \tag{19}$$

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

[72] As is implied by the expression of the problem, preferences of region 2's residents stay as before (over private consumption and public goods).

region 1 remains positive.[73] This emphasizes the fiscal advantage the resource gives to the region in which it was found.

Proposition 2. *When factors of production are completely mobile the Nash Equilibrium outcome dictates having* $k_2^m > k_1, K_2^m > K_1, L_2 > L_1, G_1 = T_1K_1, G_2 = z,$ *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 3.

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 3. *When capital is mobile and labor is immobile the Nash Equilibrium outcome dictates having* $k_2^m > k_1, K_2^m > K_1, L_2 = L_1, G_1 = T_1K_{1,} G_2 = z,$ *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 3.

Let us now 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 4. *When factors are completely immobile between regions (yet are mobile within them) the Nash Equilibrium outcome dictates having* $k_1 > k_2^m, K_1 > K_2^m, L_2 = L_1, G_1 = T_1K_{1,} G_2 = z,$ *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 3.

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[73] 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 thus the usual ‘Dutch Disease’ result is derived in the sense that the manufacturing sector of the resource abundant region contracts.[74] The opposite results of the two extreme cases provide some intuition for the mechanics that 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 now attract the ‘missing’ factors so that it maintains its size, or even grows. The opposite results of the two extreme cases (in conjunction with the insight of Proposition 3) show that there exists a threshold of capital mobility-level above which the manufacturing sector of the resource abundant region contracts, while below which it does not (or even expands), by triggering an ‘Alberta Effect’. Let us derive that threshold level to better understand the difference observed initially between the intra and cross federal cases, and to better realize the mitigating role of factor mobility.

4.3 The Threshold Cost of Factor-Mobility

Let us now assume that capital does not flow freely between regions, yet is still completely mobile within them.[75] 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 τ for moving capital from one region to the other. This cost is higher the farther apart the two regions are (meaning higher distance presents higher τ) 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:[76]

$$K_i = K_i^* + K^{im} - K^{ex} \tag{20}$$

Given positive trade, having two regions means one would be a net importer, while the other a net exporter, of capital. I define β as the per-unit cost firms in the net importer region pay on

[74] To further emphasize how labor mobility does not affect the outcome in this case, in case labor is completely mobile in Proposition 4’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.

[75] 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.

[76] 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.

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:[77]

$$\beta_j = \frac{\tau K^{im}}{K_i} \tag{21}$$

$$\gamma_v = \frac{\tau K^{ex}}{K_i} \tag{22}$$

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

$$f_{k_i} = \rho + \beta + T_i \tag{23}$$

While in the net exporter region it is:

$$f_{k_i} = \rho - \gamma + T_i \tag{24}$$

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:

$$f_{k_1} - T_1 = f_{k_2{}^m} = h_{k_2{}^r} \tag{25}$$

Condition (25) 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:

$$f_{k_1} - T_1 + \gamma_2 = f_{k_2{}^m} - \beta_1 = h_{k_2{}^r} \tag{26}$$

At this point it is possible to derive the threshold cost (τ^*) above which the 'resource movement effect' applies (as in Proposition 4), while below which it is mitigated (as in Propositions 2 and 3), as an 'Alberta Effect' is triggered. From condition (26) we see that τ^* is determined by the

[77] Subscript 'j' refers to the region to which payments are made. Subscript 'v' refers to the region from which

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 (21), (22), and (11) to the above condition, and solving for τ^*, we get:

$$\tau^* = \frac{K_2{}^m (K_1)^2 f_{k_1 k_1}}{K^{im} (K_2{}^m + K_1) U_{G_1}} (1 - L_1 m(x_1, G_1)) > 0 \tag{27}$$

As can be seen τ^* 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:[78]

Proposition 5. *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 $\tau \le \tau^*$ 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 $k_1 \le k_2{}^m$).*

Proof. See Appendix 3.

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 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 observed.

5. EMPIRICAL TESTING

Let us take the United States as a case study, and through an intra-federal analysis undertake two tests;[79] 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.

payments were received.

[78] 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.

[79] The sample includes the 50 states, and the District of Columbia. Given their high heterogeneity in resource abundance, this makes a valid case study.

5.1 Does the 'Alberta Effect' apply in resource abundant states?

The previous section implies that in case the 'Alberta Effect' applies, resource abundance should affect the inflow of physical capital through the business environment; therefore, let us test the following model:[80]

$$FDI^i = \alpha_0 + \alpha_1 B^i + \alpha_2 X^i + \varepsilon^i \quad (29)$$

$$B^i = \beta_0 + \beta_1 R^i + \beta_2 X^i + \upsilon^i \quad (30)$$

$$R^i = \gamma_0 + \gamma_1 R_*^i + \phi^i \quad (31)$$

In terms of notation, 'FDI' is average per capita Foreign Direct Investment in physical capital in 1997-2006.[81] 'B' represents the business environment, measured in three ways to capture the different competition mechanisms; firstly, by the 2006 'State Business Tax Climate Index' of the US Tax Foundation,[82] secondly by average per capita expenditure on infrastructure in 1997-2006, and thirdly by average per capita public good provision in 1997-2006.[83] 'R' is the previously used measure of resource abundance (primary share of GDP in initial year). R_* is an exogenous measure of resource abundance measured as before by either mineral share of GDP or land per capita (both in initial year).[84] Finally, 'X' is a vector of controls that includes investment, openness, human capital, institutional quality, and a dummy for landlocked.[85] We address the potential endogeneity bias of this vector with the business environment or the inflow of capital in two ways. Firstly, we express all variables in initial year and assume them to be pre-determined; secondly, albeit presenting results with 'X', we note these do not change (qualitatively) in case 'X' is not included or that otherwise its variables are gradually added to the regression,[86] implying that even in case such a bias exists, it does not alter results.

[80] 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).

[81] The investigated period is the maximum available. Data is expressed is millions of US$, 2000 prices. Due to data limitations, District of Columbia, Montana, North and South Dakota, Nevada, and Wyoming are excluded from the sample. Source: US Bureau of Economic Analysis.

[82] The ‘State Business Tax Climate Index’ (referred to as 'General Tax' in the regression results table) is an index that ranks US states by their 'tax-friendliness' to business. The index 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.

[83] Per capita expenditures on infrastructure and public goods are expressed in million of US$, 2000 prices. Period investigated corresponds to that of the capital inflow. Source: US Census Bureau.

[84] For more detailed description of the measures used in 'R', and 'R_*' (including sources), see Section 2.

[85] Variables that appear in 'X' are identical in description and source to the ones used in the previous analysis; see Section 2 for further details.

[86] Results available from the author.

We follow the identification strategy of Acemoglu et al. (2000). Thus, we start by reporting correlations between 'R' and 'R$_*$'. Results appear in Table 9. Land per capita and mineral share explain approximately 36 and 76 percent of variation in primary share, respectively. Given this result, we insert 'R$_*$' directly in equation (30) -so that 'R' represents each of the three measures- and estimate equation (30). Results appear in Table 10; these provide an indication for the positive and significant affect of resource abundance on each of the three types of business environment. Next, we estimate equations (29) and (30) using two-stage least squares. Results appear in Table 11. The top panel presents second-stage estimations, and the lower one presents first-stage results (which follow results of Table 10). The positive and significant results of α_1 in all regressions indicate that resource abundance leads to increased inflows of physical capital through the business environment – validating the 'Alberta Effect' mechanism. We further confirm this by showing that capital inflows are not affected directly by resources. Thus, we estimate equation (29), replacing 'B' with 'R'. Results appear in Table 12. Coefficients of each of the resource abundance measures are positive, yet not significant. This further supports the conjecture that resources affect capital inflows indirectly through the business environment, rather than directly due to their capital intensity.

Previous studies show this mechanism is not as applicable once mobility costs are not low enough, as the model suggests. Through a large panel of countries Poelhekke and Van der Ploeg (2011) show that resource abundance crowds out aggregate Foreign Direct Investment, which is an opposite result to the above one.[87] As was found in the earlier analysis of the 'Resource Curse' hypothesis (discussed in Section 2), the opposite results between the intra-federal and cross-country scenarios are also observed in this mechanism, implying once more for the importance of factor mobility costs in this context.

5.2 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:

$$Man^{it} = \alpha_0 + \alpha_1 \ln(Man_0{}^{it}) + \alpha_2 R^{it} + \alpha_3 X^{it} + \beta^i + \tau^t + \varepsilon^{it} \tag{31}$$

[87] Evidence for the relationship between resource abundance and the business environment under a cross-country framework are scarce; however, Poelhekke and Van der Ploeg (2011) already test for the end result (relationship between resource abundance and FDI), implying that the 'Alberta Effect' does not apply when tested on sovereign countries (meaning, once mobility costs are not sufficiently low).

This is an identical model to the one presented in (1), only here we check for growth rates in the manufacturing sector specifically. 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. As before, the sample covers the period of 1977-2008,[88] where 'Man_0' is the initial manufacturing-level (capturing convergence phenomena), 'R' is the resource-share proxy measured by primary share of GDP in initial year, 'X' is a vector of controls identical to the one used in Section 5.1, β is a state-dummy, and τ is a time-dummy. As in Section 2, to account for the possible endogeneity of the resource-share proxy, we instrument it using either mineral share of GDP or land per capita. Also, to address both the potential endogeneity of the vector 'X' and the possibility of an omitted variable bias, we measure all variables in initial year (assume they are pre-determined), and undertake panel estimation with fixed effects, in addition to a cross-sectional analysis.[89] In both the cross-sectional and panel cases results do not change (qualitatively) in case 'X' is not included, or otherwise included with gradual addition of variables,[90] in the regressions so that in case it indeed creates an endogeneity bias, it does not alter results.

Results appear in Tables 13 and 14, for the cross-sectional and panel estimations, respectively. In each, the top panel presents the second stage results (where applicable), and the lower one presents the first stage results (where applicable). In the top panel, the first three columns cover the cases where manufacturing is expressed as share of GDP, and the remaining ones cover the cases where it is expressed as share of its employment out of total employment. The positive and mostly significant results of α_2 in all regressions indicate that 'Dutch Disease' symptoms are indeed mitigated or reversed in resource rich states as the model suggests, since they imply that resource abundant states have a faster-growing manufacturing sector (or, at the least, not a slower-growing one), unlike predictions of the 'Dutch Disease' theory.[91] In addition, results also indicate that to some extent 'Dutch Disease' symptoms are transmitted to resource poor (factor exporters) states, which is consistent with the model as well as with Wahba's (1998) theory regarding this.

[88] All data was retrieved from the US Bureau of Economic Analysis.
[89] The panel is divided to sub-periods of five years, covering 1977-2008.
[90] Results available from the author
[91] The results of the regressions that use manufacturing-employment (as share of total employment) are less significant than the ones of the regressions that use manufacturing-product (as share of GDP). Although this does not imply for reversed 'Dutch Disease' symptoms at the employment-level, it nevertheless shows that these effects are mitigated, which is a relevant result for validating the suggested theory. In addition, this also implies that capital has greater impact than labor in this context, as the model suggests.

Once again, similar tests provide an opposite result once employed under a cross-county framework (where 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. This contrast in results emphasizes further how critical mobility costs can be to 'Dutch Disease' theory.

6. 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. After considering various potential differences between the intra and cross federal settings, we point at the differences in mobility costs as the 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 a novel mechanism (titled the 'Alberta Effect') through which the mitigation (and possible reversion) process of 'Dutch Disease' effects, that forms the basis for the opposite outcomes, occurs. We argue that once mobility costs are low enough, 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. Also, the model is consistent with Wahba's (1998) theory, showing that reduced mobility costs can lead to transmission of 'Dutch Disease' symptoms to resource poor (factor exporters) regions. 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 as we observe that resource abundant states indeed attract greater amounts of physical capital by presenting more competitive business environments (in the form of more competitive taxation, greater expenditures on infrastructure, and greater public good provision) which in turn expand their manufacturing sectors, so that 'Dutch Disease' effects are reversed and to some extent transmitted to the resource poor states. Thus, through the case of federations this paper demonstrates the importance of factor mobility in 'Dutch Disease' theory, especially in the regional context where resource abundance can possibly lead to regional fiscal imbalances.

These insights may carry certain policy implications for resource rich economies, especially for those with multiple neighboring regions that can act as potential factor exporters. Nonetheless, due to the limited sample size, it is important to realize that results may be sensitive to the specific periods or federations investigated. Future research may test the presented hypothesis for extended periods of time and additional federations.

Appendix 1 – Data sources and periods observed: Federal-states

Australia – The period investigated is 1990-2009, for the 8 regions. All data was retrieved from the Australian Bureau of Statistics.

Belgium – The period investigated is 1999-2007, for the 3 regions. All data was retrieved from the Institute of National Accounts of Belgium.

Brazil – The period investigated is 1995-2007, for the 27 regions. All data was retrieved from the Statistical Institute of Brazil.

Canada – The period investigated is 1984-2008 for the 10 provinces, 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 was retrieved from Statistics Canada.

Germany – The period investigated is 1991-2009, for the 16 Landers. All data was retrieved from the Federal Statistics Office of Germany.

India – The period investigated is 1980-2008, for the 27 states. Jharkhand, Chattisgarh, Uttarakhand, and Chandigarh are sampled from 1993-2008; also, Mizoram is sampled for 1999-2008. All data was retrieved from the Ministry of Statistics of India.

Malaysia – The period investigated is 2005-2008, for the 15 states. All data was retrieved from the Department of Statistics of Malaysia.

Russia – The period investigated is 2004-2008 for 77 federal subjects. Due to limitations of data availability the following federal subjects were not included in the sample: Nenets Autonomous District, Chechen Republic, Moscow, St. Petersburg, Khanty-Mansi Autonomous, Okrug-Ugra, Jewish Region, Trans-Balkai, and Yamalo-Nenets District. All data was retrieved from the Federal Statistics Service of Russia.

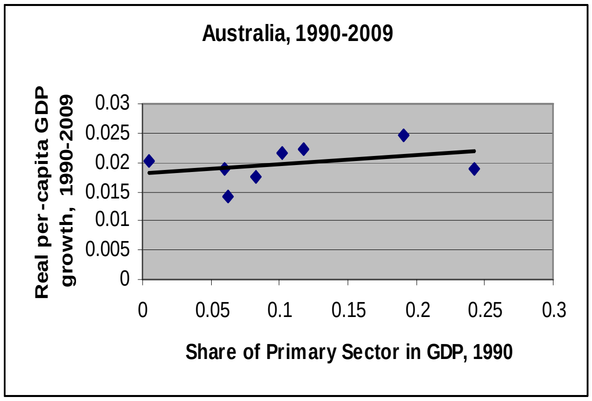
United Arab Emirates – The period investigated is 2000-2007, for the 7 states. All data was retrieved from the Ministry of Economy of the United Arab Emirates.

United States – The period investigated is 1977-2008, for the 50 states, the District of Columbia. All data was retrieved from the US Bureau of Economic Analysis.

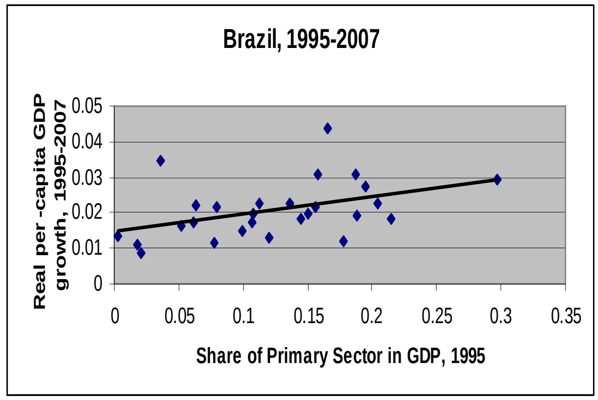
Initial income in each federal state was computed as follows – for each region real per capita GDP is taken and divided by the corresponding exchange rate measure that converts it to US$;[92] thereafter, to normalize the figures (since each correspond to a different year) this measure is further divided 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 converted and normalized measurement is used as initial income (and can be compared across federations and across years)

[92] Exchange rate measures were taken from version 6.3 of the Penn World Tables.

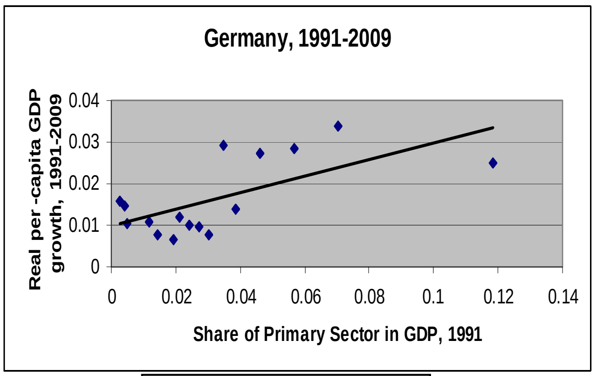
Appendix 2 – Graphs for the separate federations as well as for additional similar cases



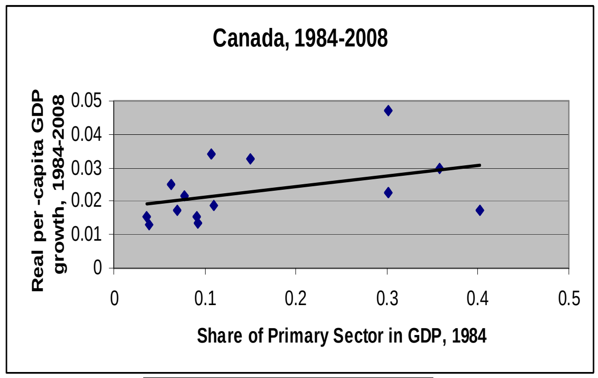
G = .0182085 + .0148108 R
R-squared = 0.1289



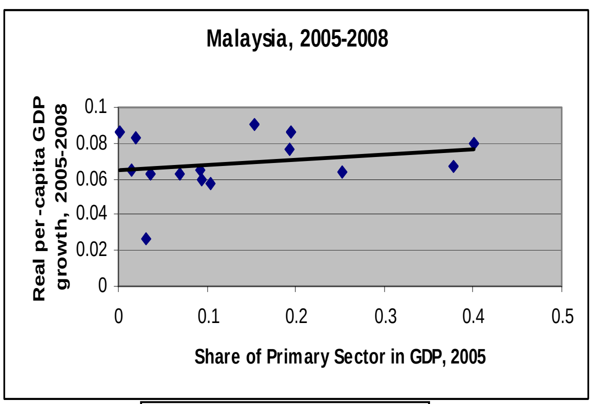
G = .0147159 + .0486238 R
R-squared = 0.1836



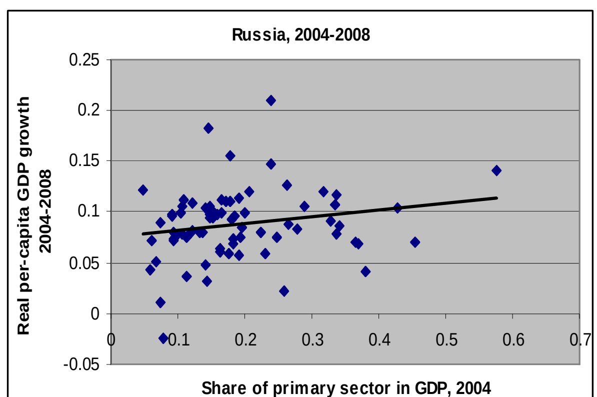
G = .009888 + .1999782 R
R-squared = 0.4291



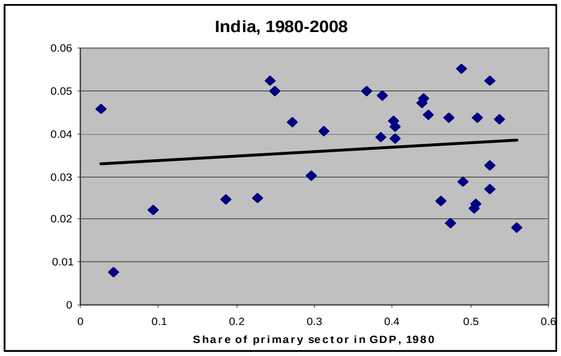
G = .0181087 + .0317517 R
R-squared = 0.1687



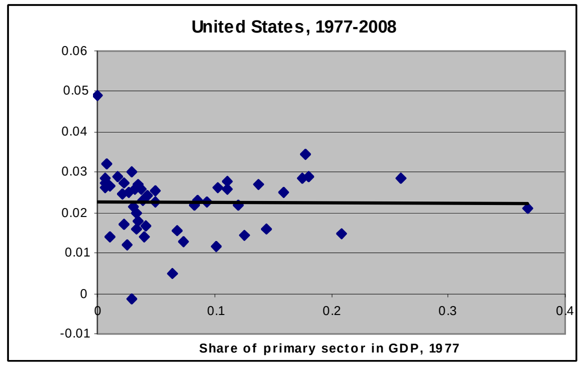
G = .0649196 + .0285786 R
R-squared = 0.0511



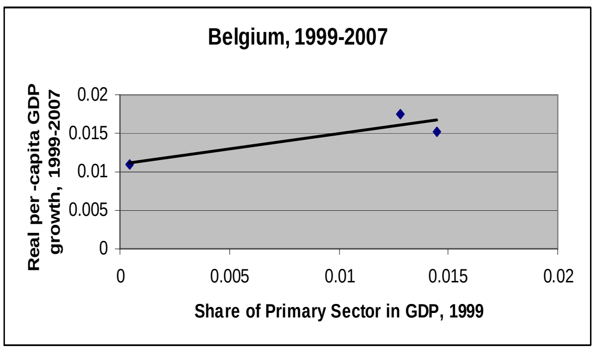
G = .0774648 + .0566971 R
R-squared = 0.031



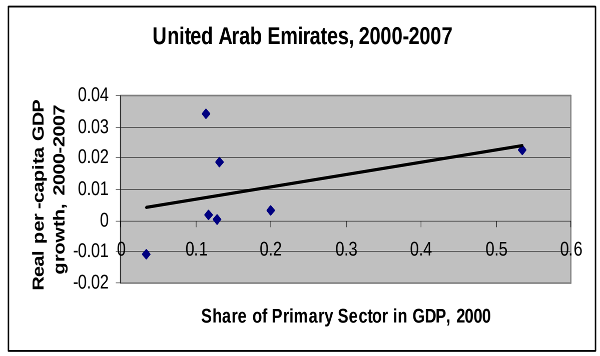
G = .0327424 + .0105524 R
R-squared = 0.0198



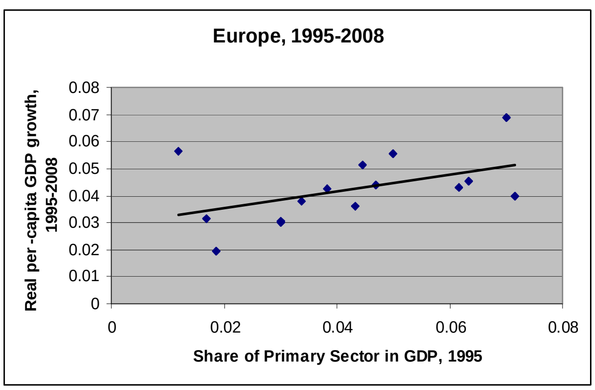
G = .0226639 - .0012689 R
R-squared = 0.00



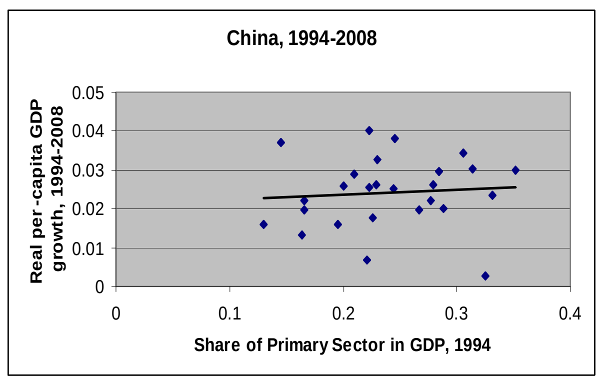
G = .0109821 + .3913342 R
R-squared = 0.8015



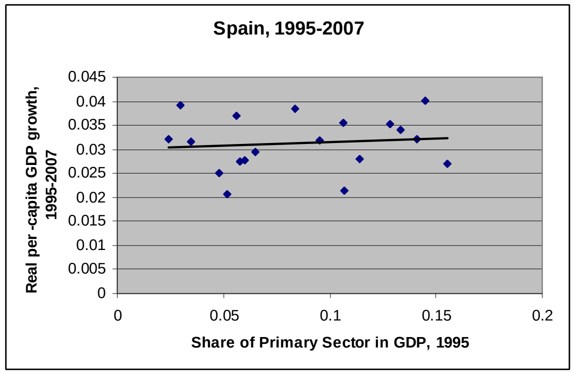
G = .0030653+ .0387144 R
R-squared = 0.1671



G = .0290523 + .3118108 R
R-squared = 0.2252



G = .0213926 + .0117045 R
R-squared = 0.006



G = .0299281 + .0154119 R
R-squared = 0.0132

As can be seen, a few of the federations (Australia, Brazil, Germany, Canada, Belgium, UAE) present positive relationship between resource abundance and growth, while the rest present no observed relationship; however – interestingly (and perhaps more importantly), none of them show any indication for an occurrence of a 'Resource Curse'.

Graphs for China, Spain, and Europe, depict a similar picture to the one observed in federations. Europe shows some indication for a 'Resource Blessing', while Spain and China show no relation between resource abundance and growth (this follows the results on Zhang et al (2008) who looked into ‘Resource Curse’ effects in China); meaning, no 'Resource Curse' is observed in none of the cases, implying that the suggested mechanism may be relevant for other regional regimes (besides federations) that may still present lower costs for factor mobility (compared to cross-country scenarios).

Data sources and periods observed: Non-federal subjects
(Note: all basic (non-transformed) figures are in millions of local currency).
Spain – Data (average annual real per capita GDP, production of primary sector in initial year) on the 19 Spanish regions covers the period of 1995-2007. All data was retrieved from the National Statistics Institute of Spain.
Europe – Data (average annual real per capita GDP, production of primary sector in initial year) on the 15 European-Union members (as of 1995) covers the period of 1995-2008. Note that the result does not change if members that were added to the Union at a later are included. All data was retrieved from Euro-stat (Central Statistics Institute of the European-Union).
China – Data (average annual real per capita GDP, production of primary sector in initial year) on the 26 Chinese provinces covers the period of 1994-2008 (note that the sample starts in 1994 due to the price liberalization scheme in the resource sector that went into action in 1994 (see Zhang et al. (2008)); prior to 1994 prices in the resource sector were heavily regulated by the federal regime, which decreases the relevance of investigating that period, given the context of the hypothesis). All data was retrieved from the National Bureau of Statistics of China.

Appendix 3 – Proofs for Propositions 1 – 5

Proof of Proposition 1

The symmetric outcome, where the regions choose an equal tax rate (and so other indicators are equal as well) follows equations (11) and (12), 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 (12) 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 (12) does not hold. Thus, rate of return of capital and the regional wage rates can not 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.[93]
- 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 1 can allow itself to present lower taxes than its neighbor 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. □

Proof of Proposition 2

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 of 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 3

The proof for Proposition 2 remains applicable for this case, with the slight modification of having immobile labor, which maintains the regional population sizes equal, so that the above outcome is reached.

□

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

Proof of Proposition 4

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 result is reached. □

Proof of Proposition 5

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 (26)); on the other hand, for the same reason region 1 will not import from region 2 (established by condition (25)). 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 $\tau \le \tau^*$ then rates of return on capital will be higher in the manufacturing sector of region 2 due to the low taxes (seen through condition (26)), 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 $k_1 \le k_2{}^m$ in equilibrium. □

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Tables

TABLE 1. *Growth regressions, as in equation* (1), *for federal-states* (OLS)

Dependent variable: *G*	(1)	(2)	(3)	(4)	(5)	(6)
Resource-share	**0.0327***** **(0.0114)**	**0.0331156*** **(0.017)**	**0.0391***** **(0 .010261)**	**0.03908**** **(0.012193)**	**0.0423**** **(0.0138634)**	**0.042241**** **(0.0134074)**
Initial Income		-0.00706** (0.002268)	-0.00301** (0.001312)	-0.0034** (0.001317)	-0.003998* (0.00204)	-0.00423 (0.00262)
Human Capital			0.0371*** (0.005018)	0.0354*** (0.005312)	0.03315*** (0.0072184)	0.0329*** (0.0068741)
Institutional quality				0.0497** (0.016133)	0.04127*** (0.016133)	0.0406*** (0.0118651)
Investment					0.03622 (0.0353631)	0.0366461 (0.0368983)
Openness						0.0817653 (0.3193)
R-squared	0.6906	0.6959	0.7206	0.7251	0.7425	0.7427
N	247	247	241	234	234	234

Note: Standard errors are robust, clustered by federation. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. Despite not presenting their results, dummies (federal, time, and landlocked effects) and intercepts are included in all regressions.

TABLE 2. *Growth regressions, as in equation* (1), *for the 10 federations* (Panel, Fixed Effects)

Dependent variable: *G*	(1)	(2)	(3)	(4)	(5)	(6)
Resource-share	**-0.0235** **(0.0192)**	**-0.0904**** **(0.03)**	**-0.154***** **(0.027)**	**-0.1268***** **(0.0236)**	**-0.1264***** **(0.0228)**	**-0.0611** **(0.049)**
Initial Income		-0.0074*** (0.0011)	-0.0092*** (0.0008)	-0.0102*** (0.001)	-0.0099*** (0.0014)	-0.0132*** (0.002)
Openness			0.03*** (0.006)	0.04*** (0.011)	0.04*** (0.011)	0.04*** (0.01)
Institutional Quality				0.006** (0.0024)	0.006** (0.0025)	0.007** (0.003)
Investment					-0.01 (0.07)	0.05 (0.06)
Human Capital						0.005 (0.003)
R-squared	0.5932	0.693	0.8069	0.8338	0.8347	0.8609
N	35	35	35	35	35	35

Note: Standard errors are robust, clustered by federation. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. Despite not presenting their results, fixed effects (federal, time, and landlocked effects) and an intercept are included in all regressions.

TABLE 3. *Growth regressions, as in equation* (1), *for sovereign countries*

	Sachs and Warner (1997) Period: 1965-1990					Sachs and Warner Extended Period: 1977-2008				
Dependent variable: G	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Resource-share	**-0.066*** (0.016)**	**-0.076*** (0.0205)**	**-0.07*** (0.02)**	**-0.064*** (0.012)**	**-0.065*** (0.012)**	**-0.04* (0.012)**	**-0.067*** (0.021)**	**-0.071*** (0.023)**	**-0.071*** (0.02)**	**-0.061** (0.02)**
Initial Income	0.0005 (0.0017)	-0.0043 (0.0033)	-0.013*** (0.0032)	-0.014*** (0.0025)	-0.015*** (0.0027)	0.001 (0.001)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.003 (0.002)
Human Capital		0.033 (0.02)	0.025* (0.0146)	0.0032 (0.0135)	-0.003 (0.014)		0.0002** (0.00009)	0.0002** (0.0001)	0.0002** (0.0001)	0.0002** (0.00102)
Investment			0.024*** (0.0038)	0.016*** (0.0032)	0.016*** (0.0034)			0.015 (0.017)	0.015 (0.019)	0.01 (0.02)
Openness				0.0244*** (0.00402)	0.019*** (0.0043)				0.00012 (0.005)	-0.004 (0.005)
Institutional quality					0.0017* (0.0009)					0.00008 (0.0011)
R-squared	0.192	0.2258	0.5349	0.7098	0.7384	0.17	0.4209	0.4284	0.4284	0.4326
N	102	86	86	82	77	84	71	71	71	68

Note: Standard errors are robust. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. A dummy for landlocked sovereign countries and an intercept are included in all regressions.

TABLE 4. *Growth regressions, as in equation* (1), *for federal states (OLS)*

	Group 1 (Federal States of: Australia, Belgium, Canada, Germany, United States)					Group 2 (Federal States of: Brazil, India, Malaysia, Russia, United Arab Emirates)				
Dependent variable: G	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Resource-share	**0.0182 (0.0261)**	**0.0241 (0.0234)**	**0.0251 (0.0222)**	**0.029 (0.0234)**	**0.0297 (0 .024)**	**0.034* (0.0153)**	**0.041*** (0.0072)**	**0.048** (0.0112)**	**0.05*** (0.01)**	**0.047*** (0.0126)**
Initial Income	-0.014*** (0.00303)	-0.0076 (0.0053)	-0.0074 (0.0054)	0.00508 (0.003)	0.0039 (0.0022)	-0.0065 (0.0032)	-0.003 (0.0013)	-0.00464 (0.004)	-0.0049 (0.004)	-0.005 (0.0041)
Human Capital		0.023*** (0.0037)	0.021*** (0.0014)	0.025*** (0.0036)	0.02*** (0.0027)		0.037*** (0.0023)	0.045*** (0.00185)	0.04*** (0.002)	0.042*** (0.0013)
Investment			0.00582 (0.0072)	0 .00165 (0 .0104)	0.0021 (0.0105)			0.067 (0.064)	0.066 (0.065)	0.0663 (0.066)
Openness				-0.0688 (0.0198)	-0.068** (0.0195)				0.0224 (0.018)	0.0304 (0.0196)
Institutional quality					0.028 (0.036					0.049** (0.013)
Federal Corruption Level										
Federal Corruption x Resource-share										
R-squared	0.3576	0.4651	0.4749	0.6906	0.6998	0.6046	0.6225	0.6651	0.6664	0.6690
N	92	92	92	92	92	155	149	149	149	142

Note: Standard errors are robust, clustered by federation. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. Despite not presenting their results, dummies (federal, time, and landlocked effects) and an intercept are included in all regressions.

TABLE 5. *Growth regressions, as in equation* (1), *for federal states (Panel, Fixed Effects)*

Dependent variable: *G*	(1) (Primary Share)	(2) (Primary Share)	(3) (Primary Share)	(4) (Primary Share)	(5) (Primary Share)	(6) (Mineral Share – Proxy)	(7) (Mineral Share – IV, Second Stage)	(8) (Land – Proxy)	(9) (Land – IV, Second Stage)
Resource-share	**0.03322 (0.023)**	**0.0657*** (0.0233)**	**0.0655*** (0.0226)**	**0.065*** (0.0228)**	**0.066*** (0.02281)**	**0.07088** (0.02965)**	**0.0748** (0.03051)**	**0.00188 (0.0018)**	**0.07827 (0.07577)**
Initial Income	-0.0054 (0.007802)	-0.0064 (0.00802)	-0.01066* (0.00644)	-0.0108* (.00641)	-0.0108* (0.0063)	-0.01706** (0.0012)	-0.011* (0.0064)	-0.01011 (0.0073)	-0.0113* (0.00183)
Human Capital		0.01875** (0.00823)	0.0221*** (0.008133)	0.0217*** (0.008123)	0.0212*** (0.00813)	0.02045** (0.00825)	0.02183*** (0.007979)	0.0169** (0.0094)	0.02205** (0.010814)
Investment			0.0775** (0.03898)	0.0778** (0.03906)	0.0773** (0.0386)	0.0784** (0.039693)	0.0773** (0.0379)	0.0768** (0.03927)	0.0772** (0.03782)
Openness				0.05567 (0.16884)	0.05633 (0.1689)	0.06325 (0.16953)	0.0519 (0.1684)	0.08979 (0.16853)	0.05015 (0.17362)
Institutional quality					0.04726 (0.0743)	0.06857 (0.07798)	0.05113 (0.0741)	0.0167 (0.07405)	0.05268 (0.0834)
R-squared	0.4982	0.6005	0.6151	0.6153	0.6155	0.6141	0.6154	0.6079	0.6152
N	711	598	598	598	598	598	598	598	598

First Stage Results

Dependent Variable: Primary-Share	Mineral Share	Land	Initial Income	Human Capital	Investment	Openness	Institutional quality	R-squared	N
(7)	0.09*** (0.034)		-0.039*** (0.009)	0.214** (0.095)	0.092* (0.0505)	-0.3207 (0.202)	0.153* (0.085)	0.1597	598
(9)		0.004** (0.002)	-0.032*** (0.0102)	0.169* (0.093)	0.089* (0.048)	-0.287 (0.183)	0.086 (0.078)	0.1423	598

Note: Standard errors are robust clustered by federal-states. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. Despite not presenting results, fixed effects (time, state, landlocked, etc. effects) and an intercept are included in all regressions.

TABLE 6. *Growth regressions, as in equation* (1), *for federal states, federations, and sovereign countries, using exogenous variation in resource-share*

	Intra-Federal, 1977-2008 (Cross Section)				Cross-Country, 1977-2008 (Cross Section)			
Dependent variable: G	Proxy		IV (Second Stage)		Proxy		IV (Second Stage)	
	(1) Mineral-Share	(2) Land	(3) Mineral-Share	(4) Land	(5) Mineral-Share	(6) Land	(7) Mineral-Share	(8) Land
Resource-share	**0.041*** (0.007)**	**0.00007 (0.0008)**	**0.042*** (0.005)**	**0.003 (0.0302)**	**-0.063*** (0.022)**	**-0.003** (0.001)**	**-0.062*** (0.019)**	**-0.15*** (0.046)**
Initial Income	-0.006* (0.003)	-0.004** (0.002)	-0.0047* (0.002)	-0.004*** (0.001)	-0.003 (0.002)	-0.004* (0.002)	-0.002 (0.002)	0.002 (0.003)
Human Capital	0.034*** (0.008)	0.03*** (0.0063)	0.0302*** (0.06)	0.0302*** (0.0054)	0.0002** (0.0001)	0.0003** (0.054)	0.0002** (0.0001)	-0.00006 (0.0001)
Investment	0.035 (0.036)	0.034 (0.03)	0.036 (0.032)	0.034 (0.031)	0.01 (0.01)	0.02 (0.02)	0.01 (0.02)	0.03 (0.02)
Openness	0.085 (0.322)	0.0778 (0.373)	0.073 (0.285)	0.08 (0.311)	-0.004 (0.006)	-0.003 (0.007)	-0.003 (0.005)	0.008 (0.007)
Institutional quality	0.036** (0.013)	0.037*** (0.011)	0.045*** (0.01)	0.037*** (0.012)	0.00007 (0.0011)	0.002 (0.001)	0.00006 (0.001)	-0.001 (0.0015)
R-squared	0.7389	0.7352	0.7467	0.7368	0.4281	0.271	0.4325	0.1488
N	234	234	234	234	68	90	68	68

First Stage Results

Dependent Variable: Primary- Share	Mineral Share	Land	Initial Income	Human Capital	Investment	Openness	Institutional quality	R-squared	N
(3)	0.95*** (0.07)		-0.05** (0.02)	0.34 (0.43)	-0.043 (0.026)	0.09 (0.589)	0.119* (0.06)	0.8300	235
(4)		0.024*** (0.004)	-0.004 (0.017)	-0.38 (0.63)	-0.062*** (0.016)	-1.09 (2.002)	0.118 (0.082)	0.5923	235
(7)	0.989*** (0.025)		0.0005 (0.003)	-0.0001 (0.0001)	-0.02 (0.02)	0.01 (0.01)	0.0002 (0.002)	0.9715	70
(8)		0.024*** (0.008)	0.076** (0.03)	-0.003*** (0.0008)	-0.1 (0.2)	0.1** (0.07)	-0.024* (0.013)	0.4908	70

Note: Standard errors are robust clustered by federal-states. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. A dummy for landlocked states and sovereign countries and an intercept are included in all regressions.

TABLE 7. *Growth regressions, as in equation* (1), *for US States, using Papyrakis and Gerlagh (2007) dataset*

Dependent variable: *G*	(1)	(2)	(3)
Resource-share	-5.266*** (1.774)	-4.341** (1.704)	7.5866 (5.135)
Corruption		-0.1553*** (0.06)	0.015 (0.097)
Resource-Share x Corruption			**-2.99** (1.17)**
R-squared	0.1578	0.2709	0.3634
N	49	49	49

Note: Standard errors are robust. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. The District of Columbia and Delaware are not included in the sample. An intercept is included in all regressions.

TABLE 8. *Growth regressions, as in equation* (1), *using per capita income instead of growth*

Dependent variable: Per Capita GDP	(1) Intra-Federal Analysis (Cross-Section)	(2) Intra-Federal Analysis (Panel, Fixed Effects)	(3) Cross-Federal Analysis (Panel, Fixed Effects)	(4) Cross-Country Analysis (Cross-Section, 1977-2008)
Resource-share	**0.1801*** **(0.091)**	**0.601***** **(0.0454)**	**-0.935***** **(0.1789)**	**-1.88**** **(0.736)**
Initial Income	0.981*** (0.0143)	0.8542*** (0.052)	0.8582*** (0.0414)	0.9086*** (0.064)
R-squared	0.9902	0.9455	0.9948	0.9458
N	235	598	35	68

Note: Standard errors are robust clustered by federation (in (1) and (3)) or state (in (2)). Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. Although results are not presented, all regressions include Human Capital, Institutional Quality, Investment, Openness, relevant dummy variables (federal, landlocked in case fixed effects not included, etc.) and an intercept.

TABLE 9. *Estimating equation (31) for US federal-subjects* (OLS)

Dependent variable: Primary Share (1977)	(1) Mineral Share (1977)	(2) Land (1977)
	0.96131*** (0 .03465)	0.02713*** (0.0065)
R-squared	0.7903	0.3616
N	51	51

Note: Standard errors are robust. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. An intercept is included in all regressions.

TABLE 10. Estimating equation (30) for US federal subjects (OLS)

Dependent variable: Business Environment	(1) General Tax	(2) General Tax	(3) General Tax	(4) Infrastructure	(5) Infrastructure	(6) Infrastructure	(7) Public Goods	(8) Public Goods	(9) Public Goods
Mineral Share	5.427*** (1.72)			16692.33** (6671)			15504** (6395)		
Land		0.314*** (0.097)			571.52*** (178)			602.5*** (162)	
Primary Share			6.243*** (1.43)			14758.15** (6670)			15515** (7089)
R-squared	0.4406	0.4629	0.4724	0.5090	0.2718	0.2718	0.4991	0.3187	0.3187
N	51	51	51	50	50	50	50	50	50

Note: Standard errors are robust. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. The following variables are included in all regressions but not reported: Investment, Education, Corruption, Openness, and Landlocked; also, an intercept is included.

TABLE 11. Estimation equations (29) and (30) for US federal subjects, (2SLS)

Dependent variable: Foreign Direct Investment	(1) Mineral-Share (2SLS)	(2) Land (2SLS)	(3) Primary Share (2SLS)	(4) Mineral Share (2SLS)	(5) Land (2SLS)	(6) Primary Share (2SLS)	(7) Mineral-Share (2SLS)	(8) Land (2SLS)	(9) Primary Share (2SLS)
General Tax	23402.04*** (4669.266)	18465** (7833)	25336.84*** (6116.76)						
Infrastructure				5.672*** (0.482)	4.935*** (0.877)	5.555*** (0.509)			
Public Goods							5.37*** (0.426)	5.235*** (0.6454)	5.37*** (0.464)
R-squared	n/a	n/a	n/a	0.6743	0.7403	0.6876	0.7238	0.7383	0.723
N	45	45	45	45	45	45	45	45	45

First Stage Results

Dependent variable: Business Environment	(1) General Tax	(2) General Tax	(3) General Tax	(4) Infrastructure	(5) Infrastructure	(6) Infrastructure	(7) Public Goods	(8) Public Goods	(9) Public Goods
Mineral Share	5.427*** (1.72)			16692.33** (6671)			15504** (6395)		
Land		0.314*** (0.097)			571.52*** (178)			602.5*** (162)	
Primary Share			6.243*** (1.43)			14758.15** (6670)			15515** (7089)
R-squared	0.4406	0.4629	0.4724	0.5090	0.2718	0.2718	0.4991	0.3187	0.3187
N	51	51	51	50	50	50	50	50	50

Note: Standard errors are robust clustered by federal-states. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. The following variables are included in all regressions but not reported: Investment, Education, Corruption, Openness, and Landlocked; also, an intercept is included.

TABLE 12. *Estimating Equation (29), replacing 'B' with 'R', for US federal subjects* (OLS)

Dependent variable: Foreign Direct Investment	(1)	(2)	(3)
Mineral Share	26469.73 (24669.21)		
Land		3638.579 (2589.762)	
Primary Share			16975.31 (19711.58)
R-squared	0.1418	0.3886	0.1158
N	45	45	45

Note: Standard errors are robust. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. The following variables are included in all regressions but not reported: Investment, Education, Corruption, Openness, and Landlocked; also, an intercept is included.

TABLE 13. Estimating equation (31) for US federal subjects, Cross-Section

	Share Out of Total GDP			Share out of Total Labor		
Dependent variable: Growth of Manufacturing Sector	(1) Primary-Share	(2) Mineral-Share (IV)	(3) Land (IV)	(4) Primary-share	(5) Mineral-Share (IV)	(6) Land (IV)
Resource-Share	0.142*** (0.043)	0.087** (0.0402)	0.294*** (0.073)	0.07** (0.027)	0.011 (0.028)	0.255*** (0.062)
Initial Manufacturing-Share	-0.004 (0.0066)	-0.0063 (0.0046)	0.006 (0.006)	-0.0024 (0.0042)	-0.005 (0.005)	0.008* (0.0047)
R-squared	0.5445	0.5139	0.3714	0.6162	0.5581	0.4057
N	51	51	51	51	51	51

First Stage Results

Dependent variable: Primary Share	(2)	(3)	(5)	(6)	R-squared	N
Mineral Share	0.726*** (0.1)				0.8956	51
Land		0.023** (0.009)			0.7282	51
Mineral Share			0.723*** (0.095)		0.9003	51
Land				0.024** (0.009)	0.7239	51

Note: Standard errors are robust. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. The following variables are included in all regressions but not reported: Investment, Education, Corruption, Openness, and Landlocked; also, an intercept is included.

TABLE 14. Estimating equation (31) for US federal subjects, Panel (Fixed Effects)

	Share Out of Total GDP			Share out of Total Labor		
Dependent variable: Growth of Manufacturing Sector	(1) Primary-Share	(2) Mineral-Share (IV)	(3) Land (IV)	(4) Primary-share	(5) Mineral-Share (IV)	(6) Land (IV)
Resource-Share	0.2076*** (0.08)	0.163** (0.08)	1.12* (0.6197)	0.0307 (0.039)	-0.0152 (0.039)	1.93** (0.867)
Initial Manufacturing-Share	-0.033*** (0.0103)	-0.035*** (0.0096)	0.006 (0.006)	0.0105 (0.006)	0.01 (0.006)	0.025 (0.02)
R-squared	0.2308	0.23	n/a	0.3571	0.3542	n/a
N	357	357	357	357	357	357

First Stage Results

Dependent variable: Primary Share	(2)	(3)	(5)	(6)	R-squared	N
Mineral Share	1.02*** (0.026)				0.9839	357
Land		0.034** (0.013)			0.9020	357
Mineral Share			1.04*** (0.023)		0.984	357
Land				0.034*** (0.015)	0.8815	357

Note: Standard errors are robust. Standard deviations for independent variables appear in parentheses. Superscripts correspond to a 10, 5 and 1% level of significance. The following variables are included in all regressions but not reported: Investment, Education, Corruption, and Openness.