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NATURAL RESOURCES AND ECONOMIC GROWTH IN RUSSIA'S REGIONS

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We examine the impact of natural resources on economic growth in Russia's regions since the introduction of the mineral tax in 2002. Using novel measures of natural resource rents produced in, but not necessarily appropriated by the regions (mineral tax collections), we demonstrate that mineral wealth has not significantly affected regional economic growth since 2002, although mineral-rich regions are significantly richer than the other regions. These results are contrary to the "resource curse" hypothesis. The absence of growth benefits to resource-endowed regions, however, is also at odds with the clearly beneficial impact of natural resources on the economic growth of t the country as a whole. We conclude that the Russian central government was successful in taxing away incremental regional resource rents during 2002-2011, but the regions preserved their pre-2002 benefits derived from mineral wealth.

Keywords: natural resources, regional growth, taxation of minerals

JEL Codes: P28, R11, Q38

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1. Introduction

The effect of natural resources on economic growth is usually examined in the framework of the "resource curse" hypothesis. This hypothesis states that natural resource abundance leads to slower long-term economic growth. Usually, this claim pertains to the so-called point-source resources such as oil or minerals rather than diffused resources such as high quality agricultural land.[4] With a few exceptions, this literature has focused on country-level comparisons, presumably because of better data availability and because some of the transmission mechanisms such as the Dutch Disease can be most readily analyzed at the country level.[5] While most of the pre-2009 empirical literature on the resource curse finds that oil and other point-source resources do impede growth, several recent papers show rather convincingly that this is not typically the case.[6] Russia represents one of the clearest examples of an economy whose growth since 1998 benefitted greatly from commodity price increases, particularly those for oil and natural gas, despite its relatively poor quality of institutions.[7]

One difficulty with using country-level data, however, is that countries differ along many dimensions that include history, culture, geography, institutional quality and macroeconomic policies. Although some of these differences can be viewed as time-invariant and accounted for by fixed effects, this is certainly not true with respect to all of them. At the same time, these differences are often hard to measure and as a result the empirical work could suffer from omitted variable biases. For this reason, a few recent papers have focused on the empirical investigation of the effect of natural resources on economic growth at the regional level of large federal economies such as the US (Papyrakis and Gerlach, 2007; James and Aadland, 2011), China (Fang, et al., 2009) and Russia (Desai, 2005; Lugovoy et al., 2007; Freinkman and Plekhanov, 2009; and Libman, 2013). Regional level analysis offers certain advantages, because even in large countries, differences among regions in history, culture, and institutions, not to

[4] The hypothesis of the "curse" of natural resources has been studied, both theoretically and empirically, in a vast literature starting at least with Auty (1993) and Sachs and Warner (1995). Mehlum et al. (2006) and Tornell and Lane (1999), among others, present theoretical arguments with some empirical estimates. Sala-i-Martin and Subramanian (2003) is one of the more comprehensive empirical works. Alexeev and Conrad (2009a) present a dissenting view arguing that oil and mineral resources do not impede long-term economic growth and do not worsen institutional quality. Frankel (2010) presents a recent survey of this literature.

[5] Although see Papyrakis and Raveh (2013) on the empirical analysis of a regional Dutch Disease.

[6] In addition to already mentioned Alexeev and Conrad (2009a), see Bruckner et al. (2012), Brunnschweiler (2009), and Alexeev and Conrad (2011). All these papers show that natural resources, particularly "point-source" ones, actually promote long-term economic growth and the latter two paper demonstrate this result for the economies in transition in particular.

[7] See Kuboniwa (2012) and references therein for the estimates of the positive relationship between international oil prices and GDP growth in Russia.

mention the effects of macroeconomic policies, are usually not as great as differences among countries. This consideration may make it easier to isolate the effects of natural resource endowments on regional economic performance.

However, the fact that regions belong to the same country may also result in economic and institutional quality convergence, blurring some of the differences that would have otherwise existed if the regions were separated by meaningful international borders. In our view, a significantly more important problem with using regional data to study the effect of natural resources on economic growth is that natural resource rents could (and perhaps should) be channeled away from the resource-rich regions mainly by central government's taxation, but also by transfer of profits away from the resource-rich regions by mining firms. We note, however, that the profit transfer is likely to be less important than taxation, because if mining companies were appropriating large rents in a region, they would have strong incentives to invest more there and hire more workers at relatively high wages, particularly because of limited mobility of Russia's population. In this case, a significant part of the resource rents would have stayed in the region presumably promoting regional growth.[8]

The main goal of this paper is to examine the impact of natural resource wealth on economic growth in Russia's regions, concentrating in particular on the degree to which the federal government has been able to tax away the regional natural resource rents and especially oil and gas rents mainly due to the unique system of taxation of oil extraction. Our results can also be viewed as a test of the regional "resource curse" in Russia.

Compared to the regionally-focused papers referenced above, our contributions include the use of more recent data (namely, 2002-2011) and a novel approach to evaluating the amount of natural resource rents produced in, but not necessarily accrued to, regional economies.

The use of recent data is particularly important in the case of Russia, because of a substantial reform of Russia's fiscal federalism arrangements and the apparent strengthening of the federal center more generally over the last few years that make the results based on pre-2002 data (i.e., the data used in Desai, et al., 2005, and in Freinkman and Plekhanov, 2009) and even 1996-2004 data (Lugovoy et al., 2007, and Ahrend, 2008) considerably less relevant to the current situation.[9] Libman (2013), whose paper is closest to ours, uses 2000-2006 data, but he

[8] We will return to the interpretational issue of the link between economic growth and resource rents in Russia in Section 3.
[9] Also, Ahrend (2008) employs natural resource endowment data only as the "initial conditions" as of the late 1990's.

emphasizes cross-sectional estimation, which is problematic because of the potential for omitted variables bias. In two panel regressions presented in his paper, Libman does not account for serial correlation in the data. Also, most of the above "regional" papers, including Libman (2013), limit their study to oil and gas measures of natural resource wealth while we consider the effects of oil and gas rents and mineral wealth separately. This is important, because of the potential importance of other natural resources, significant differences in rents generated by different types of natural resources, and very different taxation of these rents in Russia. At the same time, the papers that look at a variety of natural resources rather than only at oil and gas do not adequately take into account the differences in net economic benefits or rents of different types of point-source resources.

In addition, our estimation approach is different from other papers. Neither Ahrend (2008) nor Freinkman and Plekhanov (2009) use fixed effects specifications in the estimation, making their results subject to omitted variable biases. Desai et al. (2005), Lugovoy et al. (2008), and Libman do use fixed effects, but they do not account for substantial serial correlation in the data.[10]

We alleviate the above problems by using several different measures of natural resource abundance, including the revenues from the tax on the extraction of mineral resources (NDPI in the Russian abbreviation; hereafter, mineral tax) in addition to the share of "extractive industries" in gross regional product (GRP), and we use first difference estimator that accounts for fixed effects and adjust for serial correlation that is very much present in the non-differenced data. Mineral tax collections have the advantage that they incorporate the effects of mineral resource prices and they at least roughly account for the different rent content of different groups of minerals. Thus, we argue that mineral tax collections approximate total rents produced in a region and our main research question is to what extent these total rents actually benefit the region and to what extent these benefits are taxed away.

We use the total collections of mineral tax in the region as our main independent variable, but we also present the results of using the share of these collections retained by the regional budget. The distinction between the regional and the federal shares of the mineral taxis potentially important for hydrocarbons, because the regional share of mineral tax on oil and natural gas declined significantly during 2002-2009 (see Table 2) while the regional shares of the

[10] We also use a significantly greater variety of natural resource wealth measures than do these authors.

tax on other minerals have remained stable.[11] The retained mineral tax collections reflect the importance of this tax for regional government revenues while total collections are correlated with the overall rents from minerals, including the rents accruing to the regional private economic actors. We discuss this issue in greater detail in the next section.

We estimate our regressions in differences of the variables (except for year dummies) which is essentially estimation of fixed effects specification. We also adjust for clustering of errors by region. The use of differenced variables is preferred to within estimators in the presence of strong serial correlation in level variables, and takes into account all the time-invariant regional characteristics, alleviating the potential omitted variable bias. Clustering adjusts for arbitrary intra-region correlations of errors. The use of year dummies makes it more likely that the assumption of across group independence of errors holds. In addition, we estimate between effects regressions in levels in order to determine the effect of natural resources on GRP levels as opposed to growth rates in the 2000s.

Our main result is that regional mineral wealth tends to facilitate economic growth, although this effect is quite weak and depends on the measure of mineral wealth. This result is in obvious contrast with the effect of hydrocarbon and mineral rents on the economic growth of the entire country. It is also in contrast with the recent results by Alexeev and Conrad (2009; 2011), Brunnschweiler (2009) and Brückner et al. (2012) who find significant positive effects of natural resources on economic growth based on country-level data. We attribute this difference in results to the ability of Russia's central government to tax away regional resource rents during the 2000's.

We do not argue, however, that resource-rich regions have accrued no benefits from their mineral wealth. When we use between-effects regression specifications we find that natural resource wealth is positively associated with per capita GRP. Similar results are obtained for wages. Therefore, we conclude that while the federal government was successful in taxing away the incremental mineral and oil and gas rents during 2002-2011, the pre-2002 regional rents from natural resources have remained within the regions.

The next section describes the data used in our estimation. Section 3 presents the results, and section 4 concludes.

[11] Note, however, that the two types of tax collections are nonetheless highly correlated with the coefficient of correlation of over 0.8 even for those regions where the tax collections are greater than the median. For all regions, correlation is over 0.9. Correlations among year-to-year differences are, however, considerably smaller.

2. The Data

We use the data on all Russia's regions for which the data are available, excluding the city of Moscow and autonomous okrugs. (Okrugs are regions that have less administrative and political independence than other Russia's regions, i.e., autonomous republics and oblasts.) We exclude Moscow because it serves as headquarters of the biggest Russian natural resource companies and greatly benefits from natural resource extraction, without having any valuable natural resources of its own. While including Moscow in our regressions does not change any of the qualitative results, we feel that the results are "cleaner" without Moscow. We have only one okrug for which all the relevant data are available (Chukotsky okrug). It is a sparsely populated area rich in natural resources and is a clear outlier in per capita terms.

As we mentioned before, one of our contributions to the literature on the effect of natural resources on Russia's regions is the use of mineral tax collections as an indicator of natural resource abundance. We use both per capita measures and tax collections as a share of GRP. Below we discuss mineral tax collections variables.

We measure mineral tax collections in the region in year 2000 rubles (here and elsewhere, GDP deflator is used to convert to year 2000 rubles) and we use both (log of one plus) per capita measure and a ratio of mineral tax collections to GRP. Mineral tax in Russia is essentially a royalty and is assessed based on gross value of the minerals extracted. Tax rates differ depending on the mineral, presumably to reflect different amounts of rents for different minerals. For example, in 2012, mineral tax was assessed at the rate of 4% on the value of extracted peat, at 4.8% for "standard ores of ferrous metals," and 8% for the standard non-ferrous metals.

Mineral tax collections are particularly attractive for our purposes for two reasons. First, the *ad valorem* nature of the tax on most natural resources (except, notably, for natural gas) means that tax collections reflect relative prices of the resources and, therefore, their true importance for the economy. Second, the fact that the tax rates differentiate among minerals and reflect, at least roughly, the amount of rents generated by different minerals also gives this measure an advantage over other measures used in the literature such as the share of extractive industries value added in the regional economy or employment in extractive industries. For example, suppose in year one the gross value of the mineral is pQ, where p is the mineral's price and Q is its volume. Denote the per unit cost of extraction by c and let the royalty and the profits

tax rates be r and t, respectively. Then, assuming constant costs of labor and capital,[12] the rents generated by price increases are approximately equal to the sum of government charges (royalty and profits tax) and the after-tax profit of the miner. The latter can be written as $\pi = pQ(1-r)(1-t) - cQ(1-t)$. Mineral tax collections are $T = rpQ$, implying that $\rho \equiv \frac{\pi}{T} = \frac{(1-r)(1-t)}{r} - \frac{c(1-t)}{rp} = \frac{(1-t)(p(1-r)-c)}{pr}$. Therefore, $\frac{\partial \rho}{\partial Q} = 0$ and $\frac{\partial \rho}{\partial p} = \frac{(1-t)c}{p^2 r}$. That is, as the extracted quantity of the resource changes, π and T change proportionally. As prices of the resource change, mineral tax collections are not changing strictly proportionally to profits (the latter rise faster than the former), but the two values are strongly positively correlated as long as the average royalty rate and extraction costs are independent of the price. In Russia, average royalty rates for minerals are independent of their prices, but the average royalty rate increases in price in the case of oil. This implies that as the price of oil increases the share of rents appropriated by a royalty increases relative to what it would have been had the royalty rate stayed constant. In other words, we can use mineral tax revenue as a proxy for overall rents generated in a region. Moreover, the tax on oil follows changes in the overall rent even closer than the tax on other natural resources.[13]

Presumably regional growth would be affected not by the part of the overall rent that is taxed away by the central government but only by "purely regional" rents (mainly above-normal profits of the miners and regional share of the mineral tax). In the case of non-hydrocarbons, the regional share of the mineral tax has remained constant at 40% since 2002. The regional share of the tax on oil in Russia was significantly smaller than that in 2002-2003, became much smaller in 2004, and was eliminated completely in 2006. The regional share of the tax on natural gas was eliminated in 2004 (see Table 2).[14] Therefore, with respect to hydrocarbons, the link between overall rents proxied by the total mineral tax collection and purely regional rents is weaker than for non-hydrocarbons. This makes the use of mineral tax collections, either total or regional shares, as a proxy for purely regional resource rents problematic for oil-producing regions. We

[12] Factor costs, and wages in particular, could, of course, be affected by resource rents. It does not appear, however, that labor costs were growing significantly faster in mineral-rich regions relative to other regions in the country. We will address this issue briefly in the next section.

[13] We exclude the export fee on oil and gas from this discussion of rents. In the case of oil, export fee structure is similar to that of the mineral tax on oil and in the case of natural gas, all export rents accrue to the central government and to Russia's state-owned Gazprom that has a monopoly on natural gas exports rather than to the regions.

[14] This consideration makes the use of the regional share of the tax on hydrocarbons as a proxy for regional rents as done by Libman (2013) in one of his specifications highly questionable. We include it in our tables mainly for the purposes of comparison.

note, however, that the same considerations affect the impact of any other measure of natural resources on the economy of oil-producing regions. That is, if the regional budget share of the tax is important for economic growth, then its variations would influence the relationship between natural resource abundance, no matter how it is measured, and regional growth. In that sense, this disadvantage is not specific to mineral tax collection shares. More important, our goal in this paper is to determine to what extent regional growth in Russia benefits from the overall rent generated in a region, and so we are interested mainly in the measures of overall rents rather than measures of purely regional rents.

We also use per capita value added in extractive industries and its ratio to GRP as measures of natural resource abundance. Unlike mineral tax collections, these indicators of the region's mineral wealth do not necessarily reflect the size of rents accruing to the region or to the federal government, because this measure does not differentiate effectively between high rent and low rent minerals.

Our dependent variable is the growth of GRP in constant prices. We use the "index of physical volume" of GRP instead of deflated GRP in current prices. This is because GRP of resource-rich regions deflated by GDP deflator would grow faster than the "physical" GRP if prices of these resources grow faster than the GDP deflator. For example, if overall inflation in a given year is 10% but oil prices increase by 20%, the deflated GRP of an oil-producing region would grow even if the quantity of regional output of oil and everything else has remained constant. We stress, however, that the results obtained by using deflated GRP (available upon request) are not qualitatively different from those based on the index of physical volume of GRP.

All variables used in our regressions as well as sources for them are listed in Table 1. Descriptive statistics for all variables and pairwise correlations of our measures of natural resource wealth are presented in the Tables 3 and 4.

3. Estimation results

Our benchmark specification for estimating the effect of natural resources on regional economic growth is the following regression in first differences:

$$\Delta GRP_{it} = \alpha \Delta Resource_{it} + \beta \Delta Population_{it} + \gamma_t + \varepsilon_{it} \qquad (1)$$

where GRP_{it} denotes logarithm of the "physical volume" of GRP, $Resource_{it}$ stands for a measure of mineral resource wealth of a region, and Δ represents the difference between the

values of the variable in year t and year $t-1$. We use the following measures of mineral resources: logarithm of one plus mineral tax revenue (total collections), the ratio of mineral tax revenue to GRP, logarithm of one plus per capita product of extractive industries, and the share of extractive industries in GRP. We also use hydrocarbon portions of the mineral tax separately. $Population_{it}$ is a logarithm of population of the region, γ_t denotes time dummies, ε_{it} is the error term, and i and t denote, respectively, region and year. Errors are clustered by regions. The use of differences accounts for time-invariant differences among regions (fixed effects) and clustering of errors allows for arbitrary within-group correlations. We estimate regressions (1) for 2002-2011 periods when we use mineral tax variables, and for 2004-2011 when we use the share of extractive industries in GRP. We also present the results for years prior to the crisis of 2009 for regressions in first differences. Note that a major portion of Russia's oil and minerals are exported and, therefore, endogeneity (i.e., the effect of GRP on mineral tax collections and output of extractive industries) is unlikely to be an issue.

The use of first differences instead of fixed effects (within) estimator is justified by significant serial correlation of the errors in un-differenced equations. The Wooldridge test for serial correlation in panel data for these equations returns the F-statistics of over 300, strongly rejecting the null hypothesis of no serial correlation. The corresponding tests for the differenced data have p-values around 0.005 for all data and over 0.5 for pre-2009 data. This suggests that first difference estimators are more efficient, particularly for pre-2009 period. Given that the fixed-effects point estimates are not radically different from the first-difference results, but have lower statistical significance, the latter estimator appears to be more appropriate. The fixed effects results are available upon request.[15]

As noted earlier, we use both per capita measures of natural resources and the ratios of their output to GRP. In economic growth regressions, the former measures have a disadvantage that regressing GRP on one of its components (value added in extractive industries) or tax revenue from one of its components is likely to result in positive coefficients as long as the change in the value added of the extracted resource is due to the change in its quantity. On the other hand, if a regional economy is not functioning well for reasons unrelated to natural resources, GRP would be small, making the ratio of natural resource measures to GRP large and

[15] In addition, we tried using lagged measures of natural resources as regressors and we estimated Arellano-Bond system GMM. In both cases, the resulting coefficients of natural resource wealth were not statistically significant.

creating a false impression of the "natural resource curse." If, however, both sets of measures result in similar coefficients, the reliability of the conclusions would be enhanced.

We first present the result for the general measures of natural resource endowment: total and regional mineral tax collections and the importance of extractive industries.[16] Note, however, that the tax on hydrocarbons represents a lion's share of the mineral tax and the two values are highly correlated, although their first differences are particularly strongly correlated only in the case of shares in GRP, while the correlation of differenced per capita collections is about 0.55, which is substantial, but not likely to present a significant multicollinearity problem. The changes in per capita mineral tax collections, both total and regional, are positively associated with GRP growth at 5% significance level for 2002-2011 regressions (see Table 5A). Similarly, the share of value added in extractive industries to GRP has a positive and statistically significant coefficient. The total mineral tax collections as a share of GRP, however, has a negative coefficient significant at 5% level and neither the regional share of mineral taxes nor the per capita value added in extractive industries is statistically significant. The estimates based on pre-2009 data presented in Table 5B have the same signs but are lower statistical significance. In other words, the evidence on the effect of natural resources on economic growth is mixed with some suggestion of a weak positive relationship.

The above results combine the effect of hydrocarbon wealth with the effect of other minerals. Given significant differences in taxation of hydrocarbons and other minerals, it makes sense to separate them. As Tables 6A,B show, none of the measures based on hydrocarbon tax collections is statistically significantly associated with GRP growth, suggesting that oil and gas rents have been siphoned away from the regions either by the government or by the producers.

In order to separate the effects of mineral taxes in general and their hydrocarbon component, we run regressions that include both the mineral tax collections and their hydrocarbon component. As the results in Tables 7A,B show, changes in overall per capita mineral tax collections have a highly statistically significant positive effect on GRP growth and the effect of hydrocarbon tax collections is not statistically significantly different from the overall mineral tax collections. In the regressions that use shares of tax collections in GRP, however, overall mineral tax collections have a negative and highly statistically significant

[16] We present the results for the regional shares of mineral taxes only as a robustness check. Our main measures are total tax collections.

coefficient while the coefficient of hydrocarbon share is positive, although significantly smaller by absolute value. This indicates that the effect of hydrocarbon tax share in GRP is less negative than that of mineral tax share. Note, however, that the correlation between the first differences of shares of mineral tax and its hydrocarbon component is over 0.8 and, therefore, the standard errors in regression (2) of Tables 7A,B are unreliable. The regressions that use regional shares of these taxes have the same coefficient signs, but only one of them is statistically significant. In the regressions that include measures based on the value added in extractive industry only per capita value added measure is statistically significant at 10% level. These results suggest that the effects of mineral rents in general are not too different from those of hydrocarbon rents. This is not surprising, given that over 90% of the mineral tax comes from its hydrocarbon component.

We also tested whether the results hold if we limit the sample to the non-oil producing regions. The results (available upon request) indicate that all of our natural resource wealth measures have positive coefficients, but none of them are statistically significant. This may be explained by the lower number of observations that result from excluding all oil and gas producing regions.

The economic importance of the impact of mineral rents on regional VRP is relatively small, with point estimates of elasticity being approximately 0.01 for per capita tax collections. And, of course, the coefficients for some other measures of natural resources are either insignificant or even negative. In the case of the relationship between the mineral tax and extractive industry shares in GRP, the numerical effects are negligible. The small size of the effect of natural resource wealth on GRP growth during the times of rapidly growing prices of oil and minerals suggests that the rents due to commodity price increases during this period accrued mostly to the central government.[17]

So far, we have measured the growth benefits of natural resources in terms GRP index. It appears from casual observation that part of the regional rents from natural resources accrue to workers in the form of wages. To examine this possibility we run regressions similar to (1) but with (the growth of) average wages in year 2000 rubles as the dependent variable. The resulting coefficients of mineral resource endowments have the same signs as those for GRP growth, but

[17] Prices of natural resources indeed grew rapidly between 2002 and 2009. For example, the price of oil – arguably, the main source of rents in Russia – more than doubled in constant 2010 US dollars from $30.33 to $62.69 (see BP 2011).

none of them is statistically significant. A few of these regressions are shown in Table 10. The rest of wage regressions are available upon request.

One possible explanation for an absence of a substantial economic growth benefit from regional natural resources might be the presence of β-convergence whereby richer regions tend to grow slower than their poorer counterparts. Guriev and Vakulenko (2012) found such convergence among Russia's regions in the 2000s. If natural resource wealth is correlated with GRP levels (which it is, with correlation coefficients ranging from 0.114 to 0.557, depending on the natural resource measure) our findings might simply reflect β-convergence. To test whether this is the case we added a logarithm of lagged per capita GRP to regression (1). Although the coefficient of this additional variable was negative in most regressions, it was not statistically significant. Moreover, there was virtual no change in the value and statistical significance of the coefficients of natural resource measures. These regressions are available upon request.

As we argued above, the small values of the coefficients of natural resource rents in our regressions suggest that the central government has been effective in taxing away regional rents. It is also possible that the mining companies channeled away from the regions the rents accrued to them in the form of profits. This is likely particularly in the case of Gazprom, but also in the case of many other mining companies with headquarters in Moscow. However, if these companies did accrue large rents in a particular region, they would presumably have incentives to invest in that region to obtain greater rents. Also, they would try to attract more workers to the region and pay them higher wages in order to increase production. This would have resulted in greater growth of both GRP and regional wages. The fact that we do not observe such growth in the data suggests that at the very least, a substantial portion of the rents has been leaving the region via taxation. Note that we do not argue that taxing away resource rents is necessarily bad public policy. After all, natural resources belong to the entire country and Russia's overall economic growth has certainly benefitted from resource rents during the 2000s. It might be worrisome, however, if taxing away regional rents results in insufficient investment in the development of Russia's natural resource extraction.

Our results differ from those reported in a recent paper by Libman (2013) who finds that oil and gas producing regions grew "significantly faster" than other regions in 2000-2006 (see the first regression in Libman's Table 1). The main reason for this difference is presumably the fact that this particular Libman's regression is cross-sectional and thus is more likely to suffer

from an omitted variable bias. We note, however, that when we run a cross-sectional regression of the average growth rates of GRP for 2002-2011 on the share of mineral taxes in GRP or on the share of extractive industry in GRP, we get statistically insignificant coefficients. Another reason for the difference in our results might be the difference in the time periods. In fact, our main thesis is that the tax system introduced in 2002 has been particularly effective in siphoning natural resource, and particularly oil rents away from the regions.

While our results suggest that the central government has been able to tax away most of the benefits of regional resource rents, we do not claim that natural resources, including oil and gas, had no effect on regional GRP and wages. Note that our regressions looked only at growth rates during 2002-2011. Meanwhile, the current mineral tax became effective on January 1, 2002. Prior to that, the Russian royalty on oil and minerals was generally lower and was not collected as effectively. Therefore, it is likely that resource-rich regions enjoyed greater share of their rents prior to 2002 than afterwards. To check this conjecture, we run between-effects regressions using our un-differenced data. The estimates produced by these regressions reflect the relationship between the average mineral wealth measures and average GRP and wages for 2002-2011. The results presented in Tables 8 and 9 show that the mineral-rich regions have indeed preserved the pre-2002 rents and the elasticities of per capita "physical volume" GRP with respect to our measures of natural resource endowments are on the order of 0.1 for the broad measures, i.e., considerably higher than in the growth regressions. Similar results (available upon request) hold with respect to regional wages.[18]

4. Conclusions

We use novel measures of natural resource rents and more recent data than in the rest of the literature to evaluate the effect of mineral and hydrocarbon wealth on regional growth in Russia. We find that despite obvious growth benefits from point-source natural resources to the country as a whole, Russia's mineral producing regions grew at approximately the same rates as the rest of the country during 2002-2011. We conclude that the Russian federal government has been successful in taxing away the growth benefits of natural resource rents from the regions.

[18] We included two additional time-invariant variables in the between-effects regressions: average January temperature and a dummy variable for autonomous republics. These variables are exogenous and statistically significant, but they do not significantly affect the coefficients of the natural resource measures.

However, we also find that although most of the growth benefits of the resource-rich regions were taxed away during 2002-2011, these regions have preserved the rents accrued to them prior to 2002, i.e., prior to the introduction of the current version of Russia's mineral extraction tax. This last fact argues against the regional resource curse hypothesis.

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Table 1. – Variables and sources

Variable	Description
Extracting industries/GRP	Share of value added of extracting industries in GRP in %. Source: Regiony, various years.
GRP "physical volume" index	Logarithm of the index of GRP in constant prices expressed in percentages relative to previous year. Source: Regiony, various years.
January temperature	Average temperature (C^0) in January. Source: Regiony, various years.
Mineral tax (total)/GRP	The ratio of "Per capita mineral tax (total)" (see below) and per capita GRP in %.
Mineral tax (regional share)/GRP	The ratio of "Per capita mineral tax (regional share)" (see below) and per capita GRP in %.
Per capita GRP, "physical volume"	Per capita GRP calculated based on per capita GRP in year 2000 and the physical volume GRP index (see above)
Per capita GRP, year 2000 prices	Per capita GRP deflated to year 2000 prices by GDP deflator. Source: Regiony, various years
Per capita mineral tax (total)	Logarithm of one plus per capita mineral tax collections in a region in year 2000 rubles using Russia's GDP deflator. Source: tax Form 1-NM obtained from www.nalog.ru for various years.
Per capita mineral tax (regional)	Logarithm of one plus per capita mineral tax collections in a region assigned to regional budget (year 2000 rubles; using GDP deflator). Source: tax Form 1-NM, various years.
Per capita output of extractive industries	Logarithm of one plus per capita output of extractive industries in year 2000 rubles. Calculated based on "Extracting industries/GRP" variable and per capita GRP (see below).
Per capita tax on hydrocarbons (regional)	Logarithm of one plus per capita hydrocarbon portion of mineral tax collections assigned to the regional budget in year 2000 rubles using Russia's GDP deflator. Source: tax Form 1-NM, various years.
Per capita tax on hydrocarbons (total)	Logarithm of one plus per capita hydrocarbon portion of mineral tax collections in a region in year 2000 rubles using Russia's GDP deflator. Source: tax Form 1-NM obtained from www.nalog.ru for various years.
Population	Logarithm of regional population in thousand. Source: Regiony, various years.
Tax on hydrocarbons (regional) /GRP	The ratio of "Per capita tax on hydrocarbons (regional share)" and per capita GRP in %.
Tax on hydrocarbons (total)/GRP	The ratio of "Per capita tax on hydrocarbons (total)" and per capita GRP in %.
Wages (monthly)	Logarithm of average wages deflated by CPI (year 2000 rubles). Source: Regiony, various years.

Table 2. Allocation of the mineral tax between federal and regional budgets (%)

	2002		2003		2004		2005	2010
Oil								
Federal share	80	74.5	80	74.5	85.6	81.6	95	100
Regional share	20	5.5	20	5.5	14.4	5.0	5	
Autonomous district (okrug) share		20		20		13,4		
Natural gas								
Federal share	80	74.5	80	74.5	100	100	100	100
Regional share	20	5.5	20	5.5				
Autonomous district (okrug) share		20		20				
Minerals other than hydrocarbons								
Federal share	40		40		40		40	40
Regional share	60		60		60		60	60

Source: Russia's Budget Code available at http://base.consultant.ru/nbu/cgi/online.cgi?req=home

Table 3. – Descriptive statistics

	Mean	Standard deviation	Minimum	Maximum	Number of observations
GRP Index (% of previous year)	104.9	5.6	77.2	128.5	776
Per capita GRP (in year 2000 prices)	46,097	34,396	5,761	306,333	776
Per capita GRP (physical volume)	44,409	34,263	6,295	305,823	770
Per capita mineral tax (total; rubles)	1,812	8,817	0.0	101,552	776
Per capita mineral tax (regional share; rubles)	187	763	0.0	11,146	776
Mineral tax (total)/GRP	.018	.043	0	.370	776
Mineral tax (regional share) /GRP	.002	.004	0	.028	776
Per capita hydrocarbon tax (total; rubles)	1,689	8,822	0	101,435	775
Per capita hydrocarbon tax (regional share; rubles)	110	716	0	11,101	775
Hydrocarbon tax (total)/GRP	.016	.042	0	.370	775
Hydrocarbon tax (regional share) /GRP	.001	.003	0	.021	775
Extracting industries/GRP	.074	.115	0	0.609	622
Per capita output of extractive industries; rub.	6,704	21,030	0	183,493	622
Population (thousand)	1,701	1,303	156	7,152	776
Wages (monthly; year 2000 rubles)	4,593	2,000	1,344	12,943	775
Average temperature in January (C^0)	-13.2	7.2	-36.5	-.1	776

Note: no variables are in logarithms

Table 4A. Pairwise correlations of natural resource wealth measures

	PC mineral tax (total; rub.)	PC mineral tax (reg.; rub.)	Mineral tax (total) /GRP	Mineral tax (reg) /GRP	PC tax on hydro-carbons (total; rubles)	PC tax on hydro-carbons (reg.; rub.)	Tax on hydro-carbons (total) /GRP	Tax on hydro-carbons (reg.) /GRP	PC output of extractive industries (rubles)	Extractive industries /GRP
PC mineral tax (total; rub.)	1.000									
PC mineral tax (regional; rub.)	.857	1.000								
Mineral tax (total)/GR	.693	.509	1.000							
Mineral tax (regional)/ GRP	.595	.753	.434	1.000						
PC tax on hydrocarbons (total; rub.)	.849	.564	.722	.356	1.000					
PC tax on hydrocarbons (regional; rub.)	.711	.665	.650	.447	.824	1.000				
Tax on hydrocarbons (total) /GRP	.624	.395	.948	.356	.702	.608	1.000			
Tax on hydrocarbons (regional) /GRP	.458	.435	.463	.527	.550	.724	.495	1.000		
Extracting industries/GRP	.804	.781	.729	.646	.684	.683	.653	.387	1.000	
PC output of extractive industries (rub.)	.876	.831	.525	.546	.566	.456	.464	.331	.759	1.000

Note: per capita variables are in logarithms

Table 4B. Pairwise correlations of first-differenced natural resource wealth measures

	PC mineral tax (total; rub.)	PC mineral tax (reg.; rub.)	Mineral tax (total) /GRP	Mineral tax (reg.) /GRP	PC tax on hydro-carbons (total; rubles)	PC tax on hydro-carbons (reg.; rub.)	Tax on hydro-carbons (total) /GRP	Tax on hydro-carbons (reg.) /GRP	Extractive industries /GRP	PC output of extractive industries (rubles)
PC mineral tax (total; rub.)	1.000									
PC mineral tax (regional; rub.)	.336	1.000								
Mineral tax (total)/GR	.420	-.024	1.000							
Mineral tax (regional)/ GRP	.197	.481	.180	1.000						
PC tax on hydrocarbons (total; rub.)	.547	.034	.382	.007	1.000					
PC tax on hydrocarbons (regional; rub.)	.034	.792	-.100	.364	.046	1.000				
Tax on hydrocarbons (total) /GRP	.312	-.067	.842	.241	.311	-.092	1.000			
Tax on hydrocarbons (regional) /GRP	.014	.460	.008	.628	.006	.444	.009	1.000		
Extracting industries/GRP	.147	.011	.114	.057	.025	-.093	.088	-.154	1.000	
PC output of extractive industries (rub.)	.146	.055	.038	.038	.045	-.009	.028	-.017	.307	1.000

Note: per capita variables are in logarithms

Table 5A. – The effect of natural resources on GRP growth, 2002-2011

	Regressions in differences with clustered errors					
	(1)	(2)	(3)	(4)	(5)	(6)
PC mineral tax (total)	.011** (.005)	-	-	-	-	-
Mineral tax (total)/GRP	-	-.206** (.099)	-	-	-	-
PC mineral tax (regional share)	-	-	.007** (.004)	-	-	-
Mineral tax (regional share)/GRP	-	-	-	.195 (1.11)	-	-
PC Extractive industries	-	-	-	-	.003 (.003)	-
Extractive industry/GRP	-	-	-	-	-	.275** (.135)
Population	1.13*** (.320)	1.12*** (.312)	1.18*** (.328)	1.12*** (.315)	1.04*** (.283)	1.09** (.552)
R-square	.485	.483	.485	.481	.548	.561
No. regions	78	78	78	78	78	78
Observations	699	699	699	699	545	545

Notes: robust standard errors adjusted for clustering by region are in parentheses;
significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%;
regressions (5) and (6) are for 2004-2011
all regressions contain dummy variables for years

Table 5B. – The effect of natural resources on GRP growth, 2002-2008

	Regressions in differences with clustered errors					
	(1)	(2)	(3)	(4)	(5)	(6)
PC mineral tax (total)	.012* (.006)	-	-	-	-	-
Mineral tax (total)/GRP	-	-.305 (.253)	-	-	-	-
PC mineral tax (regional share)	-	-	.007 (.007)	-	-	-
Mineral tax (regional share)/GRP	-	-	-	.049 (1.57)	-	-
PC Extractive industries	-	-	-	-	.004 (.004)	-
Extractive industry/GRP	-	-	-	-	-	.357*** (.135)
Population	1.48*** (.378)	1.47*** (.362)	1.50** (.575)	1.48*** (.373)	1.50*** (.346)	1.56** (.334)
R-square	.176	.174	.172	.170	.251	.295
No. regions	78	78	78	78	78	78
Observations	465	465	465	465	311	311

Notes: robust standard errors adjusted for clustering by region are in parentheses;
significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%;
regressions (5) and (6) are for 2004-2008
all regressions contain dummy variables for years

Table 6A. The effect of hydrocarbon taxes on GRP growth, 2002-2011

	Regressions in differences with clustered errors			
	(1)	(2)	(3)	(4)
PC tax on hydrocarbons (total)	.001 (.004)	-	-	-
Tax on hydrocarbons (total)/GRP	-	-.067 (.113)	-	-
PC tax on hydrocarbons (regional share)	-	-	.001 (.002)	-
Tax on hydrocarbons (regional share)/GRP	-	-	-	-.932 (2.36)
Population	1.12*** (.314)	1.12*** (.312)	1.12*** (.318)	1.11*** (.314)
R-square	.485	.486	.486	.486
No. regions	78	78	78	78
Observations	697	697	697	697

Notes: robust standard errors adjusted for clustering by region are in parentheses; significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%; all regressions contain dummy variables for years

Table 6B. The effect of hydrocarbon taxes on GRP growth, 2002-2008

	Regressions in differences with clustered errors			
	(1)	(2)	(3)	(4)
PC tax on hydrocarbons (total)	.005 (.007)	-	-	-
Tax on hydrocarbons (total)/GRP	-	-.016 (.128)	-	-
PC tax on hydrocarbons (regional share)	-	-	.005 (.009)	-
Tax on hydrocarbons (regional share)/GRP	-	-	-	-.890 (3.08)
Population	1.47*** (.375)	1.48*** (.374)	1.48*** (.378)	1.47*** (.370)
R-square	.171	.170	.171	.170
No. regions	78	78	78	78
Observations	465	465	465	465

Notes: robust standard errors adjusted for clustering by region are in parentheses; significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%; all regressions contain dummy variables for years

Table 7A. The separate effect of mineral and hydrocarbon resources and on GRP growth, 2002-2011

	(1)	(2)	(3)	(4)	(5)	(6)
PC mineral tax (total)	.015*** (.005)	-	-	-	-	-
PC tax on hydrocarbons (total)	-.006 (.004)	-	-	-	-.003 (.003)	-
Mineral tax (total)/GRP	-	-.443*** (.101)	-	-	-	-
Tax on hydrocarbons (total)/GRP	-	.210*** (.049)	-	-	-	-.078 (.112)
PC mineral tax (regional share)	-	-	.013** (.005)	-	-	-
PC tax on hydrocarbons (regional share)	-	-	-.005* (.003)	-	-	-
Mineral tax (regional share)/GRP	-	-	-	.867 (.583)	-	-
Tax on hydrocarbons (regional share)/GRP	-	-	-	-1.79 (2.41)	-	-
PC Extractive industries	-	-	-	-	.003 (.003)	-
Extractive industry/GRP	-	-	-	-	-	.261* (.138)
Population	1.14*** (.321)	1.10*** (.315)	1.18*** (.329)	1.12*** (.316)	1.03*** (.282)	1.08*** (.268)
R-square	.490	.488	.490	.486	.543	.565
No. regions	78	78	78	78	78	78
Observations	697	697	697	697	554	543

Notes: robust standard errors adjusted for clustering by region are in parentheses;
significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%;
regressions (5) and (6) are for 2004-2011
all regressions contain dummy variables for years

Table 7B. The separate effect of mineral and hydrocarbon resources and on GRP growth, 2002-2008

	(1)	(2)	(3)	(4)	(5)	(6)
PC mineral tax (total)	.012* (.007)	-	-	-	-	-
PC tax on hydrocarbons (total)	-.001 (.006)	-	-	-	-.004 (.003)	-
Mineral tax (total)/GRP	-	-.627** (.308)	-	-	-	-
Tax on hydrocarbons (total)/GRP	-	.241*** (.063)	-	-	-	-.041 (.125)
PC mineral tax (regional share)	-	-	.006 (.007)	-	-	-
PC tax on hydrocarbons (regional share)	-	-	-.001 (.010)	-	-	-
Mineral tax (regional share)/GRP	-	-	-	.822 (1.08)	-	-
Tax on hydrocarbons (regional share)/GRP	-	-	-	-1.72 (3.31)	-	-
PC Extractive industries	-	-	-	-	.005 (.004)	-
Extractive industry/GRP	-	-	-	-	-	.359*** (.135)
Population	1.48*** (.379)	1.45*** (.364)	1.50*** (.386)	1.47*** (.372)	1.51*** (.345)	1.56*** (.335)
R-square	.176	.177	.172	.171	.252	.296
No. regions	78	78	78	78	78	78
Observations	465	465	465	465	311	311

Notes: robust standard errors adjusted for clustering by region are in parentheses;
significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%;
regressions (5) and (6) are for 2004-2008
all regressions contain dummy variables for years

Table 8. – The effect of natural resources on GRP, 2002-2011

	Between-effects estimation					
	(1)	(2)	(3)	(4)	(5)	(6)
PC mineral tax (total)	.091*** (.019)	-	-	-	-	-
Mineral tax (total)/GRP	-	5.42*** (1.10)	-	-	-	-
PC mineral tax (regional share)	-	-	.189*** (.030)	-	-	-
Mineral tax (regional share)/GRP	-	-	-	68.0*** (16.0)	-	-
PC Extractive industries	-	-	-	-	.109*** (.019)	-
Extractive industry/GRP	-	-	-	-	-	.027*** (.004)
Population	.176*** (.058)	.164*** (.058)	.193*** (.052)	.229*** (.058)	.085*** (.019)	.202*** (.049)
Republic	-.190* (.107)	-.192* (.106)	-.197** (.098)	-.232** (.112)	-.163 (.109)	-.218** (.093)
Average January temperature	-.022*** (.007)	-.026*** (.006)	-.006 (.007)	-.015* (.008)	-.021*** (.007)	-.016*** (.006)
R-square (between)	.500	.508	.579	.475	.483	.624
No. regions	77	77	77	77	77	77
Observations	770	770	770	770	616	616

Notes: robust standard errors adjusted for clustering by region are in parentheses;
significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%;
regressions (5) and (6) are for 2004-2011
all regressions contain dummy variables for years
Republic = 1 if the region is a "republic"; Republic = 0 otherwise

Table 9. The effect of hydrocarbon taxes on GRP, 2002-2011

	Between-effects estimation			
	(1)	(2)	(3)	(4)
PC tax on hydrocarbons (total)	.053*** (.015)	-	-	-
Tax on hydrocarbons (total)/GRP	-	5.50*** (1.26)	-	-
PC tax on hydrocarbons (regional share)	-	-	.109*** (.026)	-
Tax on hydrocarbons (regional share)/GRP	-	-	-	54.9** (24.6)
Population	.164*** (.063)	.164*** (.060)	.158** (.061)	.203*** (.064)
Republic	-.188 (.113)	-.193* (.109)	-.197* (.111)	-.177 (.120)
Average January temperature	-.033*** (.006)	-.029*** (.006)	-.032*** (.006)	-.033*** (.007)
R-square (between)	.445	.483	.470	.387
No. regions	77	77	77	77
Observations	769	769	769	769

Notes: robust standard errors adjusted for clustering by region are in parentheses;
significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%;
all regressions contain dummy variables for years
Republic = 1 if the region is a "republic"; Republic = 0 otherwise

Table 10. – The effect of natural resources on wages, 2002-2011

	Regressions in differences with clustered errors					
	(1)	(2)	(3)	(4)	(5)	(6)
PC mineral tax (total)	.005 (.005)	-	-	-	-	-
Mineral tax (total)/GRP	-	-.103 (.078)	-	-	-	-
PC mineral tax (regional share)	-	-	.006*** (.002)	-	-	-
Mineral tax (regional share)/GRP	-	-	-	.269 (.855)	-	-
PC Extractive industries	-	-	-	-	.003 (.002)	-
Extractive industry/GRP	-	-	-	-	-	.001 (.001)
Population	.086 (.320)	.084 (.259)	.130 (.243)	.083 (.260)	.121 (.283)	.127 (.253)
R-square	.663	.663	.665	.662	.707	.708
No. regions	78	78	78	78	78	78
Observations	697	697	697	697	543	543

Notes: robust standard errors adjusted for clustering by region are in parentheses;
significance levels for coefficient estimates: *** – 1%; ** – 5%; * – 10%;
regressions (5) and (6) are for 2004-2011
all regressions contain dummy variables for years

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