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Rule of Law and the Resource Curse: Abundance Versus Intensity

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Abstract We examine the 'resource curse' using new data on historic resource stocks and an improved econometric methodology. The paper distinguishes between resource abundance (stocks) and extractive intensity (flows), focusing on relationships between resources and rule of law. Previously unavailable information on past resource stocks is estimated. We find that economically large initial natural resource stocks are associated with subsequent lower levels of rule of law and do not directly affect growth, while raw resource exports do not have a significant effect on rule of law when stocks are included in the analysis but do affect average growth rates. Sample size is maximized through the use of an EMis (expectation maximization with importance sampling) algorithm to replace missing data, minimizing the bias and inefficiency associated with listwise deletion, which commonly eliminates half or more of the available data in this setting.

Keywords Cross-country comparisons · Multiple imputation · Resource curse · Resource extraction · Resource stocks · Rule of law

1 Introduction and Background

In the last decade, researchers have shown a robust association between natural resources and poor growth and development outcomes. Cross-country analyses and case studies suggest that countries rich in natural resources, particularly in fuels and minerals, have grown more slowly than other countries, established less effective institutions, and suffered lower levels

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of welfare indicators such as child health and life expectancy. The intuition that starting out with more wealth of this or indeed any form must be advantageous or at worst neutral appears to be wrong. Resource bounty is linked strongly enough to ongoing growth and development failures that it is referred to as a ‘curse’.

Empirical work in this area has suffered from data limitations; data on past natural resource bases and use is patchy and often unreliable, especially in historically poor and less developed countries. This makes distinguishing between outcomes linked to resource abundance (large stocks) and those linked to resource extraction intensive patterns of economic activity problematic. Additionally, the cross-country growth regressions used in this literature are hampered by the limited data available for many conditioning variables, and large amounts of the available data are discarded as countries are dropped from consideration for missing data on a conditioning variable.

This work addresses both of these empirical difficulties. First, we develop estimates of 1970 resource stocks for a large sample of countries using information on current reserves and past extraction flows. Potential selection problems are avoided and sample sizes maximized by taking advantage of an algorithm to impute maximum-likelihood distributions for missing information, so all observed countries are included in the empirical analysis.

We focus on the relationship between abundance and the institutions that establish or fail to establish rule of law. The chief finding is that mineral abundance, in particular, is associated with lower subsequent scores on a commonly used rule of law measure, even when controlling for resource flows. In contrast with earlier work, resource extraction rates do not have a significant relationship with the rule of law when stocks are controlled for.

Though it proves difficult to make precise estimates of the size of the indirect effect resource abundance has on growth rates operating through rule of law, results are provided, allowing comparison with the previous literature. Similarly, results using listwise deletion—eliminating a country from the sample if it is missing any of the conditioning variables—are provided. We argue that results using multiple imputation for missing information are preferable.

This work fits into a broader literature on the resource curse and more closely into a subset of this work that focuses on institutions. In an influential series of papers, Sachs and Warner (1995a,b, 1999, 2001) investigate the relationship between raw resource export intensity (*sxp*) and growth rates using cross sectional analyses of income growth between 1970 and 1990. After controlling for political and trade characteristics, they find that an increase of one standard deviation in the resource intensity variable is associated with about a one percentage point lower growth rate. This prompted empirical investigations suggesting that links to political and economic institutions were important channels through which the curse operated.

We focus on theories of the resource curse which act through weak institutions—endogenous or exogenous to natural resources—as the key channel through which the curse operates. Other theories suggest that the resource sector (or expectations of an expanding resource sector) crowds out activity and investment in, and undermines the competitiveness of, other sectors such as manufacturing (which might provide more growth-enhancing externalities than the resource sector), or that terms of trade effects tend to systematically deteriorate for primary commodities,[1] or that the volatility associated with export income

[1] Cuddington (1992) suggests that this is not supported empirically.

from resource extraction is sufficiently greater than in other sectors so as to tend to confound planning and investment and thus growth (e.g. Rosenberg and Birdzell 1986).[2]

There is an extensive literature on the ways in which institutions matter for growth and development and on institutional change. Rosenberg and Birdzell, using a primarily historical approach, emphasize the importance of institutions that allow and reward innovation for growth, particularly with regards to property rights and rule of law. Hubbard (1997) provides a more recent discussion of the transactions-cost approach to understanding the role and form of institutions emphasized by North (e.g. North 1990). Rodrik et al. (2004) conclude that 'institutions rule' over other potential determinants of growth and, in particular, that geographic variables have a strong impact on institutions but little or no effect on growth beyond the institutional linkage.

Leite and Weidmann (1999); Gylfason et al. (1999); Gylfason (2001), and Isham et al. (2005) investigate relationships between resource flows and indicators related to institutions, investment, and education, finding that point-source resource flows matter for characteristics that affect growth, including rule of law. Similarly, Sala-i-Martin and Subramanian (2003) find that once the effect of resource flows on institutions (with an emphasis on rule of law) is accounted for, resources have no effect or a small positive effect on growth rates of per capita GDP. Bulte et al. (2005) show that the curse appears in welfare indicators, even when income levels are controlled for, suggesting links to social capital.

Many of these authors examine the resource curse using flow measures of resource intensity or dependence, based on trade in commodities, production of minerals, or the size of the workforce employed in resource extraction. This is problematic because flows are choice variables: high levels of natural resource export intensity are plausibly endogenous to numerous political, economic and institutional variables as well as to the presence of resource stocks. Using the initial period flow variable as a proxy for resource abundance precludes distinguishing between effects on growth associated with abundance and effects associated with the economic intensity of extraction activity.[3] Brunnschweiler and Bulte (2008) emphasize this point and the endogeneity of the intensity variables, finding that abundance determines average intensity over a 20-year-period, suggesting that starting point-intensity is the wrong variable to use to investigate institutional and growth outcomes. In contrast to the findings of this paper, their work suggests that abundance itself is not linked to poor institutional quality or poor growth outcomes. They, as well as Gylfason (2001), Ding and Field (2005) and Hodler (2006) use estimates of 1994 subsoil abundance from the World Bank. Our approach differs in that we estimate historic reserves for 1970, the beginning of the sample period, rather than using later data. Given the relatively slow rate of institutional change, and the use of early 1970s starting point for much of this work, we prefer these estimates to more contemporary ones. There remain important endogeneity concerns with either approach; see below and Brunnschweiler and Bulte for further discussion.

Explanations of observed links between resources and institutions can be sorted into a few main categories. Several authors have suggested that resources or their extraction and export place pressure on institutional arrangements, leading to their deterioration, making weak institutions endogenous to natural resources.

Early work on the 'staple trap' noted that dependence on one or a few extractive sectors, or staples, can lead to the development of institutions suitable for that sector but not for

2 Two helpful survey articles on the resource curse literature are Ross (1999) and Stevens (2003), both of which set forth the major theories regarding the mechanism by which the curse operates.

3 Stijns (2005) provides an empirical accounting of possible direct stock effects on growth; his effort is hampered, however, by his use of current reserves data rather than historic information, which raises the possibility of significant endogeneity problems.

sustained growth (Watkins 1988). Another explanation is that decision makers in resource-rich countries are not as responsible to the population at large as they might otherwise be. Rents from the extractive sector are more easily captured than revenues from taxation and the public purse is less closely watched. A related hypothesis argues that wealth (from rents) is concentrated (through corruption and rent-seeking) in the politically dominant group that determines policy (Stevens 2003) and that these dominant groups have incentives to 'loot' the country for private benefit rather than grow the economy for the common good. Conning and Robinson (2007) show how ambiguous property rights to natural resources (agricultural land in their model) and anticipated or actual conflicts over their distribution can lead to inefficient outcomes.

It is possible that leaders of resource-rich countries systematically make poor choices about important growth-related policies, through excessive borrowing, irrational optimism, bad investment choices, or other failures. In this case it is not necessary that resources determine institutions, only that any existing weaknesses will become problematic in situations where resource extraction is a main activity of the economy. Thus the mix of bad governance and resources is the problem, not resources in and of themselves (see Mehlum et al. 2006 and Hodler 2006 for models where conflict over resources in 'grabber friendly' regimes leads to declines in income).

Theory suggests that conflict over natural resource stocks or flows can affect human, social and institutional capital. There is empirical evidence from studies using measures of resource flows of an association between resource extraction and growth. Further empirical evidence suggests that linkages between export intensity and institutions are important and complex and that these drive at least part of the resource curse through an indirect effect on growth. Thus far no study has carefully examined resource stocks from the same period as the more commonly seen flow measures. This is the first work to consider resource stocks and flows simultaneously and to investigate their relationships with both growth and institutional outcomes.

2 Empirical Issues and Data

The analysis requires measures of resource stocks in 1970. Measured reserves depend on endogenous exploration activities, which in turn depend on local technology, prices, and expectations about the conditions under which extraction will take place. To minimize this imprecision as much as possible, starting-period stocks are estimated by adding past production data to current reserves, so that any resources not mapped or included in stocks in the earlier period but nonetheless present and mapped or included later as technology or other variables changed are included. Thus, the measure of resource stocks used to represent abundance in the analysis consists of the broadest available measure of current reserves plus the total quantity extracted between 1970 and the date reserves are measured. We prefer this to data on known stocks in 1970 (if it were widely available, which is not the case) because it allows for forward looking actors to be influenced by their expectations about future discovery and extraction.

Stock values rather than physical quantities are used in the analysis. This enhances comparability across resources; physical measures of abundance per person may be suitable for considering the impact of abundance of that commodity in isolation, but they provide little insight into the relative importance of different commodities. They are also unsuitable for indices of resource abundance comprised of multiple commodities. Given the large number of commodities potentially of interest, using values enables the construction of an economically meaningful index of abundance, one that recognizes the differential economic impact of a ton of gold and a ton of barite. It should be noted, however, that where values changed dramatically over the period being studied, this measure will over- or under-estimate relationships.

Mined nonfuel minerals are represented by a composite variable. The 1970 value of the 1970 reserve of 35 different minerals in 170 countries is calculated using 1970 prices and an estimate of 1970 stocks based on the 2002 "reserve base" added to extraction flows from 1970 to 2001. The reserve base includes deposits considered 'economic', i.e. worth extracting at current prices and extraction costs, as well as marginally economic reserves and sub-economic reserves "that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics" (U.S. Department of the Interior 2003). The measure of aggregate abundance in oil, coal, gas, and mined minerals, *fuelminratio*, is the total value of the estimated 1970 commodity stocks divided by total GDP in 1970, and *coalratio, oilratio, gasratio* and *minratio* are analogous for disaggregated measures.[4] Full details of the data sources, and of the minerals included in the composite variable, are in the Appendices.

The procedure of adding past production to current reserves mitigates but does not eliminate the partial endogeneity of known reserves. These data should, however, cover most mineral resources that 1970 economic actors were aware of or might reasonably have suspected. This is a clear improvement over reserves data from 1970, which underestimate resources that could plausibly have mattered to growth in the period under consideration (and which, as Sachs and Warner (1995b) note, are not generally regarded as of high quality), as discovery was ongoing. It is also an improvement over the approach of using present-day reserves, because it accounts for depletion during the intervening period. Further, it allows for greater coverage of minerals and countries than is consistently available using historical reserves data.

To see how the abundance measures are constructed and where the endogeneity arises, consider the following identity:

$$R_0 + \sum_{t=1}^{t} D_t - \sum_{t=1}^{t} Y_t = R_t \tag{1}$$

where R_0 is known reserves at the start of the observation period, R_t is current reserves, D_t is discoveries in year t, and Y_t is extraction in year t. The stock estimate,

$$\sum_{t=1}^{t} Y_t + R_t \tag{2}$$

is equal to

$$R_0 + \sum_{t=1}^{t} D_t \tag{3}$$

or measured historic reserves plus discoveries during the sample period, which may be endogenous. In the absence of reliable data on discoveries over time, the measure is the best available indicator of endowed natural resource wealth at the beginning of the sample period.

The endogeneity is moderated if we believe that actors had some knowledge about reserves suspected but not yet enumerated in 1970. If the concern is that richer and more stable countries will discover more natural resources than poorer and less stable countries, this works

[4] Results using population in the denominator rather than GDP are similar.

Table 1 Summary statistics—estimated initial resource stocks

	Mean	Standard deviation*
Fuel and mineral value	136995.4	411943.2
Mineral value	64845.4	236544.2
Fuels value	72150.0	236646.1
Oil value	34635.4	129528.3
Coal value	28676.9	128335.1
Natural gas value	8837.7	43938.9
Fuel and mineral/GDP	34.8	153.3
Mineral/GDP	22.8	151.3
Fuels/GDP	13.5	54.6
Oil/GDP	8.9	39.3
Coal/GDP	2.2	20.0
Natural gas/GDP	2.3	18.5

* Includes outliers
Values in millions of USD

against any finding of a relationship between resource abundance and growth or rule of law. For a finding of a resource curse in stocks to be spurious due to this endogeneity, it must be the case that there is systematically more exploration and discovery of natural resources in poor, unstable countries rather than less.[5]

Most of these commodities are found in a variety of differentially priced grades. This procedure does not distinguish grades (though measures of mineral content in mined ore for stocks and production flows have been used wherever available) or geological variations affecting extraction and transport costs. Regional pricing might be of particular importance for coal and natural gas, which are not traded in a global market to the same extent that oil, metals and ores are. These data do not allow for such differences. The physical difficulty of extraction or the distribution of various grades of many different kinds of minerals should not vary systematically with other variables influencing growth. However, using world commodity prices to construct values implies measurement error in these variables with attendant attenuation bias in estimated coefficients. Detailed data on grades of commodities and on regional prices was not broadly available for this analysis. Some insignificant coefficients on resource abundance variables in the results may reflect this bias. Summary statistics for resource variables are shown in Table 1.

This study uses the *sxp* variable popularized by Sachs and Warner, as well as disaggregated measures of resource flows, to capture the resource intensity of the economies under consideration. *Sxp* measures the ratio of the value of raw resource exports in 1970 to national income. This is a measure of intensity; it is not a measure of extraction or extraction values—for instance, countries which process their mineral resources rather than exporting them will have lower values.

Measuring rule of law is also not straightforward. This analysis follows Rodrik et al. (2004) in treating current institutions as a stock which has been created by a past flow of good or bad policies, that is, by the operation of past institutions. Results thus rely upon current measures of rule of law. For some specifications, rule of law is instrumented in the growth regression using 2SLS. The focus is on the effect of abundance on rule of law, but the two stage process may enable estimation of any indirect effect of resource abundance on growth, as it operates through rule of law. We are also interested in any direct effect of

[5] A reviewer points out that poor countries might be expected to have higher ratios of discovery to GDP even if they did not have more discovery in absolute terms. Concern about this may be mitigated somewhat by the similar population denominated results, not shown here but available from the author.

resource stocks on growth after controlling for rule of law, as this suggests that institutional links may be insufficient to explain observed links between resource abundance and growth.

Rule of law data are for 2002, from the Kaufmann et al. (2003) series of governance indicators. The variable captures the reliability, transparency and predictability of the judicial system, the ease of contract enforcement, crime rates and the security of property rights. This measure captures some of the institutional characteristics that link directly with economic activity and thus, arguably, with economic growth rates. Rule of law was chosen primarily for comparability with the existing literature and also in the hopes that a narrower measure than general 'institutional quality' might suffer from reduced measurement error.[6] This measure should reflect both the kinds of institutions in place and something of the environment in which they operate, for example the degree and pervasiveness of conflict. In the context of institutional change and rule of law, results reflect that data are not used for countries which came into or went out of existence in the study period. Clearly, country dissolution or formation reflects major institutional change at the same time that it makes growth and other statistics difficult to compile.[7]

Measures of land abundance are also included as controls for relatively diffuse natural resources, which have not generally been found to have deleterious development impacts; FAO data on arable land and land in permanent crops (e.g. grapevines, coffee, and cocoa), are considered separately, to allow for differential impacts of capital-intensive plantation agriculture and temporary crops. Land variables are measured in terms of acres per capita.

Data on economic growth are from the United Nations Statistical Division. This allows for a considerably larger sample than the Penn World Tables (PWT), which feature in much of the previous literature. To investigate the possibility that systematic differences in these data might drive different results, raw correlations between the two measures of growth and key independent variables in a common sample were examined. The UN data appear to reflect the same patterns of economic activity as the PWT with greater coverage and thus are used throughout. Sources for additional conditioning variables are given in the appendix.

3 Analysis and Empirical Investigation

We briefly examine the relationship between natural resource export intensity and our measure of resource abundance. For the 110 countries with data on export intensity in 1970, the correlation between *sxp* and the aggregate measure of point-source abundance, *fuelminratio*, is 0.49. The rank-order correlation is 0.31. Countries such as India and China had low export intensity in 1970, but had values in the top quartile for *fuelminratio* in that sample, while countries such as Uganda and the Gambia had high export intensity and relatively low levels of abundance. This could reflect large changes in extraction and/or export patterns after 1970, drawdown of reserves, or variation in ease and intensity of exploration activity across countries and commodities. It appears that the distinction is empirically as well as theoretically important, and that export flows are an unsatisfactory proxy for resource abundance.

Initial analysis of the relationships observed between growth, rule of law and resource abundance is performed under listwise deletion of observations missing data on at least one

6 Aixala and Fabro (2007) compare aggregate measures of institutional quality as well as each of the six component measures (of which our rule of law measure is one) developed by the World Bank. They find that rule of law has the highest explanatory power for growth and that it performs similarly to the Easterly and Levine (2003) composite index of institutional quality.

7 This eliminates all of the former Soviet and Yugoslav republics, Ethiopia and Eritrea, the Czech and Slovak states, Yemen, and the UAE.

variable. This yields results for the sample of countries for which all conditioning data are available. Then, multiple imputation techniques are applied in an effort to use all of the data available and reduce problems associated with sample restriction. Both results are included for purposes of comparison to the existing literature and to one another; the imputation methodology is more statistically sound.

First, we consider whether our measure of resource abundance is related to growth rates or rule of law in the largest sample available. This allows us to consider as a preliminary question whether there is evidence of a curse in abundance that requires explanation. The sample will be a good deal smaller once additional conditioning variables are considered without missing variables procedures, and results of this analysis for the smaller sample are presented as well.

The first equations estimated are:

$$G7000_i = \alpha + \beta\ lgdp70_i + \gamma fuelminratio_i + \delta landea_i + \varepsilon_i \tag{4}$$

and

$$RL_i = \alpha + \beta\ lgdp70_i + \gamma fuelminratio_i + \delta landea_i + \varepsilon_i \tag{5}$$

OLS regressions of growth rates from 1970 to 2000 and current rule of law on the log of initial income (allowing for convergence in incomes, the tendency of poor countries to grow at a faster rate), the aggregate stock variable *fuelminratio* (the value of the stock of coal, oil, gas and minerals at the beginning of the sample period to GDP), and the amount of arable land and land under plantation crops per capita are performed for all countries that did not form or dissolve in the sample period.

Examination of the *dfbeta* statistics verifies that evident outliers in resource abundance, Botswana, Guinea, and Qatar, are also acting as regression outliers for point-source resources. For land resources, Australia appears to be an outlier as well as an influential observation in the regression.[8] Botswana is a clear outlier in coal abundance (gem-quality diamonds, also important for Botswana, are not included in the mineral variable), Guinea in minerals (chiefly aluminum), and Qatar in natural gas and oil.[9] Of these countries, Botswana is a fast growing country and Guinea and Qatar are growing very slowly and shrinking, respectively, over the period observed.

Dropping Australia, Botswana, Guinea and Qatar leaves 166 observations of growth and abundance and 159 observations of rule of law and abundance. Results are reported in columns 1 and 5 of Table 2. The coefficient on *fuelminratio* is negative and significant in both regressions. The standard deviation of *fuelminratio* is equal to 55.5 with the outlying observations dropped, so a one standard deviation increase in point-source resource abundance is associated with a decline of 0.39 in the growth rate, significant but smaller than previous estimates based on Sachs and Warner's *sxp* variable, and a decline of 0.1 in our rule of law measure. Arable land is also negative and significant.

[8] The statistic used is abs(dfbeta); abs(dfbeta) $> 2\hat{n}(-0.5)$ indicates that the observation should be evaluated for inclusion, where *n* is the number of observations in the regression (STATA 8 manual). The *dfbeta* statistic is a regression diagnostic which combines the regression residual with the leverage an observation exerts on the estimated coefficient. It is scaled such that a *dfbeta* statistic equal to 1 for a particular country reveals that the omission of that country from the analysis would change the estimated coefficient by one standard deviation from the estimate with that country included. The Central African Republic and Niger appear to be outliers in land but are not leverage points in the regression and so are left in the sample.

[9] Guinea's mineral stocks in 1970 were worth 1,892 times the size of their economy; ten countries have oil and natural gas or mineral stocks that were worth more than 100 times their start-period GDP, and Botswana had coal stocks valued at 262 times GDP.

Table 2 Growth 1970–2000, rule of law, and natural resource stocks: OLS in full and listwise deletion samples

	Full	Sample	Listwise deletion			Full	Sample			Listwise deletion		
			Restricted	Sample						Restricted	Sample	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Growth rates				Rule of law							
Log income per capita 1970	0.2343	0.2689*	0.4815***	0.4739***	0.6248***	0.4469***	0.6294***	0.4610***	0.6758***	0.4807***	0.6892***	0.5129***
	0.1453	0.1396	0.1524	0.1537	0.0503	0.0808	0.0486	0.0881	0.0667	0.1276	0.0546	0.1197
Fuel & mineral stocks/GDP	**−0.0070** **	–	**−0.0128***	–	**−0.0018***	**−0.0014***	–	–	**−0.0046***	**−0.0050***	–	–
	0.0037		0.0032		0.0006	0.0007			0.0013	0.0015		
Arable and plantation land per cap.	**−0.9586***	–	**−0.4762** **	–	**−0.2127***	−0.1462	–	–	0.0110	−0.0438	–	–
	0.2608		0.2086		0.1281	0.101			0.1069	0.0955		
Oil stocks/GDP	–	**−0.0299***	–	−0.0247	–	–	**−0.0045***	−0.0034	–	–	**−0.0487** **	−0.0322
		0.0084		0.0504			0.0025	0.0038			0.0238	0.0198
Natural gas stocks/GDP	–	0.0756	–	−0.0027	–	–	0.0215	0.0233	–	–	0.0643	0.0051
		0.0807		0.1321			0.0227	0.0377			0.0629	0.0559
Coal stocks/GDP	–	0.0380	–	−0.0101	–	–	0.0074	−0.0051	–	–	−0.0114	−0.0126
		0.0310		0.0494			0.0097	0.0085			0.0184	0.0137
Mineral stocks/GDP	–	−0.0035	–	**−0.0118***	–	–	**−0.0016***	**−0.0016***	–	–	**−0.0039***	**−0.0037***
		0.0022		0.0029			0.0006	0.0006			0.0010	0.0013
Arable land per capita	–	**−0.9722***	–	**−0.4690** **	–	–	−0.1743	−0.1228	–	–	0.0605	−0.0032
		0.2624		0.2044			0.1150	0.0913			0.0899	0.0791
Plantation land per capita	–	−1.1525	–	−5.6889	–	–	**−1.2050** **	−0.7854	–	–	**−3.7474***	**−2.8162** **
		1.3210		3.6888			0.4784	0.5503			1.2098	1.2312
Fraction English language	–	–	–	–	–	0.6734***	–	0.6494***	–	0.7881***	–	0.5280 **
						0.2135		0.2100		0.2588		0.2173
Fraction European language	–	–	–	–	–	−0.0903	–	−0.0779	–	−0.3476	–	−0.2129
						0.1820		0.1827		0.2492		0.2155
Latitude (absolute value)	–	–	–	–	–	0.0218***	–	0.2050***	–	0.0184 **	–	0.0160*
						0.0057		0.0063		0.0086		0.0081
Constant	2.1322***	2.1816***	2.1464***	2.4064***	0.7098***	0.0408	0.7506***	0.1086	0.6830***	0.1611	0.9062***	0.3847
	0.2156	0.2214	0.2430	0.2973	0.0802	0.2533	0.0808	0.2791	0.1021	0.3802	0.1046	0.3693
Observations	166	166	74	74	159	129	159	129	73	73	73	73
R-squared	0.1122	0.1687	0.1911	0.2230	0.5528	0.5970	0.5703	0.6889	0.6270	0.7133	0.7168	0.7611
Instrument F-scores	–	–	–	–	–	8.8	–	6.6	–	6.4	–	3.9

Robust standard errors under coefficient estimates

$*p < 0.1$, $**p < 0.05$, $***p < 0.01$

The aggregate stock and land variables require different kinds of abundance to have similar effects on growth, which may be unreasonable. In the data, mineral and oil abundance tend to dominate the *fuelminratio* variable, and arable land dominates *landea.* The different abundance variables are not highly correlated; the most closely related, oil and natural gas, have a correlation coefficient of 0.51.

In an OLS regression of growth on a convergence term and oil, gas, mineral, and coal abundance as well as arable land per capita and land in plantation crops, only oil and arable land have a significant (and negative) relationship with growth rates. Mineral stocks and plantation land have highly significant associations with lower rule of law, and oil is weakly linked to the same outcome. Results are reported in columns 2 and 7 of Table 2. A few countries that are not outliers in aggregate stock abundance are outliers in one of the narrower classifications, but the sign, approximate magnitude and significance of the results are robust whether they are included or not. Because both theory and the empirical results suggest that different kinds of abundance have different effects, the preferred specifications are those using disaggregated resource stock data. Columns 6 and 8 add instruments for rule of law; note that they are not directly comparable as the sample drops to 129, but results for minerals or aggregate stocks are quite similar.

Moving to a more detailed specification, the Hall and Jones (1999) language variables instrument for endogenous rule of law in a two stage least squares growth regression[10]. The equations estimated are a first stage regression with rule of law as a dependent variable, and a second stage regression with the growth rate as a dependent variable,

$$RL_i = \lambda + \delta\ lgdp70_i + \tau NR_i + \rho CV_i + \sigma Z_i + \mu_i \quad (6)$$

$$G7000_i = \alpha + \beta\ lgdp70_i + \gamma NR_i + \eta CV_i + \kappa RL_i + \varepsilon_i \quad (7)$$

where *RL* is a current measure of rule of law in country i, lgdp70 is log per capita GDP in 1970 for country i, *NR* is a set of measures of natural resource stock abundance in a particular country in 1970,[11] *CV* is a set of conditioning variables for each country, Z is an instrument or instruments explaining some of the variation in institutional quality, $G7000$ is the rate of growth between 1970 and 2000, and μ_i and ε_i are mean-zero error terms. Our focus will be on the first stage results, but second stage results are reported as well, chiefly for comparison with the existing literature.

Durlauf (2001) and others point out that this two-stage approach is vulnerable to criticism because the instruments may be correlated with variables omitted from the main growth regression, leading to correlation between the error term and the instrumented variable. If the instruments are correlated with anything that should be in the growth regression but is not, problems can arise even when the instruments pass standard statistical tests.

Due to the open-endedness of growth theory and the great number of variables that have been shown to have significant relationships with growth rates in some specifications (Sala-i-Martin et al. 2004), it is reasonable to suspect that variables that might influence growth

[10] This is not intended as a suggestion that European or British influence and/or contact implies good or bad institutional quality relative to one another or to other influences; it reflects empirical findings that these variables are associated with some of the variation in institutions, while having no theoretical or intuitive effect on growth itself. Hall and Jones suggest that this is because 'modern' capitalism developed in Europe and the nature of other countries first exposure to this system had lasting effects on the forms of institutions put in place that relate to capitalist economic activity. Results using the Acemoglu et al. (2001) colonial mortality instruments show negative impacts of resource stocks on growth and rule of law, but the sample size is quite small, plausibly prone to meaningful selection bias, and the instrument's performance is weak. Full results using this variable are available from the author.

[11] For natural gas, coal and oil, stocks are measured in 1971 as 1970 flows were not available.

are not included in the regressions. The analysis presented here uses new data to estimate a measure of the stock of natural resources available to a country at the beginning of the period analyzed. This should be uncorrelated with determinants of growth not included in cross-country growth regressions. However, concern about missing variables remains, especially given the marginal performance of the instruments used, so discussion emphasizes the first stage results, relating initial resource abundance to subsequent rule of law. If the only relationship that can be determined with some precision is the effect of resources on rule of law, this remains informative both about likely indirect effects on growth, and about the process of institutional development. Results using a variety of potentially important additional variables are discussed briefly below and available on request.

Other criticisms of cross country growth regressions highlight the importance of considering what countries are of interest to the question and how robust results are to small changes in the sample (e.g. Knabb 2005). If inclusion in the sample is driven by the availability of conditioning variables, choice of variables amounts to choice of sample, and different results may confuse the different effects of the controlling variables and of the changing sample. Under listwise deletion, researchers examining the impact of different conditioning variables are likely to look at different samples of countries, or, if only countries for which data is available for all conceivably important variables are considered, will evaluate a very restricted and likely non-random sample.

The imputation stage of analysis addresses the problem of listwise deletion—eliminating an observation if it is missing information about any variable used in the analysis—by allowing all countries in the sample to be included in the growth regression even if data on one or more conditioning variables are missing. There is evidence that the discarding of information associated with countries that are missing data for any variable used in the analysis has serious consequences for econometric results beyond the obvious efficiency loss. Our results vary somewhat when excluded data are included using imputation methods.

With these concerns in mind, results for a sample of countries for which all conditioning variables are available are presented. Following Sala-i-Martin and Subramanian (2003), we add primary education in 1970, the relative price of investment goods during 1960–1964, a measure of how favorable the ecology of a country is to malaria transmission (used in preference to the MALFAL variable used in Sala-i-Martin and Subramanian because it is designed to be exogenous to economic and policy conditions), a measure of the volatility of the terms of trade for each country between 1970 and 2000, our measure of rule of law, and a measure of coastal population density. OLS results are also reported for purposes of comparison.

For the 2SLS specifications, we will refer to the indirect and the direct relationship between resource abundance and growth. The indirect relationship is the impact of resource abundance on growth that operates through the rule of law. Algebraically, it is estimated by $\Delta NR(\hat{\tau})(\hat{\kappa})$. The direct relationship is the relationship between growth and resource abundance after instrumented rule of law is controlled for, estimated by Δ NR($\hat{\gamma}$).

Results for aggregate measures of abundance are shown in Table 3. In column 2, the direct relationship between resource abundance and growth is both larger and more significant than the indirect one. The standard deviation of *fuelminratio* in this sample is 32.8, so the estimated direct effect of a one-standard-deviation increase in point-source resource abundance is a decline of 0.34 percentage points in the average growth rate over the sample period, and the indirect effect is a decline of 0.17 percentage points. The signs of the other conditioning variables are as expected. If there is a resource curse in stocks operating through rule of law in this sample, it appears not to operate through rule of law alone, as the indicator of

Table 3 Growth 1970–2000, rule of law, and aggregate natural resource stocks

	OLS (1)	2SLS (2) Dependent variable		2SLS (3) Dependent variable	
	Growth	Rule of law	Growth	Rule of law	Growth
Fuel & mineral stocks/GDP 1970	**−0.0095** **	**−0.0046** **	**−0.0104*** **	**−0.0037***	**−0.0081*** **
	0.0041	0.0019	0.0030	0.0020	0.0023
Arable and plantation land p.c.	0.0422	0.0786	0.0681	0.0207	−0.0871
	0.2201	0.1066	0.2165	0.0944	0.1736
Share of NRX/GDP (sxp), 1970	–	–	–	−0.9289	**−5.5296*** **
				0.8790	1.7788
Rule of law	1.4276***	–	1.1374 **	–	0.9740*
	0.2235		0.4815		0.5405
Log income per capita 1970	−1.0176***	0.5848***	−0.8372***	0.6321***	−0.7521*
	0.1987	0.0806	0.3123	0.0844	0.3809
Primary education level 1970	1.8097 **	0.3114	1.7928 **	0.0795	1.7562 **
	0.8194	0.4927	0.7297	0.5141	0.7096
Price of investment	−0.0068 **	−0.0026***	−0.0074 **	−0.0024 **	−0.0090***
	0.0028	0.0010	0.0035	0.0009	0.0031
Malarial ecology	−0.0896***	−0.0004	−0.0888 **	0.0086	−0.0621 **
	0.0281	0.0158	0.0357	0.0137	0.0280
Coastal population density	0.0008***	0.0002 **	0.0009***	0.0002 **	0.0008***
	0.0003	0.0002	0.0003	0.0001	0.0002
Terms of trade volatility	0.0042	−0.0155 **	−0.0010	−0.0144 **	0.0027
	0.0130	0.0073	0.0115	0.0068	0.0115
Fraction English language users	–	0.8561***	–	0.7777 **	–
		0.3171		0.3240	
Fraction European language users	–	−0.5940***	–	−0.5221 **	–
		0.2093		0.2266	
Constant	0.5113	0.9595***	0.7963	1.1422***	1.6203 **
	0.626324	0.2913	0.8083	0.2987	0.8041
Observations	74	74	74	72	72
R-squared	0.6591	0.7540	0.6933	0.7662	0.7489
Instrument F-scores	–	5.5	–	4.3	–

Robust standard errors under coefficient estimates
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

concentrated abundance has a direct effect on growth that persists after controlling for an impact of resource abundance on rule of law.

Including the Sachs and Warner and Sala-i-Martin and Subramanian measures of export intensity, shown in column 3, yields similar results.[12] There is evidence from the literature that export intensity can be important for growth. Since the stock variable is intended to capture a different characteristic, resource abundance, it may invite a specification error to exclude flows, particularly given the interest in relationships between resources generally, rule of law and growth. Including flows allows for institutional linkages with resource stocks or flows, as well as the crowding out or other effects of resource flows postulated in previous literature. With *sxp*, the coefficient for fuels and minerals declines in absolute value by a little under 20% in both stages of the regression and decreases in significance in the rule of law regression. The coefficients on *sxp* and land are negative and insignificant in the rule of law regression; *sxp* and *fuelminratio* are both negative and highly significant in the growth stage. The coefficient on *sxp* is −5.53, comparable with Sachs and Warner's results.

[12] Using *sxp* with listwise deletion does drop the sample size by two. Running the regression in the previous columns on this sample yields similar signs and size of the coefficients of interest.

Note the F-test scores associated with the instruments. An F-statistic of 4 with two instruments has an approximate bias equal to 2% of the OLS bias with a 'perfect' instrument, and higher values of the statistic are associated with decreasing bias relative to OLS with endogeneity. F-statistics below 10 are considered suggestive of weak instruments bias, and second-stage results should be interpreted with this in mind.

Results using disaggregated measures of resource abundance are shown in Table 4. Mined non-fuel minerals, in particular, exhibit strong negative associations with rule of law and with the growth rate. In column 2, the direct effect of a one standard deviation increase in non-fuel mineral wealth is a 0.34 decline in the growth rate. The effect of the same change in

Table 4 Growth 1970–2000, rule of law, and disaggregated natural resource stocks

	(1) OLS	(2) Dependent variable		(3) Dependent variable	
	Growth	Rule of law	Growth	Rule of law	Growth
Oil stocks/GDP 1971	**0.0614***	−0.0180	0.0509	−0.0206	0.0478
	0.0322	0.0240	0.0411	0.0242	0.0415
Natural gas stocks/GDP 1971	−0.0367	0.0837	0.0187	0.0800	−0.0344
	0.0811	0.0597	0.1184	0.0592	0.1228
Mineral stocks/GDP 1970	**−0.0086*****	**−0.0044 ****	**−0.0103 ****	**−0.0038 ****	**−0.0073 ****
	0.0026	0.0021	0.0044	0.0018	0.0035
Coal stocks/GDP 1971	−0.0092	−0.0106	−0.0131	−0.0093	−0.0106
	0.0215	0.0161	0.0208	0.0161	0.0203
Arable land per capita 1970	0.0394	0.1270	0.1033	0.0762	−0.0721
	0.0394	0.1014	0.2896	0.0958	0.2128
Plantation land per capita 1970	0.5059	**−2.8486 ****	−1.0229	**−2.6934***	−0.5294
	2.0674	1.3342	3.9640	1.3591	3.6900
Share of NRX/GDP (sxp), 1970	–	–	–	−0.6678	**−5.3122*****
				0.8109	1.8915
Rule of law	1.4775***	–	1.0270	–	0.9983
	0.2491		0.8267		0.9008
Log income per capita 1970	−1.1261***	0.5735***	−0.8619*	0.6198***	−0.8408
	0.2344	0.0859	0.4878	0.0944	0.5810
Primary education level 1970	1.8339 **	0.4215	1.9398 **	0.2104	1.8435 **
	0.8254	0.5321	0.9080	0.5720	0.7994
Price of investment	−0.0061	−0.0020 **	−0.0069*	−0.0018 **	−0.0084 **
	0.0037	0.0008	0.0040	0.0009	0.0036
Malarial ecology	−0.0899 **	−0.0009	−0.0892 **	0.0063	−0.0646 **
	0.0354	0.0175	0.0398	0.0164	0.0309
Coastal population density	0.0008***	0.0002*	0.0009***	0.0002*	0.0007 **
	0.0002	0.0001	0.0003	0.0001	0.0003
Terms of trade volatility	−0.0223	−0.0210	−0.0334	−0.0183	−0.0184
	0.0244	0.0127	0.0303	0.0133	0.0280
Fraction English language users	–	0.5353*	–	0.4908	–
		0.2989		0.3079	
Fraction European language users	–	−0.4087*	–	−0.3622*	–
		0.2094		0.2183	
Constant	0.5604	1.0077***	1.0187	1.1406***	1.6498
	0.7492	0.3021	0.9954	0.3278	1.3157
Observations	74	74	74	72	72
R-squared	0.7154	0.7879	0.7004	0.7958	0.7591
Instrument F-scores	–	2.3	–	1.8	–

Robust standard errors under coefficient estimates
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

the first stage is a 0.14 decline in rule of law (roughly the difference between Honduras and Chad in our rule of law variable), which is itself associated with a 0.15 additional decline in the growth rate if the (not significant, $p = 0.219$) point estimate for rule of law is used.

These results are robust to including the Sachs and Warner and Sala-i-Martin and Subramanian measures of export intensity, shown in column 3. When added, *sxp* has an insignificant effect on rule of law and a negative and highly significant ($p = 0.007$) direct effect on growth when stocks are controlled for, again with a coefficient comparable to that found by Sachs and Warner. Land in plantation crops has a negative effect on rule of law in both two-stage specifications. A one standard deviation increase in these land uses is associated with a 0.18 decline in rule of law (the difference between Mexico and Syria, or Argentina and Libya).

Table 5 repeats the analysis of table four with an additional instrument, absolute latitude. While this is not the specification most common in the literature addressed, it does improve the performance of the second stage somewhat, though F-scores remain low. The most notable change is that oil stocks now show a weak direct, positive effect on growth, though this does not persist when *sxp* is included.

We now allow for different resource flows to have differing impacts, following the same reasoning that we did for stocks. Table 6 replicates the analysis of column 2 in Table 4 using the sample available for columns 3 and 4. Column 3 shows results using four categories of export flow intensity and column 4 condensed into two broader categories intended to capture differences between point-source and more broadly based resource flows. Results for the smaller sample without adding flows, reported in columns 1 and 2, are roughly comparable to those reported in Table 4, although the effect of resource stocks is now more significant in the first stage than in the second.

However, when flow measures are included the results change. Again the stock that matters consistently is mined mineral abundance, but the nature of the relationship is different. When flows are controlled for, mineral stocks exhibit coefficient estimates consistent with a resource curse in abundance operating only through rule of law, while results for the flow measures are consistent with a crowding-out or other direct process. No stock measure is significant in the second stage, while some or all of the flow measures are significant and negative in the second stage of each specification. Plantation land is no longer significant even in the first stage, perhaps because it is more closely linked to production than mineral stocks are. The results for resource flows contrast with the Sala-i-Martin and Subramanian results, which found that second stage results were generally non-significant while first stage effects were negative and significant, though it should be noted that extremely weak instruments and non-significant or barely significant coefficients on instrumented rule of law remain problematic.

In an effort to reach firmer conclusions about the complex relationships between resource abundance, flows, rule of law, and growth, a key constraint to our analysis needs to be addressed: missing data. This would be worthwhile even if results under listwise deletion were more precise; those results would still reflect relationships between resources, rule of law and growth in fewer than half of the observed countries.

3.1 Missing Data and Multiple Imputation

For the results reported above, more than half of the available observations were discarded due to missing conditioning variables. A relatively small (about 12%) fraction of the data are missing, but all the available information about more than half of the countries potentially

Table 5 Growth, rule of law, and disaggregated natural resource stocks with latitude instrument

	(1) Dependent variable		(2) Dependent variable	
	Rule of law	Growth	Rule of law	Growth
Oil stocks/GDP 1971	−0.0163	**0.0607**∗	−0.0178	0.0496
	0.0204	0.0364	0.0208	0.0377
Natural gas stocks/GDP 1971	0.0436	−0.0333	0.0471	−0.0423
	0.0646	0.0875	0.0658	0.0919
Mineral stocks / GDP 1970	**−0.0036**∗	**−0.0087**∗∗∗	**−0.0034**∗	**−0.0074**∗∗∗
	0.0019	0.0032	0.0020	0.0024
Coal stocks / GDP 1971	−0.0023	−0.0094	−0.0022	−0.0101
	0.0223	0.0214	0.0226	0.0194
Arable land per capita 1970	0.0605	0.0433	0.0421	−0.0779
	0.1104	0.2301	0.1163	0.2001
Plantation land per capita 1970	**−2.3149** ∗∗	0.4118	**−2.2882** ∗∗	−0.3123
	1.0252	2.6102	1.0471	2.6697
Share of NRX/GDP (sxp), 1970	–	–	−0.1180	**−5.2615**∗∗∗
			0.7802	1.8698
Rule of law	–	**1.4497**∗∗∗	–	**1.0674**∗
		0.4926		0.5810
Log income per capita 1970	0.4048∗∗∗	−1.1098∗∗∗	0.4447∗∗∗	−0.8851 ∗∗
	0.0941	0.3347	0.1059	0.4049
Primary education level 1970	0.3615	1.8404 ∗∗	0.2353	1.8423 ∗∗
	0.4148	0.8475	0.4391	0.7860
Price of investment	−0.0014	−0.0062	−0.0012	−0.0083 ∗∗
	0.0013	0.0038	0.0014	0.0033
Malarial ecology	0.0124	−0.0898 ∗∗	0.0148	−0.0652 ∗∗
	0.0143	0.0355	0.0150	0.0305
Coastal population density	0.0003 ∗∗	0.0008∗∗∗	0.0003 ∗∗	0.0007∗∗∗
	0.0001	0.0003	0.0001	0.0002
Terms of trade volatility	−0.0134	−0.0230	−0.0131	−0.0169
	0.0108	0.0232	0.0111	0.0221
Fraction English language users	0.5427∗	–	0.5095	–
	0.3044		0.3106	
Fraction European language users	−0.1047	–	−0.0956	–
	0.2243		0.2286	
Latitude (absolute value)	0.0196∗∗∗	–	0.0185 ∗∗	–
	0.00672		0.00717	
Constant	0.1190	0.5886	0.2228	1.5693 ∗∗
	0.4177	0.8080	0.4709	0.7706
Observations	74	74	72	72
R-squared	0.8150	0.7153	0.8177	0.7633
Instrument F-scores	6.0	–	5.4	–

Robust standard errors under coefficient estimates
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

in the sample is discarded. This leads to statistical problems above and beyond the obvious efficiency loss, as has been known for some time by statisticians and econometricians.[13] Unless missing data are MCAR (missing completely at random—there is no possible data, missing or available, that provides information about whether an observation is more or less likely to be missing), listwise deletion is biased, often severely (King et al. 2001). A simple investigation suggests that sample changes may be meaningful; columns 3, 4, and 9–12 of

[13] See Rubin (1996) for a discussion of the theoretical properties of analyses performed with missing data and under various methods for filling in missing data, as well as an extensive bibliography of earlier work.

Table 6 Growth 1970-2000, rule of law, and disaggregated natural resource stocks and flows

	(1) OLS	(2) Dependent variable		(3) Dependent variable		(4) Dependent variable	
	Growth	Rule of law	Growth	Rule of law	Growth	Rule of law	Growth
Oil stocks/GDP 1971	**0.0786**∗	−0.0081	**0.0749**∗	0.0094	0.0525	−0.0087	0.0640∗
	0.0398	0.0203	0.0416	0.0153	0.0479	0.0204	0.0380
Natural gas stocks/GDP 1971	−0.0014	0.0569	0.0344	**0.1543** ∗∗	−0.0052	0.0681	0.1072
	0.0775	0.0443	0.1152	0.0671	0.1637	0.0416	0.1056
Mineral stocks/GDP 1970	−**0.0058**∗∗∗	−**0.0041** ∗∗	−**0.0073**∗	−**0.0051** ∗∗	−0.0019	−**0.0038** ∗∗	−0.0036
	0.0019	0.0018	0.0043	0.0019	0.0039	0.0018	0.0033
Coal stocks/GDP 1971	−0.0247	−0.0040	−0.0257	0.0065	−0.0414	−0.0042	−0.0339
	0.0250	0.0146	0.0246	0.0162	0.0265	0.0152	0.0233
Arable land per capita 1970	−0.0394	0.1370	0.0272	0.1327	−0.1918	0.1319	−0.1798
	0.1510	0.1298	0.2522	0.1448	0.2091	0.1358	0.1964
Plantation land per capita 1970	**2.6265** ∗∗	−**2.5497**∗	1.4284	−2.3990	2.7610	−2.5869	2.0609
	1.2626	1.4978	2.9981	1.7647	2.6728	1.5596	2.6755
exag/GDP	–	–	–	0.0001	−0.1192	–	–
				0.0301	0.0977		
exfood/GDP	–	–	–	0.0025	−**0.0347**∗	–	–
				0.0126	0.0189		
ex ag+food/ GDP	–	–	–	–	–	−0.0003	−**0.0393**∗
						0.0107	0.0204
exfuels/GDP	–	–	–	−**0.0387**∗	−0.0260	–	–
				0.0219	0.0344		
exore-minerals/GDP	–	–	–	0.0020	−**0.0568**∗∗∗	–	–
				0.0058	0.0083		
ex fuels, ores & minerals/GDP	–	–	–	–	–	−0.0041	−**0.0501**∗∗∗
						0.0060	0.0082
Rule of law	1.3864∗∗∗	–	0.9753	–	1.7662∗	–	1.3323
	0.2650		1.0671		0.9911		0.9374
Log income per capita 1970	−1.0089∗∗∗	0.5415∗∗∗	−0.7809	0.5248∗∗∗	−1.2186 ∗∗	0.5464∗∗∗	−0.9582∗
	0.2494	0.0891	0.6092	0.0089	0.9911	0.0895	0.5363

Table 6 continued

	(1) OLS	(2) Dependent variable		(3) Dependent variable		(4) Dependent variable	
	Growth	Rule of law	Growth	Rule of law	Growth	Rule of law	Growth
Primary education level 1970	0.5311	0.4836	0.6490	0.6166	0.2231	0.4891	0.4756
	0.7491	0.4823	0.7936	0.5714	0.7656	0.5066	0.7041
Price of investment	−0.0086***	−0.0019***	−0.0093***	−0.0017*	−0.0093***	−0.0019 **	−0.0098***
	0.0024	0.0007	0.0030	0.0009	0.0028	0.0008	0.0027
Malarial ecology	−0.0809 **	0.0078	−0.0759 **	0.0103	−0.0702***	0.0084	−0.0571 **
	0.0305	0.0189	0.0340	0.0233	0.0250	0.0204	0.0258
Coastal population density	0.0021	0.0010	0.0027	0.0014*	0.0000	0.0009	0.0011
	0.0018	0.0007	0.0026	0.0007	0.0022	0.0007	0.0021
Terms of trade volatility	−0.0421	−0.0378***	−0.0598	−0.0410***	−0.0017	−0.0364***	−0.0247
	0.0292	0.0101	0.0544	0.0113	0.0448	0.0012	0.0393
Fraction English language	–	0.5353	–	0.5467*	–	0.4178	–
		0.2989		0.3239		0.3057	
Fraction European language	–	−0.4087*	–	−0.3355	–	−0.3736*	–
		0.2094		0.2234		0.2128	
Constant	1.4103 **	1.0077***	1.8294	0.8962 **	1.8577	1.0541***	2.0703*
	0.5941	0.3021	1.2350	0.4243	1.1136	0.3642	1.0938
Observations	57	57	57	57	57	57	57
R-squared	0.7145	0.8617	0.7049	0.8714	0.7654	0.8625	0.7657
Instrument F-scores	–	1.6	–	1.6	–	1.6	–

Robust standard errors under coefficient estimates
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 2 reproduce the naive OLS regressions with the listwise deletion sample. Patterns of the size and significance of relationships between outcomes and abundance are quite different; the impact of oil on rule of law is an order of magnitude larger in the restricted sample, and effects for minerals and plantation land are also bigger. For growth, minerals become significantly negative and oil drops to insignificant.

Methods other than listwise deletion have not been in widespread use in empirical environmental or growth economics,[14] perhaps due to computational complexity. King et al. (2001) and Honaker et al. (2001) develop a generally applicable EMis (Expectation Maximization with Importance re-Sampling) algorithm for imputing missing values and provide software to implement it. They show that listwise deletion is preferable to filling in missing values using this algorithm only under very strong conditions and assumptions about the observed data. These assumptions are not supported for the data or models used in growth or institutional quality regressions.[15] EMis imputation is efficient and unbiased if data are MCAR or MAR (Missing At Random; some observations are more likely than others to be missing data, but within that group or groups data are missing at random) and ignorable. If missing values are not ignorable, listwise deletion will not eliminate bias and remains relatively inefficient. Kofman and Sharpe (2003) include additional tests and descriptions of various imputation approaches and likewise find that EMis outperforms listwise deletion for a variety of variable types and estimation strategies.

The imputation stage generates a series of datasets in which all the known (observed) values are the same but the missing observations are filled in with draws from their estimated distribution, avoiding the spurious precision that can result from other imputation methods. The analytical stage (regression) is performed on each of these datasets, and the EMis coefficient estimate is the average of the estimates from this procedure. The standard error of the EMis estimate combines the standard errors in each individual estimation and the variance in the point estimates across the datasets.

Table 7 replicates the results in Table 4 using EMis with five imputation runs, using only information in the variables in the regression, without resource outliers.[16] Fifty-seven percent of the observations have at least one missing value imputed; only 14% of the total values are imputed by EMis. *Forty nine percent* of the data were discarded under listwise deletion. There is a significant and negative effect on rule of law for minerals only; its size and significance are robust to the inclusion of *sxp*. Results differ from those in Table 4 in three key ways. The effect of mineral abundance on rule of law is smaller and more precisely estimated, there is no estimated direct effect of abundance on growth in any regression, including OLS, and neither oil abundance nor plantation cropland is statistically significant. The effect on rule of law amounts to a decline of 0.144 or 0.151 (in columns two and three, respectively) for an increase of one standard deviation in mineral abundance. These differences and sample

[14] Some exceptions include DeCanio and Watkins (1998) Imai and Weinstein (2000) and Bar-Hen (2002). Kofman and Sharpe (2003) examine a sample of published economics papers and note that listwise deletion remains the most common way of dealing with missing data.

[15] The conditions are: (1) that the functional form of the analysis model is completely and correctly specified, (2) that the missing data is nonignorable (missing values are ignorable if an observation for which the datum is missing is indistinguishable from an observation for which it is not missing that has the same value; there is no statistical test for ignorability), (3) that there is no data excluded from the analysis model that can be included in the imputation model to correct any nonignorability, and (4) that the number of observations lost to missingness is small.

[16] Too much data is missing to replicate the disaggregated flow analysis presented in Table 6.

Table 7 Growth 1970-2000, rule of law, and disaggregated natural resource stocks with EMis

	(1) OLS	(2) Dependent variable		(3) Dependent variable	
	Growth	Rule of law	Growth	Rule of law	Growth
Oil stocks / GDP 1971	−0.0079	−0.0017	−0.0074	−0.0022	0.0054
	0.0084	0.0031	0.0106	0.0037	0.0095
Natural gas stocks / GDP 1971	0.0909	0.0383	0.0996	0.0359	0.1511
	0.0740	0.0283	0.0984	0.0332	0.0965
Mineral stocks / GDP 1970	−0.0032	**−0.0026*** **	−0.0035	**−0.0028** **	−0.0003
	0.0024	0.0010	0.0033	0.0011	0.0028
Coal stocks / GDP 1971	−0.0016	−0.0006	−0.0026	−0.0004	−0.0065
	0.0353	0.0139	0.0375	0.0159	0.0404
Arable land per capita 1970	−0.2269	−0.0308	−0.1951	−0.0258	−0.3598
	0.2914	0.1148	0.3169	0.1271	0.2693
Plantation land per capita 1970	−0.1617	−0.7905	−0.3215	−0.8576	1.3549
	1.2589	0.5319	1.8648	0.5876	1.5268
Share of NRX/GDP (sxp), 1970	–	–	–	0.1907	**−4.9299*****
				0.4766	1.3322
Rule of law	1.2119***	–	1.1623	–	0.9086
	0.2065		1.3104		0.8428
Log income per capita 1970	−0.9997***	0.5401***	−0.9975	0.5385***	−0.8036
	0.1968	0.0619	0.7931	0.0679	0.6063
Primary education level 1970	3.2360***	0.4248	3.5101***	0.4305	3.1475 **
	1.1945	0.5691	1.3248	0.5868	1.3497
Price of investment	−0.0083***	−0.0005	−0.0077 **	−0.0004	−0.0089***
	0.0029	0.0014	0.0033	0.0015	0.0027
Malarial ecology	−0.0220	−0.0081	−0.0229	−0.0086	−0.0069
	0.0264	0.0107	0.0325	0.0117	0.0283
Coastal population density	0.0010**	0.0002	0.0010*	0.0002	0.0009*
	0.0004	0.0001	0.0006	0.0001	0.0005
Terms of trade volatility	−0.0050	−0.0137 **	−0.0051	−0.0135 **	−0.0091
	0.0164	0.0056	0.0280	0.0061	0.0212
Fraction English language	–	0.6807***	–	0.6927***	–
		0.2480		0.2586	
Fraction European language	–	−0.2795	–	−0.2759	–
		0.2333		0.2422	
Constant	0.1759	0.6792 **	0.0054	0.6494*	1.0003
	0.6702	0.3384	1.4172	0.3523	0.8117
Observations	167	167	167	167	167
Mean R-squared	0.5744	0.6583	0.5206	0.6590	0.6300
Instrument average F-scores	–	5.0	–	5.0	–

Robust standard errors under coefficient estimates
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

descriptive statistics suggest that there is some selection driving inclusion in the sample for estimation using listwise deletion.[17] Average F-scores remain weak.

Table 8 repeats the analysis in 4a with a new imputation run including the absolute latitude instrument. It performs fairly well; these are the only regressions with F-scores for the instruments over ten. With the first stage performing reasonably well, we continue to see no

[17] One striking difference is that the mean of *fuelminratio* is about 2/3 higher in the full sample than in the restricted one. Disaggregated, natural gas to GDP is about twice as large and oil is more than three times as large. Mined non-fuel minerals and coal are also larger, but not dramatically so. In general, countries in the smaller sample are bigger (in population) and grew slightly faster during the sample period. They began the period with very similar income levels but ended better off.

Table 8 Growth 1970-2000, rule of law, and disaggregated stocks with EMis and latitude instrument

	(1) OLS	(2) Dependent variable		(1) Dependent variable	
		Rule of law	Growth	Rule of law	Growth
Oil stocks/GDP 1971	−0.0112	0.0006	−0.0110	−0.0007	−0.0005
	0.0083	0.0035	0.0077	0.0039	0.0074
Natural gas stocks/GDP 1971	0.0843	0.0336	0.0652	0.0287	0.1298
	0.0974	0.0355	0.0976	0.0350	0.1164
Mineral stocks/GDP 1970	−0.0041	−0.0016	−0.0032	**−0.0020***	−0.0017
	0.0029	0.0012	0.0028	0.0012	0.0037
Coal stocks / GDP 1971	0.0029	−0.0066	−0.0007	−0.0054	−0.0115
	0.0347	0.0137	0.0339	0.0137	0.0303
Arable land per capita 1970	−0.0893	−0.1266	−0.0851	−0.1193	−0.2119
	0.2620	0.1243	0.2560	0.1243	0.2579
Plantation land per capita 1970	−0.2572	−0.2188	0.0332	−0.3147	0.5201
	2.2324	0.6812	2.3053	0.6983	2.5388
Share of NRX/GDP (sxp), 1970	–	–	–	0.5141	**−3.9858*****
				0.5511	1.5570
Rule of law	1.0840***	–	1.3639***	–	0.7665*
	0.2727		0.4416		0.4203
Log income per capita 1970	−0.9571***	0.2857	−1.0954***	0.2582***	−0.7405***
	0.1898	0.2172	0.2549	0.0763	0.2502
Primary education level 1970	3.2760***	0.5494	3.0314***	0.5760	3.2262***
	0.8484	0.3898	0.9030	0.3907	0.9277
Price of investment	−0.0071	−0.0003	−0.0071	−0.0002	−0.0077
	0.0045	0.0010	0.0044	0.0010	0.0051
Malarial ecology	−0.0358	0.0167*	−0.0365	0.0166*	−0.0209
	0.0291	0.0098	0.0289	0.0098	0.0257
Coastal population density	0.0012***	0.0004***	0.0011***	0.0005***	0.0011***
	0.0003	0.0001	0.0003	0.0001	0.0003
Terms of trade volatility	−0.0019	−0.0091	0.0032	−0.0086	−0.0055
	0.0184	0.0077	0.0193	0.0074	0.0204
Fraction English language	–	0.5222 **	–	0.5349 * *	–
		0.2577		0.2517	
Fraction European language	–	0.0900	–	0.1390	–
		0.1879		0.1999	
Latitude (absolute value)	–	0.0280***	–	0.030412***	–
		0.0050		0.005847	
Constant	−0.0344	−0.5601*	−0.1528	−0.7469 * *	0.7221
	0.8037	0.2905	0.8105	0.3575	0.8988
Observations	167	167	167	167	167
Mean R-squared	0.5839	0.7208	0.57516	0.7187	0.6257
Instrument average F-scores	–	15.0	–	16.8	–

Robust standard errors under coefficient estimates
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

direct affect of abundance on growth. Mineral abundance drops out of significance for rule of law in the specification that excludes *sxp*, but remains weakly significant and negative when flows are accounted for. *Sxp* is again significant on the second stage and not the first, contrary to previous work.

3.2 Robustness to Additional Conditioning Variables

To verify that the link between resource stocks and rule of law outcomes persists across a wide variety of specifications, the analysis in Tables 4 and 7 was replicated with the inclusion of additional variables that may matter for cross-country comparisons. Variables were chosen based on the Sala-i-Martin et al. BACE study (2004) and added one at a time.

Thirteen possible additional conditioning variables were considered.[18] Under listwise deletion, the coefficient on *minratio* in the rule of law regression averaged −0.0040 (with a variance of 0.0006) when *sxp* was excluded and −0.0037 (with a variance of 0.0007) with *sxp*, comparable to the −0.0044 and −0.0038 shown in Table 1. The coefficient on *minratio* was significant in twelve of the thirteen cases; with the Latin American dummy it dropped to insignificance. Repeating this analysis with EMis yields similar congruence with the results in Table 2. The *minratio* coefficient is generally highly significant with or without sxp; the single exception is again the Latin American dummy.[19] The mean *minratio* coefficient is −0.0025 without *sxp* and −0.0026 when *sxp* is included; variances are 0.0004 and 0.0005, respectively. Table 2 values were −0.0026 and −0.0028.

4 Conclusion

Mineral abundance, as distinct from a resource extraction intensive economy, has a negative effect on rule of law, an important requirement for growth, but we do not find robust evidence for a direct effect on growth. In contrast to the existing literature, extractive intensity does not appear to impact institutions when abundance is controlled for, but remains associated with slower growth. For developing countries, the difference in rule of law associated with a standard-deviation increase in resource abundance is generally about a 10% move in the ordered rule of law rankings. Additionally, the practice of discarding as much as half of the available information, as is common in the resource curse literature, is worth discontinuing, as alternatives are available and listwise deletion leads to inefficient estimation as well as bias in the results under all but the most stringent conditions. The EMis algorithm allows us to examine the resource curse in a much broader range of countries than previously available and without concern about sample selection driving the results.

The link between stocks and institutions rather than directly to growth suggests that the anticipation of future resource flows itself can change the incentives of political actors as they make decisions about drivers of current and future institutional quality, or as they engage in conflict to acquire expected future resource rents. Resource flows may well have other impacts, or may arise endogenously from other poor outcomes, but do not appear to explain a curse through institutions. If resource stocks are a partial explanation of the ‘curse’ of natural wealth, then the advice to simply limit extraction may miss the point of an effect on the incentives acting on governments setting the rules of the game in anticipation of eventual resource exploitation. Controlling resource flows so that they do not blight growth becomes the goal, and research can usefully focus on questions of how that control can be facilitated and exercised, as well as why flows might hamper growth. Taking care to support

[18] East Asian, sub-Saharan African and Latin American dummies, fraction of population and land area in the tropics, life expectancy, fraction of population practicing Confucianism, Islam, and Buddhism, ethnolinguistic fractionalization, years ‘open’ to trade, Spanish colonial history, and GDP in mining.

[19] Given the nature of statistical hypothesis testing, we can reasonably expect that for a large series of similar specifications on similar data, any general pattern will not necessarily be observed in each and every specification. See Sala-i-Martin et al. (2004) for a fuller discussion of the topic.

the development of rule of law in resource-rich developing countries may be of particular importance.

Appendix A: Data Sources

Mineral Stocks—In cases where countries are listed in the 2003 *Mineral Commodities Summaries (MCS)* from the USGS as having a reserve of a mineral with its size, those reserve base figures are used as current reserves. In several cases, the background material for a mineral in the MCS will name countries having substantial resources of a mineral but not provide an estimate of the size of those reserves (e.g. mercury). Where the MCS does not report figures for deposits of a given mineral in a particular country, as only 'major' reserves are detailed in the commodity reports, data from the 2001 *Minerals Yearbook (Volume III.—Area Reports: International)* published by the US Geological Survey is used if available. The area reports are not used as the general source because only some countries in this publication series include reserve data. Small countries' reserves may be undercounted, as they may have resources which are economically significant in their economy but are not significant in the global market for that particular commodity and thus are less likely to be included in the MCS. Production data is from the commodity specific *Minerals Yearbooks* (Volume I, Metals and Minerals or, for 1976 and earlier, Volume I, Metals, Minerals and Fuels).A few commodities for which the Minerals Yearbooks do not report global production data were dropped, leaving 35 mineral commodities represented in the composite variable. This variable will not account for all mined mineral resources because reserve and production data are not available for all traded resources, but it should correlate with overall mineral abundance; the major traded commodities and high-value commodities are more likely to have precise data. Historical mineral prices are taken from *Metal Prices in the United States through 1998,* published by the USGS. Some minerals are not included in this source and in those cases prices are from the USGS Open File Report 01-006 (version 8.1), available online only at minerals.usgs.gov.

Coal Stocks—Data on reserves comes from the 2002 IEA 'World Estimated Recoverable Coal'. Figures are for hard (bituminous and anthracite) coal and thus do not include lower grade coals. Production after 1980 is also from the IEA. Production data for 1971–1977 is from April editions of International Coal Trade (US Department of the Interior, Bureau of Mines) for the years 1975 to 1978. 1978 and 1979 data for hard coal alone are not available; they were constructed from the 1981 IEA information on world coal production in all grades under the assumption that the proportion of hard coal in total coal output for each country was equal to the average of the 1977 and 1980 proportions. 1971 price to convert stocks to values is the F.O.B. pithead price from the 1982 Annual Energy Review (Table 63).

Gas and Oil Stocks—Data on reserves as of January 1, 2003 is from the Oil and Gas Journal figures reported in the 2002 International Energy Annual (IEA) published by the US Energy Information Agency (EIA). Crude oil and gas production data is compiled from a variety of sources; data from 1980 to 2002 is from the EIA tables available online, data for 1977–1979 is from the 1981 IEA, and data from 1971 to 1976 is from the 1976 and 1973 US Geological Survey (USGS) Minerals Yearbooks (Volume 1, Metals, Minerals and Fuels). The prices used to convert the 1971 quantities to values are the EIA Annual Energy Review composite crude oil refiner acquisition cost and the natural gas wellhead price.

Arable Land and Land in Permanent Crops—1976 FAO Production Yearbook (FAO 1977), values reported for 1970. For countries forming subsequent to 1970, data are from the 1995 FAO Production Yearbook (FAO 1996).

Institutional Quality Variables—Kaufmann, Kraay and Mastruzzi update of Kaufmann, Kraay and Zoido-Lobaton indicators. Available at http://www.worldbank.org/wbi/governance/govdata2002/index.html.

Income Data—United Nations Statistical Division, National Accounts Main Aggregates Database. Growth rate calculated as (100/years)* (logGend-logGstart). Available at http://unstats.un.org/unsd/snaama/.

Population Data—US Bureau of the Census International Data Base. Available at http://www.census.gov/ipc/www/idbnew.html.

Primary Education—Barro and Lee, April 2000 update. Available at http://www.cid.harvard.edu/ciddata/ciddata.html.

Relative Price of Investment Goods—Available from Sala-i-Martin et al. (2004).

Malarial Ecology—Earth Institute, Columbia University; October 2003 update. Available at http://www.earthinstitute.columbia.edu/about/director/malaria/.

Coastal Population Density—Estimated for the mid-1960s. Available from Sala-i-Martin et al. (2004).

Terms of Trade Volatility—Standard Deviation of annual changes in the terms of trade reported in the WDI.

Language Instruments: Fraction English-Speaking, Fraction Non-English European Language-Speaking—Taken from Hall and Jones (1999). Available at http://elsa.berkeley.edu/~chad/HallJones400.asc.

Colonial Mortality Instrument—Acemoglu et al. (2001) Appendix Table A2.

East Asian Dummy—From Sala-i-Martin et al. (2004), with the addition of Bhutan, Brunei, Cambodia, Cook Islands, French Polynesia, Kiribati, Laos, Mongolia, Nauru, New Caledonia, North Korea, Macau, and Vietnam, which are not in the original dataset.

Latin American Dummy—From Sala-i-Martin et al. (2004), with the addition of Belize and French Guiana, which are not in the original dataset.

African Dummy—From Sala-i-Martin et al. (2004)—excludes N. Africa—with the addition of Djibouti, Equatorial Guinea, and Reunion, which are not in the original dataset.

Spanish or Portuguese Colonial Dummy—From Sala-i-Martin et al. (2004), who got it from Barro (1999), with the addition of Cuba, Equatorial Guinea, Macau, and Sao Tome and Principe, which are not in the original dataset.

Flow Measures of Resource Intensity: sxp, ratio of raw natural resource exports to GDP, is from Sachs and Warner (1995a,b, 1999, 2001). Disaggregated export data is from the Food and Agriculture Organization of the United Nations (faostat.org).

Latitude: Absolute value of the latitude of the geographic centroid of the country. Latitude is from Sala-i-Martin et al. (2004).

Appendix B: Minerals Included in the Composite Measure of Mineral Abundance

Antimony
Barite
Aluminum
Bismuth
Boron
Chromium
Cobalt
Columbium
Copper

Industrial diamond
Fluorspar
Gold
Graphite
Iodine
Iron
Lead
Lithium
Manganese
Mercury
Molybdenum
Nickel
Perlite
Phosphate rock
Platinum group metals
Potash
Silver
Talc/pyrophyllite
Tantalum
Tin
Titanium concentrate, Ilmanite
Titanium concentrate, Rutile
Tungsten
Vanadium
Zinc
Zirconium

References

Acemoglu D, Johnson S, Robinson JA (2001) The colonial origins of comparative development. Am Econ Rev 2001:1369–1401

Aixala J, Fabro G (2007) A model of growth augmented with institutions. Econ Aff 27(3):71–74

Bar-Hen A (2002) Influence of missing data on compact designs for spacing experiments. J Appl Stat 29(8):1229–1240

Barro RJ (1999) Determinants of democracy. J Polit Econ, Part 2, S158–S183

Brunnschweiler CN, Bulte E (2008) The resource curse revisited and revised: A tale of paradoxes and red herrings. J Environ Econ Manage 55(3):248–264

Bulte EH, Damania R, Deacon RT (2005) Resource intensity, institutions, and development. World Dev 33(7):1029–1044

Conning JH, Robinson JA (2007) Property rights and the political organization of agriculture. J Dev Econ 82(2):416–447

Cuddington J (1992) Long-run trends in 26 primary commodity prices: a disaggregated look at the Prebisch–Singer hypothesis. J Dev Econ 39:207–227

DeCanio SJ, Watkins WE (1998) Investment in energy efficiency: do the characteristics of firms matter? Rev Econ Stat 80:95–107

Ding N, Field BC (2005) Natural resource abundance and economic growth. Land Econ 81(4):496–502

Durlauf SN (2001) Econometric analysis and the study of economic growth: a skeptical perspective. In: Backhouse RE, Salanti A (eds) Macroeconomics and the real world: econometric techniques and macroeconomics. Oxford University Press, Oxford

Easterly W, Levine R (2003) Tropics, germs, and crops: how endowments influence economic development. J Monetary Econ 50:3–39

Food and Agriculture Organization of the United Nations (1977) Production yearbook volume 30, 1976. FAO statistics series No. 7, Rome
Food and Agriculture Organization of the United Nations (1996) Production yearbook volume 49, 1995. FAO statistics series No. 130, Rome
Gylfason T (2001) Natural resources, education, and economic development. Eur Econ Rev 45:847–859
Gylfason T, Herbertsson TT, Zoega G (1999) A mixed blessing: natural resources and economic growth. Macroeconomic Dyn 3:204–225
Hall RE, Jones CI (1999) Why do some countries produce so much more output per worker than others? Q J Econ 114:83–116
Hodler R (2006) The curse of natural resources in fractionalized countries. Eur Econ Rev 50:1367–1386
Honaker J, Joseph A, King G, Scheve K, Singh N (2001) Amelia: a program for missing data (Windows Version). Harvard University, Cambridge, MA. http://Gking.Harvard.edu/
Hubbard M (1997) The 'New Institutional Economics' in agricultural development: insights and challenges. J Agric Econ 48(2):239–249
Imai K, Weinstein J (2000) Measuring the economic impact of civil war. Harvard University Center for international development working paper series, No. 51
Isham J, Woolcock M, Pritchett L, Busby G (2005) The varieties of resource experience: natural resource export structures and the political economy of economic growth. World Bank Econ Rev 19(2):141–174
Kaufmann D, Kraay A, Mastruzzi M (2003) Governance matters III: governance indicators for 1996–2002. World Bank Policy Research Department working paper
King G, Honaker J, Joseph A, Scheve K (2001) Analyzing incomplete political science data: an alternative algorithm for multiple imputation. Am Polit Sci Rev 95(1):49–69
Knabb SD (2005) The contribution of institutions, trade, and geography to the development process: how robust is the empirical evidence to variations in the sample? Empir Econ 30(2):393–409
Kofman P, Sharpe IG (2003) Using multiple imputation in the analysis of incomplete observations in finance. J Financ Econom 1(2):216–249
Leite C, Weidmann J (1999) Does mother nature corrupt? Natural resources, corruption, and economic growth. Working paper of the International Monetary Fund, WP/99/85
Mehlum H, Moene C, Torvik R (2006) Institutions and the resource curse. Econ J 116:1–20
North D (1990) Institutions, institutional change and economic performance. Cambridge University Press, Cambridge
Rodrik D, Subramanian A, Trebbi F (2004) Institutions rule: the primacy of institutions over integration and geography in economic development. J Econ Growth 9(2):131–165
Rosenberg N, Birdzell LE Jr (1986) How the west grew rich. Basic Books, New York
Ross ML (1999) The political economy of the resource curse. World Polit 51(2):297–322
Rubin DB (1996) Multiple imputation after 18+ years. J Am Stat Assoc 91(434):473–489
Sachs J, Warner A (1995a) Economic convergence and economic policy. NBER working paper No. 5039. NBER, Cambridge, MA
Sachs J, Warner A (1995b) Natural resource abundance and economic growth. Development discussion paper No. 517a, Harvard Institute for International Development
Sachs J, Warner A (1999) The big push, natural resource booms and growth. J Dev Econ 59:43–76
Sachs J, Warner A (2001) The curse of natural resources, with Andrew Warner. Eur Econ Rev 45:827–838
Sala-i-Martin X, Subramanian A (2003) Addressing the natural resource curse: an illustration from Nigeria. NBER working paper No. 9804. NBER, Cambridge
Sala-i-Martin X, Doppelhofer G, Miller RI (2004) Determinants of long-term growth: a Bayesian averaging of classical estimates (BACE) approach. Am Econ Rev 94(4):813–835
Stevens P (2003) Resource impact: curse or blessing? A literature survey. J Energy Lit IX(1):3–42
Stijns JC (2005) Natural resource abundance and economic growth revisited. Resour Policy 30(2):107–130
United States Department of the Interior and United States Geological Survey (2003) Mineral commodity summaries 2003. U.S. Government Printing Office, Washington, DC
Watkins MH (1988) A staple theory of economic growth. In: Easterbrook WT, Watkins MH (eds) Approaches to Canadian economic history. Carleton library series #31, Carleton University Press, Ottawa