RESOURCES, RENT DIVERSIFICATION, AND THE COLLAPSE OF AUTOCRATIC REGIMES – WEB APPENDIX

SECTION 1:

TABLE A1: DESCRIPTIVE STATISTICS

Variable	Obs.	Mean	Std. Dev.	Min	Max
Autocratic Regime Failure	2330	0.05	0.22	0	1
Rent Diversification	2330	0.35	0.22	0	0.79
Rent Diversification^2	2330	0.17	0.15	0	0.62
Rent Diversification (oil and gas combined as "fuel" rents)	2330	0.30	0.22	0	0.75
Rent Diversification^2 (oil and gas combined as "fuel" rents)	2330	0.14	0.14	0	0.56
Rent Diversification (ODA excluded)	2618	0.24	0.23	0	0.75
Rent Diversification^2 (ODA excluded)	2618	0.11	0.14	0	0.57
Total Rents as % GDP	2330	12.96	15.03	0.0006	93.55
Log GDP per capita	2330	7.67	1.03	5.62	11.09
Economic growth (one year lag)	2330	1.81	6.67	-47.31	91.67
Coup attempt (one year lag)	2330	0.03	0.17	0	1
Party autocracy	2330	0.45	0.50	0	1
Physical integrity	1716	3.92	2.03	0	8
Log population	2330	16.08	1.41	13.01	21.01
Religious fractionalization	2305	0.44	0.24	0.00	0.86
Oil state (oil per capita > $100)	2330	0.27	0.45	0	1
Total Non-tax revenue (% GDP)†	717	8.90	7.52	-3.3	44.98
State owned enterprise revenue (% GDP) †	742	4.06	5.01	0.05	44.33
National Oil Company (binary variable) †	2330	0.37	0.48	0	1
Total tax revenue (% GDP) †	745	17.05	7.19	0.07	49.24
Total tax revenue (per capita) †	743	282.6	395.8	0.13	3875.8
Time	2330	23.09	32.69	1	269
Time^2	2330	1601.48	7751.42	1	72361
Time^3	2330	2.70E+05	1.97E+06	1	1.95E+07

† =Discussed and used in Appendix C only

SECTION 2

CONCERNING MISSING NATURAL RESOURCE RENT DATA AND THE CALCULATION OF *RENT DIVERSIFICATION*

The measurement of our key independent variable *rent diversification* depends on underlying data from the World Bank's World Development Indicators (WDI) on the size of natural resource rents as a share of total GDP for the following five natural resources: coal, forest, mineral, natural gas, and oil rents. These represent five of the six rent-generating sources we use in the calculation of the variable.

Data for these components are presented in the WDI as individual values for the five particular sectors. In addition, the WDI includes a summary indicator labeled "Total Natural Resource Rents as a Percent of GDP." When the WDI reports non-missing data for all five individual components, this variable, "Total Natural Resource Rents," is simply the sum of each component. In such instances, there are no data limitations that preclude us from calculating our key independent variable for a particular country-year.

However, missing data – a pervasive problem in the WDI, particularly for developing economies in the years before 1980 – is an issue for many of the country-years in our sample. In practical terms, there are three different situations in which missing data becomes an issue for our empirical analysis. We discuss each situation and our response in turn.

First, there are many instances when the WDI reports missing data for all five resource components and the summary indicator "Total Natural Resource Rents." In such instances, we cannot calculate our key variable and have little choice but to allow this country-year to fall out of our estimation sample.

Second, there are many instances in which the WDI reports missing data for some of the individual resource components, but a non-missing value for at least one of these resource components. In these instances, the summary indicator "Total Natural Resource Rents" reports a value equal to the sum of all non-missing individual resource components. In these instances, we interpret the presence of some non-missing data for individual resource components as a sign that the WDI's data captures the underlying nature of a country's resource wealth completely, and set the remaining missing values for individual resource components to 0. For instance, if the WDI reports that in country-year X_{it} that coal rents are 4% of GDP, and that the Total resource rents are 4% of GDP, we assume that the other resource components are actually zero, rather than missing values. This process allows us to calculate our key independent variable for the particular country-year.

Third and finally, there are other country-years in which the WDI reports missing values for all five resource components, but reports a non-missing value of 0 for the summary "Total Natural Resource Rents" variable. In these instances, we interpret the WDI as suggesting that a

country's GDP does not rely on natural resource rents, and thus we set the individual components to 0, rather than missing.

These decisions about how to treat missing data in the WDI has the practical effect of allowing us to calculate our measure of *rent diversification* rather than dropping the country-year because of missing data. We find our decisions in these later two categories defensible; if the World Bank has sufficient data to classify a country's total resource dependence as a percentage of GDP, it stands to reason that the individual components of resource wealth can safely be considered zero rather than missing.

Nevertheless, we have calculated our key independent variable in an alternative fashion which does not make this assumption about missing data. In other words, we calculate our key independent variable *rent diversification* only for the country-years in which each component is reported as a non-missing value. As expected, this procedure dramatically reduces the sample sizes that we use to estimate our regressions. Nevertheless, our key results remain. These results are presented in Table A2 on the following page. The only difference between the two models concerns the inclusion of a control variable to measure a regimes' total resource dependence; Model 1 includes the measure *total rents (% GDP)* while Model 2 replaces this measure with a dummy variable for oil states, using Ross' (2012) criteria of those with more than $100 per-capita oil incomes. Note also that, due to the considerably diminished sample size, these regressions do not include the measure of past political instability, as this particular measure perfectly predicts four instances of regime failure.

Table A2: Robustness results for alternative calculation of main independent variable

	(1)	(2)
Rent diversification	-4.91***	-4.84***
	(1.853)	(1.773)
Rent diversification^2	6.59***	6.33***
	(2.254)	(2.236)
Total Rents (% GDP)	0.00	-
	(0.008)	
Oil state dummy	-	-0.11
		(0.310)
Log GDP per capita	0.14	0.17
	(0.147)	(0.158)
Economic growth (one year lag)	-0.02	-0.02
	(0.016)	(0.016)
Party autocracy	-0.63**	-0.58**
	(0.252)	(0.288)
Time	0.06	0.06
	(0.038)	(0.039)
Time^2	-0.00*	-0.00*
	(0.001)	(0.001)
Time^3	0.00**	0.00**
	(0.000)	(0.000)
Constant	-2.28*	-2.42**
	(1.176)	(1.183)
Observations / clusters	519 / 43	519/ 43
LR (chi2)	34.81	34.53
Prob > chi2	< 0.001	< 0.001

Notes: Dependent variable is binary measure of autocratic regime failure.
Probit regression with standard errors clustered on regimes.
See text for full variable description.
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

SECTION 3

FURTHER ROBUSTNESS ANALYSES

This appendix reports the results of additional robustness exercises. We report two different types of exercises, though each deal with the same underlying issue, namely the relationship between resources and rents. As we note on pages 13-14 of the manuscript, the mere presence of natural resources does not automatically imply that governments capture the available rents that come from their exploitation. Transforming resource abundance into actual government rents depends on a variety of issues. For instance, whether resource sectors are privately or publically owned will strongly influence the beneficiaries of this wealth, or in our terms, whether governments capture these rents.

To be clear, our argument hinges on the tendency of governments to capture these potential rents. Based on prior theoretical and empirical work, we believe this is a reasonable assumption (see, for instance, the discussion on pages 13-14 in the manuscript). Nevertheless, our empirical approach follows the vast majority of work in this research agenda by employing measures of potential rents and assuming that governments are the main beneficiaries. Ross (2012),[1] for instance, measures the value of domestic oil and gas production in per-capita terms, even though this measurement strategy cannot ensure that all of these rents accrue directly to central governments. This empirical approach is necessitated by the absence of data which systematically report rents captured by governments or even the kind of detailed government revenue data that researchers might be able to parse into more valid conceptual measures. Remedying this gap is an important avenue for future research.

In the meanwhile, however, we report the results of two sets of analyses that help us, at least indirectly, test whether or not this process occurs. The first exercise focuses on evaluating whether this main assumption underpinning our empirical approach is reasonable. The second exercise evaluates whether or not our main results are robust to the inclusion of control variables that offer some ability to empirically measure circumstances that might prevent rents from accruing directly to governments. We discuss each set of analyses below.

Part 1

First, we demonstrate that governments who preside over economies with a greater volume of *potential* rents behave in ways consistent with their appropriation of these rents. This is indirect evidence that is consistent with the assumptions underpinning our theoretical argument.

For instance, in columns 1 and 2 of Table A3, we examine the relationship between the total volume of potential rents in an economy (measured as the sum of all rent-generating sectors as a share of GDP) and government reliance on non-tax revenue and state-owned enterprise revenue, respectively. If governments tend to appropriate the potential rents in their economy, we would expect that greater levels of potential rents should be associated with greater reliance on non-tax revenue, as the resource rents provide a key substitute for normal revenue collection through

[1] Ross, Michael. *The Oil Curse: How Petroleum Wealth Shapes the Development of Nations*. (2012). Princeton, NJ: Princeton University Press.

taxation. Similarly, we would expect that greater levels of potential rents are associated with a larger share of GDP derived from state-owned enterprises, as the later are often the vehicles by which these resource rents are appropriated.

These expected relationships are confirmed by our empirical analysis. Specifically, the OLS regressions in columns 1 and 2 show that as the total volume of potential rents increases, the volume of non-tax revenue and state-owned enterprise revenue, both as a share of GDP, also increase. These findings are present even when we control for the level of income per-capita in a country. Data for both dependent variables is drawn from Morrison's (2009)[2] replication materials. The sample consists of the same regime-year observations reported in the main results of Table 2, though data limitations reduce this considerably.

In column 3, we examine a different measure of government behavior that is nonetheless still consistent with our main assumption. Specifically, we examine whether or not a greater volume of potential rents in the economy is associated with the existence of a National Oil Company, or NOC, which is a state-controlled firm that dominates the petroleum industry domestically. NOCs play a critical role for governments, since they provide a direct mechanism to capture revenue streams from petroleum resources.

Our logic is as follows: if potential resource rents exist, governments will build the kinds of institutions necessary to effectively appropriate these rents. We use the existence of a NOC as a proxy measure of these kinds of institutions. Though the existence of a NOC only provides government access to petroleum rents, we argue that it can be viewed as a reasonably proxy for the kinds of institutions that would facilitate more widely-ranging government capture of potential rents. We follow the approach of Cheon, Lackner, and Urpelainen (2015)[3] to create a binary variable measuring the existence of a NOC in our sample. Since this dependent variable is binary, we estimate the model using logistic regression.

The results, presented in column 3 of Table A3, show that a greater volume of potential resource rents are strongly associated with the existence of a NOC, which we view as proxy measure of government's creation of institutions designed to capture these rents. This too is evidence that is consistent with our underlying assumption.

Our goal in this section is not to fully model the determinants of government's reliance on non-tax revenue, use of state-owned enterprises, or the decision to create a NOC. Rather, we view these results as consistent with our empirical assumptions and providing indirect evidence that governments tend to appropriate the potential rents in their economies. Given the centrality of this assumption to the entire resource curse literature, future research should focus on directly measuring this appropriation process or the other kinds of institutions that facilitate the direct

[2] Morrison, Kevin M. "Oil, nontax revenue, and the redistributional foundations of regime stability." *International Organization* 63.01 (2009): 107-138.
[3] Cheon, Andrew, Maureen Lackner, and Johannes Urpelainen. "Instruments of Political Control National Oil Companies, Oil Prices, and Petroleum Subsidies." *Comparative Political Studies* 48.3 (2015): 370-402.

capture of rents by governments. We look forward to seeing how this literature develops. For now, however, we find these results reassuring for our argument.

Table A3: Total Rents and Government Capture

	DV: Total Non-tax Revenue as % GDP (OLS Regression)	DV: State Owned Enterprise Revenue as % GDP (OLS Regression)	DV: Existence of National Oil Company (Logistic Regression)
Total Rents (% GDP)	0.28***	0.23***	0.03**
	(0.081)	(0.066)	(0.011)
Log GDP per capita	-0.50	1.38***	0.56***
	(0.619)	(0.519)	(0.187)
Constant / Cut-point	10.17**	-8.73**	-5.26***
	(4.897)	(4.081)	(1.446)
Observations / clusters	717/85	742/85	2,330/172
F / Lr(chi2)	6.73	7.06	-1379.5
R-squared / Prob > chi2	0.13	0.33	< 0.001

Notes: Dependent variable listed in column title; standard errors clustered on regime
See text for full variable
description.
Sample is that of Table 2, Column 1, subject to data availability
*** p<0.01, ** p<0.05, * p<0.1

Part 2

One common objection to the assumption that potential rents are captured by governments concerns issues of ownership.[4] If governments do not directly own these resource rents, then they will only reap the financial benefits indirectly. For instance, governments may be forced to rely on taxation of private firms, which – from the perspective of the central government – is a less efficient method of generating revenue. Moreover, prior research has shown that tax revenues are not synonymous with rents.[5]

In this section, we examine whether our main regression results are robust to the inclusion of additional control variables which offer some ability to distinguish whether governments benefit directly or indirectly. Again, issues of data availability make this difficult; just as we lack data that indicate whether resource sectors generate rents that accrue directly to central governments, we also lack data that would indicate the opposite (i.e. that resource sectors are owned privately or in some other configuration that reduces central government capture). As a second-best approach, we add to our main regressions a measure of total government tax revenue, in share of GDP and per-capita terms. If resource rents tend to accrue to governments only indirectly, then including a measure of tax reliance ought to weaken our main results. By contrast, if direct capture by governments is the rule rather than the exception – an argument we view as consistent with the vast majority of existing work on this topic, as discussed on pages 13-14 of the main article – then controlling for tax reliance should have no impact on our main findings. Though a blunt test of this potential criticism, we view this as a useful test of this core assumption.

Table A4 presents the results from re-estimating our core logistic regressions from Table 2 in the article, with each model introducing a measure of total tax revenue as a control variable. Data on tax reliance are drawn from the replication materials in Morrison (2009).[6] The results from each model continue to provide support for our argument on the role of diversification. Moreover, there is no evidence that greater tax reliance exerts any impact on autocratic regime survival, though the reduced sample size tempers this conclusion somewhat.

Again, we reiterate that future research would benefit tremendously from better measures of state versus private ownership of resources and the rents they generate, and we look forward to seeing this literature develop. In the meanwhile, the results in Table A4 suggest that, to the extent we can measure these concepts currently, they do not impact the conclusions we have drawn on the relationship between rent diversification and autocratic collapse.

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[4] Luong, Pauline Jones, and Erika Weinthal. "Rethinking the Resource Curse: Ownership Structure, Institutional Capacity, and Domestic Constraints." *Annual Review of Political Science* 9 (2006): 241-263.

[5] Lieberman, Evan S. "Taxation data as indicators of state-society relations: possibilities and pitfalls in cross-national research." *Studies in Comparative International Development* 36.4 (2002): 89-115. We thank an anonymous reviewer for raising this issue.

[6] c.f footnote #2

Table A4: Further Robustness of Main Results

	(1)	(2)
Rent diversification	-3.81***	-3.76***
	(1.027)	(1.037)
Rent diversification^2	5.08***	5.10***
	(1.597)	(1.617)
Total Rents (% GDP)	-0.01	-0.01
	(0.008)	(0.008)
Log GDP per capita	0.05	0.03
	(0.080)	(0.101)
Economic growth (one year lag)	-0.03**	-0.03**
	(0.013)	(0.013)
Coup attempt (one year lag)	0.47	0.46
	(0.389)	(0.387)
Party autocracy	-0.59***	-0.55***
	(0.190)	(0.171)
Total tax revenue (% GDP)	0.01	-
	(0.011)	
Total tax revenue (per capita)	-	0.00
		(0.000)
Time, Time^2 , Time^3, and Constant included in regressions but omitted from tables		
Observations / clusters	745 / 85	742 / 85
LR (chi2)	-148.80	-148.72
Prob > chi2	< 0.001	< 0.001

Notes: Dependent variable is binary measure of autocratic regime failure.
Probit regression with standard errors clustered on regimes.
See text for full variable description.
*** p<0.01, ** p<0.05, * p<0.1