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U.S. State Fiscal Policy and Natural Resources*

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Abstract

An analytical framework predicts that, in response to an exogenous increase in resource-based government revenue, a benevolent government will partially substitute away from taxing income, increase spending and save. Forty-two years of U.S. state-level data are consistent with this theory. Specifically, a baseline fixed effects model predicts that a 1% point increase in resource revenue results in a .20% point decrease in non-resource revenue, a .50% point increase in spending and a .30% point increase in savings. These results are generally robust to alternative model specifications and the instrumentation of resource-based government revenue. Interaction effects reveal some asymmetry in the fiscal response to revenue shocks according to state political leanings.

Keywords: Severance Tax; Fiscal Policy; Natural Resources.

JEL Classification: Q38; H20

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I will not propose to take the peoples dividends or impose an income tax. Given our current revenue projections, I will focus my administration toward developing our natural resources and establishing an agreement to build a gas pipeline. Sarah Palin.

Introduction

Of the seven U.S. states that currently do not have an individual income tax, four (Wyoming, Alaska, Texas and Nevada) are resource rich.[1] More surprising is that in 2005, state government spending per resident was greater in Wyoming and Alaska than in any other state. In fact, spending per resident in Alaska was approximately equal to that in California and Massachusetts, combined. Are low tax rates and high spending rates a result of natural-resource endowments? The answer to this question has important policy implications and is particularly relevant to both the development literature and the ongoing debate over the tax-expenditure nexus.

An analytical framework indicates that a benevolent government will set an income tax rate to equate the marginal utility of private and public consumption. In response to an exogenous increase in resource revenue, the government decreases the income tax rate and increases public savings and expenditures. The model is estimated using 42 years of U.S. state-level public finance data. The empirical results are consistent with the theory. Specifically, a baseline fixed effects model suggests that a 1% point increase in resource revenue results in a .20% point decrease in non-resource revenue,[2] a .50% point increase in government spending and a .30% point increase in public savings. Instrumenting for resource-based revenue using proven reserves of natural resources yields similar results. Interaction effects reveal some asymmetry in the fiscal response to positive and negative resource shocks according to state political leanings. These interactions reveal, for example, that in response to a negative resource shock, conservative states tend to increase non-resource revenue by more—and cut spending by less—than their more liberal counterparts.

Recent development literature argues that non-resource tax cuts decrease public scrutiny which can breed corruption and form weak democratic institutions. According to this theory, there needs to be taxation for there to be representation (Collier and Hoeffler, 2006; McGuirk, 2009). While this argument is popular in the development literature, empirical evidence of a negative relationship between resource and non-resource revenue is surprisingly

[1]New Hampshire and Tennessee do not tax wage income, but tax other types of income including dividends and capital interest.

[2]Revenue, savings and expenditures are expressed relative to personal income.

scant. One recent exception is Bornhorst, Gupta and Thornton (2009) who, using a panel of 30 countries, empirically estimate a negative relationship between hydrocarbon government revenue and government revenue from other sources. They conclude that a 1% point increase in hydrocarbon revenue results in a .20% point decrease in non-hydrocarbon revenue.

A valid question is whether there is sufficient heterogeneity across U.S. states to warrant concerns of resource-induced political corruption. It is possible, though not obvious, that federal institutions are strong enough to mitigate the corroding effect that natural resources may have on state-level institutional quality. Though, regarding the determinants of corruption across U.S. states, Glaeser and Saks (2006) point out that "many of the basic patterns that hold for countries, hold for states as well". For example, similar to cross-country studies, they find that states with higher incomes and education levels are significantly less corrupt. Additionally, the part of this paper that overlaps with the earlier work of Bornhorst, Gupta and Thornton should be considered a robustness check on their results. If their main result holds across U.S. states—namely that there is an inverse relationship between resource and non-resource-based government revenue—it would reaffirm their study, which relies on the use of national data that is often of questionable integrity.

This paper also contributes to the ongoing debate over the tax-expenditure nexus. Milton Friedman famously argued that the only way to shrink the size of government is to "starve the beast" by decreasing tax revenue. Specifically, Friedman (1978) argued that:

> *Government will spend whatever the tax system will raise plus a good deal more. Every step we take to strengthen the tax system, whether by getting people to accept payroll taxes they otherwise would not accept, or by cooperating in enacting higher income taxes and excise taxes or whatnot, fosters a higher level of government spending. That's why I am in favor of cutting taxes under any circumstances, for whatever excuse, for whatever reason.*

While others have echoed this argument (Barro, 2003), testing its efficacy has proven difficult given the simultaneous nature of the problem. Does increased government spending require governments to tax more or does increased government revenue allow governments to spend more? Knight (2002) considers whether federal highway grants crowd-out state government highway spending. He argues that federal grants are endogenous and instruments for them using the political power and committee membership of state delegates. He concludes that federal grants largely, if not completely crowd out state spending. Romer and Romer (2009) similarly consider how exogenous changes to the tax code affect federal government spending. They find that federal spending is unresponsive to changes in tax structure; a negative revenue shock simply results in a bloated federal deficit. See Payne (2003) for a nice review of this literature.

Extending Bornhorst *et al.*'s analysis to the U.S. state level is important for a couple of reasons. First, U.S. state-level data is more reliable and disaggregated than it is across countries. This allows for a more focused and detailed analysis that is not limited to an examination of non-resource tax revenue, but one that explores the relationship between natural resources and fiscal policy decisions more generally. Second, and perhaps most importantly, unobserved heterogeneity is minimized in a subnational setting. This decreases the likelihood of experiencing omitted variable bias and increases the reliability of the econometric estimates.

A Motivating Analytical Framework

A benevolent government chooses an income tax rate that maximizes social welfare over two periods. The government can borrow and save but must have a balanced budget by the end of the second period. For simplicity, government debt is financed exogenously and the rate of interest is zero. Further, growth and private savings are zero. Welfare, W, is

$$W = \ln(c_t) + \alpha \ln(g_t) + \beta[\ln(c_{t+1}) + \alpha \ln(g_{t+1})], \tag{1}$$

where c_t is private consumption in period t, $t \in \{1, 2\}$, g_t is consumption of a government-provided public good, β is the representative person's relative preference for consumption in the second period and α is the representative person's relative preference for the government-provided good. Private consumption is equal to disposable income:

$$c_t = (1 - \tau_t)y, \tag{2}$$

where τ_t is the income tax rate in time period t and y is income. Government spending is equal to the sum of income-tax revenue, resource revenue and deficit spending. Specifically, government spending in the first period is:

$$g_1 = \tau_1 y + r_1 - s, \tag{3}$$

where r_1 is resource revenue in the first period and s is public savings. By assumption, the government has a balanced budget by the end of the second period such that:

$$g_2 = \tau_2 y + r_2 + s, \tag{4}$$

where r_2 is resource revenue in the second period. Note that because the government chooses the income tax rate in the first period, r_2 is assumed to be known by the government in the first period. Alternatively, r_2 can be viewed as the government's expectation of resource revenue in the second period. For tractability, the government's expectation of resource revenue in the second period is expressed as a fraction of first-period resource revenue:

$$r_2 = \phi r_1, \tag{5}$$

where $\phi \geq 0$. Substituting (2), (3), (4) and (5) into (1) and taking the derivative of welfare with respect to the first and second-period income tax rates and savings gives three first-order conditions that can be combined to derive expressions for the optimal first-period income tax rate, public savings and government spending. The optimal income tax rate is

$$\tau_1 = \frac{\alpha(1+\beta)+\beta-1}{(1+\alpha)(1+\beta)} - \hat{r}_1 \frac{(1+\phi)}{(1+\alpha)(1+\beta)}, \tag{6}$$

where $\hat{r_1}$ is resource revenue relative to income. Taking the derivative of (6) with respect to $\hat{r}_1$ offers the first testable hypothesis of the model, namely that the income tax rate is decreasing in resource revenue:

$$H_{A,1} : \frac{d\tau}{d\hat{r}_1} < 0,$$
$$H_{0,1} : \frac{d\tau}{d\hat{r}_1} \geq 0.$$

This is an intuitively pleasing result. The government transfers some resource revenue back to tax payers in the form of lower, non-resource tax rates in order to smooth private and public consumption. Note that this result is independent of the value of ϕ. In fact, either an increase in first - or second period resource revenue results in a decrease in the income tax rate in the first period. A similar expression for public savings can be derived:

$$\hat{s} = \frac{\beta-1}{1+\beta} + \hat{r}_1 \frac{\beta-\phi}{1+\beta}, \tag{7}$$

where $\hat{s}$ is public savings relative to income. Taking the derivative of (7) with respect to $\hat{r}_1$ indicates that, for a sufficiently small ϕ, public savings are increasing in resource revenue:

$$H_{A,2} : \frac{d\hat{s}}{d\hat{r}_1} > 0,$$
$$H_{0,2} : \frac{d\hat{s}}{d\hat{r}_1} \leq 0.$$

Again, this is an intuitive result. An increase in first period resource revenue leads to an increase in public savings as the government attempts to smooth consumption across the two periods. Note that for ϕ close to β, an increase in resource revenue has a small effect on the savings rate. In fact, for $\phi = \beta$ an increase in resource revenue does not affect the savings rate.[3] This implies that only temporary changes in resource revenue affect the size of public savings. Lastly, equations (6) and (7) define optimal government expenditures:

$$\hat{g} = \frac{2\alpha}{(1+\alpha)(1+\beta)} + \hat{r}_1 \frac{\alpha(1+\phi)}{(1+\alpha)(1+\beta)}, \tag{8}$$

where $\hat{g}$ is government spending relative to income. Taking the derivative of equation (8) with respect to $\hat{r}_1$ indicates that government spending is strictly increasing in resource revenue:

$$H_{A,3} : \frac{d\hat{g}}{d\hat{r}_1} > 0,$$
$$H_{0,3} : \frac{d\hat{g}}{d\hat{r}_1} \leq 0.$$

In conclusion, the model predicts that the "extra" government revenue created by natural resource endowments is spent in three ways. Some amount is transferred to tax payers in the form of lower non-resource tax rates, some is used to increase public expenditures and the rest is saved for future consumption.

Estimation Strategy and Results

In this section, the predictions of the model are tested using U.S. state-level data. Specifically, variations of the following equation are estimated:

$$\tilde{\tau}_{i,t} = \alpha_1 + \beta_1 \hat{r}_{i,t} + S_i + Z_t + \epsilon_{i,t,1}, \tag{9}$$

where $i = 1, ..., 50$ and $t = 1958, ..., 1999$. National trends in preferences for taxation and government spending are captured by time fixed effects, Z_t, while time invariant, state-specific characteristics are captured by S_i. All dependent variables are expressed as shares of income. Weighting variables is important because resource revenue is likely to be positively correlated with, for example, government expenditures and non-resource revenue. Put differently, larger states are more likely tax more, spend more and save more. Specifically, $\tilde{\tau}_{i,t} = T_{i,t}/y_{i,t}$, where T is defined as either non-resource-government revenue, income tax revenue, total government expenditures, expenditures on education or public savings. All regressions feature standard errors that are clustered at the state level. All public finance and income data are collected from the U.S. Census Bureau, Federal, State & Local Government data base.

[3]For exhaustible resources ϕ is likely to be small if the government expects to earn less from the resource in the future.

Alaska is a clear outlier and its inclusion in the data set significantly affects the results. This may be due to a number of things. The state government of Alaska is substantially more resource-dependent than most other governments. For example, in 1970, resource-based government revenue was 115% of total personal income (the next most resource-dependent government is that of Wyoming, for which resource revenue relative to personal income was 11.7% in 1986). The relationship between resource revenue and state fiscal policy may not be linear across such dramatic differences in resource revenue dependence. For example, if the state government of Alaska initially collects very little tax revenue, it can't lower tax rates by much more when faced with a large positive resource shock.

Additionally, in 1977, the Alaska Permanent Fund was created to manage state oil revenues. Each year, residents of Alaska receive Permanent Fund Dividends which in 1999 were about $1,700 per resident (Goldsmith, 2002). Direct transfer payments of this kind may dampen the relationship between natural resources and state fiscal policy decisions that would otherwise exist. In a similar vein, the state government of Wyoming established the Permanent Mineral Trust Fund in 1974 and New Mexico established the Severance Tax Permanent Fund in 1973. However, while these wealth funds produce interest revenue for the respective state governments, they do not pay residential dividends (Truman, 2008).

More troubling is that an examination of Alaskan data shows that levels of resource-based government revenue vary drastically over short periods of time. For example, relative to personal income, resource-based revenue was 2.7% in 1969, 61.3% in 1970 and 7.4% in 1971. Such temporal variation in the data may reflect major policy changes, data errors or dramatic resource-revenue shocks that can confound the results. In light of this, the remainder of the paper focuses on the results after removing Alaskan observations from the data set.

Before turning to the empirical estimation, it is helpful to be familiar with the relative magnitudes of the key variables and parameters. As can be seen in Table 1, averaged across all states and time, resource revenue is .7% of income. It is worth noting that this number is significantly smaller than average non-resource revenue (12.1% of income). There is substantial variation in tax and spending rates across observations. For example, resource revenue ranges from 11.7% (Wyoming, 1986) to .03% (Illinois, 1962). Similar variation is found when looking at government spending and public savings which range from 23.9% (Wyoming, 1987) to 4.2% (New Jersey, 1960) and 6.4% (Wyoming, 1982) to -3.5% (Connecticut, 1958), respectively. Education expenditures account for a large amount of total government spending. Averaged across all observations, education expenditures are 3.9% of income, or 32% of total spending. Lastly, of note is the fact that income tax revenue relative to personal income is only about 1.7%. This is due in large part to the fact that seven states don't have a personal income tax, which will draw the average tax rate down. Additionally, personal income includes transfer payments from the federal government, including, for example, social security payments which are not subject to an income tax.

As a starting point, I estimate the relationship between resource revenue and non-resource revenue by defining T as total revenue that is not resource based. Resource revenue, r, is defined as the sum of severance-tax revenue, revenue earned from property and investments which includes resource rents and royalties, land use and licensing fees, interest payments from wealth funds (in the case of Wyoming and New Mexico) and resource-based federal intergovernmental grants. The conditional results are given in Table 2. Dropping Alaska from the data set (column 2), the coefficient on resource revenue is -.199 and significant at the 1% confidence level, implying that a 1% point increase in resource revenue results in approximately a .20% point decrease in non-resource revenue. This is an important result as it implies that governments transfer 20% of resource revenue back to tax payers in the form of lower non-resource tax rates. This result is also remarkably similar to that in Bornhorst *et al.* who, using an international panel of data find a 20% offset between hydrocarbon and non-hydrocarbon revenue sources. However, as is discussed in the next section, this estimate may be biased if resource revenue is endogenous and should therefore be viewed with caution.

Governments may offset resource-based revenue shocks using other specific tax rates. For example, in response to a positive resource shock, governments may reduce income tax rates while leaving property tax rates unchanged. While this does not invalidate the proceeding specification, it does suggest that it might be a noisy one. In light of this, I estimate an additional model where $T_{i,t}$ is defined as income tax revenue, rather than total tax revenue. This approach yields similar results. Referring to Table 3, the coefficient on resource revenue is negative (-.117) and significant at the 1% confidence level, implying that about half of a resource revenue shock is offset by adjusting the income tax rate alone.

How does a revenue shock affect government spending? I attempt to answer this question by defining $T_{i,t}$ as total government expenditures. The results are given in Table 4. Controlling for fixed effects, the coefficient on resource revenue is .50 and significant at the 1% confidence level, implying that about half of a positive revenue shock is spent. One concern here is that a resource boom leads to an increase in government expenditures by creating additional costs for the government. For example, increased truck traffic may increase the cost of road repairs, or perhaps given the dangerous nature of the mining industry, a resource boom increases state government health care costs. Given this, it's possible that governments increase spending during a resource boom only because the mining process requires it. In this scenario, the empirical results would appear to support the prediction of the model, but this would be a misguided conclsuion. I therefore estimate an additional model where $T_{i,t}$ is defined as total government expenditures on education, the idea being that the mining process itself does not directly require additional educational services (relative to income).[4] The baseline fixed effects results are given in column 2 in Table 5. The results show that a 1% point increase in resource revenue induces a .16% point increase in education expenditures (significant at the 1% confidence level). This implies that about $.16/.50 = 32\%$ of the increase in expednditures that results from a rseource boom is on education.

Because 20% of resource revenue is transferred back to constituents in the form of lower, non-resource tax rates and 50% is used to increase spending, it is an accounting identity that 30% of the extra revenue should be saved. As a robustness check on the quality of the data set, I formally test this by re-defining $T_{i,t}$ as public savings. The results are given in Table 7. Controlling for fixed effects, the coefficient on resource revenue is .29 and is significant at the 1% confidence level, confirming that approximately 30% of resource revenue is saved. While this result is unsurprising, it nonetheless confirms the previous results and additionally provides a confidence interval for the relationship between resource revenue and savings.

Further Analysis

Robustness Checks

While the production of oil and gas may be exogenous due to binding geological constraints, resource-based government revenue is a function of various types of natural resources including coal, minerals, metals and ores. It is therefore possible that resource-based revenue, as defined above, is endogenous. If this is indeed the case, estimating equation (9) using OLS will yield biased econometric estimates. Specifically, if in an effort to finance additional expenditures, governments collect more resource and non-resource tax revenue, an upward bias will exist both in the relationship between resource revenue and non-resource revenue and resource revenue and expenditures.

To address this concern, resource revenue is instrumented for using state endowments of oil and natural gas. Specifically, I estimate the following equation in the first stage:

$$\hat{r}_{i,t} = \alpha_2 + \beta_2 \text{Endowment}_{i,t} + \epsilon_{i,t,2}, \tag{10}$$

where $\text{Endowment}_{i,t}$ is the value of energy endowments in state i at time t. Provided $\text{corr}(\text{Endowment}_{i,t}, \epsilon_{i,t,1}) = 0$ and β_2 is sufficiently significant, this procedure eliminates problems of endogeneity and reverse causality because variation in the fitted value of resource revenue is solely explained by variation in endowment—which is assumed to be exogenous.

[4]A resource boom may attact people that require education services. In this case, a resource boom would probably lead to an increase in education costs; this is precisely the reason that such variables are expressed relative to personal income.

How should one measure exogenous resource endowments? One option is to use proven reserves of oil, coal and natural gas that is provided by the Energy Information Administration (EIA). A shortcoming of this approach is that EIA estimates of energy reserves partly reflect production levels, which may invalidate the use of EIA energy reserves as an instrument. Given this, I proxy for $\text{Endowment}_{i,t}$ using data on undiscovered, technically recoverable stocks of oil and natural gas available from the United States Geological Survey (USGS).[5] The USGS does not provide data on state-level resource stocks. Rather, it provides data on stocks of oil and gas located within so-called "provinces", the boundaries of which are defined, in part, by geological features. A province may be entirely within a state, or may spread across many states. To create an instrument with this data, ARCGIS is employed to compute the percent of each province within each state, where provincial data reflect 1995 estimates.[6] Interacting the percent of each province within each state with provincial values of resource stocks then gives a proxy of resource endowments. Specifically, $\text{Endowment}_{i,t}$ is defined as,

$$\text{Endowment}_{i,t,1999} = \sum_{j} \sum_{n} \text{Province}_{j,n,1999} \times P_{n,t} \times \rho_i, \tag{11}$$

where $\text{Province}_{j,n}$ is the volume of resource n in province j estimated by the USGS in either 1995 or 2002, $P_{n,t}$ is the price of resource n, which in this case is either oil or natural gas and ρ_i is the percent of province j in state i. See Figure 1 for a graphical description of provincial sizes and locations. The shaded region is the Western Great Basin and provides an example of how provinces are divided across states. 38% is in California, 32% is in Nevada and 29% is in Oregon.

The USGS-IV results, which are reported in the third column of Table's 2-6, generally compliment the previous findings, though there are some notable differences. First, the IV results suggest that 53% of resource revenue is used to substitute for non-resource revenue (significant at the 10% confidence level). Similarly, after instrumenting for resource revenue, the relationship between resource and income tax revenue is around -.177, and significant at the 1% confidence level. Also consistent with ex-anti expectations, the IV results indicate the relationship between government expenditures and resource revenue is positive (.17) but insignificant. Finally, in line with the fixed effects results, about 30% of resource revenue is saved.

Instrumenting for resource revenue addresses concerns of endogeneity and reverse causality.

[5] This data is available at: http://energy.usgs.gov/OilGas/AssessmentsData/NationalOilGasAssessment.aspx

[6] For some provinces, 1995 data is not available. In those cases, 2002 provincial data is used. More recent projections by the USGS, such as those made in 2013 are not used, as they reflect stocks of resources that were only recently made "technically recoverable" due to advancements in drilling technology, such as hydraulic fracturing and horizontal drilling.

However, it does not address the confounding problem created by weighting left-hand-side variables by personal income. Consider the implication of an oil price boom that triggers a rapid increase in resource-based government revenue. This kind of shock has the potential to increase both resource revenue relative to income, $\hat{r}$, and income, y. This may induce a negative correlation between $\hat{r}$ and non-resource revenue (expressed as a share of income); instrumentation does not correct for this bias. In light of this, I estimate additional variations of equation (9) in which both the right and left-hand-side variables are weighted by non-resource income, rather than by total income.

The results of these additional model specifications are given in Tables 7-11 where $\tilde{r}$ is defined as resource-based government revenue divided by non-resource-based personal income.[7] There are a couple of significant differences between these results and the previous ones. Referring to the more reliable USGS-IV estimates, the relationship between resource-based revenue and non-resource-based revenue is -.23, which is larger than the previous USGS-IV estimate of -.53. Similarly, these results suggests that resource-based revenue offsets income tax revenue by 16%. More in line with the fixed effects results, this specification indicates that 32% of resource revenue is spent (but is only significant at the 10.8% confidence level) and the remainder, about 30%, is saved.

Finally, while the previous results are reassuring, I address remaining concerns attributed to the weighting of left-hand-side variables by estimating the relationship between resource-based revenue and actual, legislated top marginal tax rates. There are two advantages of focusing on marginal income tax rates. First, the previous results suggest a negative and significant relationship exists. This approach therefore acts as a robustness check on some previous results. Second, there is sufficient variation in top marginal income tax rates over relatively short periods of time. For example, from 2005 to 2010, the top marginal income tax rate in California increased from .093 to .105, a 13% increase; in Maryland it increased from .047 to .062, a 29% increase; and in North Dakota it decreased from .055 to .048, an 11% decrease.[8]

One confounding issue with this approach is that marginal income tax rates are tiered such that the value of income tax revenue that is collected depends on both the marginal tax rate and the designation of tax brackets. A state government can actually adjust the value of income tax revenue it receives by adjusting tax brackets while leaving marginal tax rates constant. This will add noise to the estimation and decrease the reliability of the estimates.

[7]Data on personal income earned from the energy mining industry is collected from the Bureau of Economic Analysis Regional Data Base. Non resource revenue is then computed by subtracting income earned in the energy sector from total personal income.

[8]North Dakota does not have an individual state income tax, but does have a corporate state income tax.

The results of this model should therefore be viewed with caution.

The Tax Foundation provides annual, state level data on marginal tax rates from 2000-2010. Unfortunately, the public finance data used for this study is not available for these more recent years. One option then is to proxy for resource-based government revenue using endowments of natural resources. Similar to USGS-IV, I proxy for resource-based government revenue using data on undiscovered, technically recoverable energy stocks from the USGS.

Some provincial stocks of oil and natural gas increased dramatically from 2000 to 2010. This makes it difficult to use USGS-IV as an explanatory variable given it is based off of energy stock estimates from 1995 and 2002. To address this issue, I compute a proxy for resource-based government revenue that relies on more recent (2013) USGS estimates of technically recoverable stocks of oil and gas. Similar to USGS-IV, to compute the value of energy stocks in state i, volumes of oil and gas are then multiplied by the price of the respective mineral at time t and the percent of the province in state i.

The results are given in Table 12. While the coefficient on energy endowment is negative (-3.77), it lacks statistical significance (p-value = .14). While the magnitude of the coefficient is of little importance, the results nonetheless support the idea that states with large energy deposits use resource revenue to substitute for income tax revenue. Additionally, this approach demonstrates that there is sufficient temporal variation in tax rates to produce some of the earlier results—especially in the context of a 42-year time frame.

Asymmetric Fiscal Responses

An important question is whether the relationship between resource revenue and fiscal policy is symmetric for positive and negative changes in resource revenue. Bornhorst *et al.* address this concern by interacting resource revenue with indicator variables for periods of rising and falling resource revenue. I follow their methodology by defining a period of rising (falling) resource revenue as one in which resource revenue is greater than (less than) it was in the immediately preceding period. I then generate an indicator variable for periods of falling resource revenue and interact this variable with the main explanatory variable, resource-based government revenue. The results of this approach are given in the second-to-last columns of Tables 2 - 6

Interacting resource revenue with an indicator variable implicitly creates an additional endogenous variable. I therefore interact the instrument, $\text{Endowment}_{i,t}$, with the same indicator variable for periods of rising and falling revenues. However, this approach fails tests of under-identification, suggesting the endogenous variables are not uniquely identified. In light of this, I also estimate these interaction effects by estimating the effects on fiscal policy of positive and negative resource revenue shocks in separate regressions. This yields the coefficient estimates in the last column of Tables 2-6.

As in Bornhorst *et al.*, I find the negative relationship between resource and non-resource revenue is largely symmetric. Specifically, a 1% point increase (decrease) in resource revenue results in approximately a .50% point decrease (increase) in non-resource revenue. There does appear to be asymmetry in the relationship between resource revenue and expenditures however. In fact, a 1% point decrease in resource revenue results in about a .13% point decrease in spending while an increase in revenue leaves spending unchanged. There is additional evidence of asymmetry in the relationship between public savings and resource revenue. A 1% point increase in resource revenue results in a .36% point increase in savings, while a 1% point decrease in resource revenue results in a .36-.17=.19% point decrease in savings. Together, these results suggest that governments focusing on saving during a resource boom and spending cuts during a resource bust.

Political Interactions

The pooled sample results are revealing and largely support the predictions of the theoretical model. However, relative preferences for private and public good consumption vary across states and time and may affect how governments spend resource revenue. For example, conservative governments may prefer to use additional resource revenue to substitute for non-resource revenue while more liberal governments may prefer to use it to finance additional spending.

In consideration of preference heterogeneity across states, I estimate additional variations of equation (9) which interact an indicator variable that describes whether a state is conservative with resource-based government revenue and the indicator variable for periods of falling resource revenue. This specification identifies whether conservative state governments respond to positive or negative resource shocks differently from more liberal ones.

How should one measure state-specific political leanings? One approach would be to define state i at time t as "conservative" if state i at time t had a republican governor. One weakness of this specification is that preferences within political parties likely vary across space. For example, a democrat in Georgia may have similar preferences to a republican in California. To address this potential problem, I define a state as "conservative" if more than 50% of the votes cast in 2000 were for George Bush.[9]

[9] A valid concern is that a state's political leanings are spuriously correlated with the level of resource wealth in a state—George Bush won Alaska, Texas, Wyoming and North Dakota by a large margin. If the relationship between natural resources and fiscal policy are resource-wealth dependent, i.e., governments in highly-resource-rich states respond differently to resource shocks than those in resource-poor states, this could bias the results. In consideration of this, additional models were estimated that include USGS-IV directly, and

These results, which are given in last columns of Tables 2-6, suggest that conservative states respond differently to negative resource shocks than more liberal ones. Specifically, in response to a 1% point decrease in resource revenue, conservative states increase non-resource revenue by .23% points *more* and cut expenditures by .25% points *less* than their less conservative counterparts. In fact, while there is little evidence that conservative states decrease total spending in response to a decrease in resource revenue, a slightly different story is told when looking specifically at education expenditures. A 1% point decrease in resource revenue leads to a .10% point decrease in education expenditures in conservative states.

In conclusion of the main empirical results, governments offset resource-revenue shocks by making counter adjustments to non-resource tax rates, such as income tax rates, and this is true both for positive and negative revenue swings. This inverse relationship is particularly strong for conservative states which tend to increase non-resource tax rates in response to a negative resource shock by more than liberal states—opting instead to maintain non-education expenditures during a resource bust. Finally, public savings are positively related to resource revenue and there is symmetry in this relationship across states with different political leanings. However, this effect is particularly strong for positive resource-revenue shocks.

Conclusion

An analytical framework predicts that, in response to an increase in resource-based government revenue, a benevolent government will decrease non-resource tax rates, increase spending and increase public savings. Forty two years of U.S. state-level data are consistent with this prediction. Specifically, a 1% point increase in resource revenue leads to a .20% point decrease in non-resource revenue, a .30% point increase in public savings and a .50% point increase in government expenditures. Instrumenting for resource revenue using estimates of resource reserves from the Energy Information Administration or stocks of undiscovered, technically recoverable reserves from the United States Geological Survey yields similar results.

The development literature has argued that taxation is necessary for democratic representation. In fact, some have warned that natural-resource endowments can breed corruption given the substitutability that is assumed to exist between resource and non-resource government revenue. While formally testing this hypothesis using U.S. state-level data is beyond the scope of this paper, casual observation of corruption rates across states offers some interesting results. Of the ten most corrupt states in the country, four (Louisiana, Montana, Alaska and North Dakota) are resource rich (Glaeser and Sak, 2006) and four (Florida, Alaska, South

USGS-IV interacted with right-hand-side variables as additional controls. The inclusion of these additional controls does not change the estimates in a meaningful way. A full set of results are available upon request.

Dakota and Montana) are among the most tax friendly states according to the Tax Foundation.

At a more fundamental level, the results of this paper offer caution to a handful of governors from resource-poor states who have recently proposed to emulate the fiscal structure of resource-rich states—like Wyoming, Texas and Alaska—by eliminating their state's income tax. The state government of Wyoming did not eliminate income-tax revenue from its budget. Rather, the state substituted for it using resource revenue while simultaneously maintaining expenditures—which is something the governments of resource-poor states cannot do.

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Figure 1

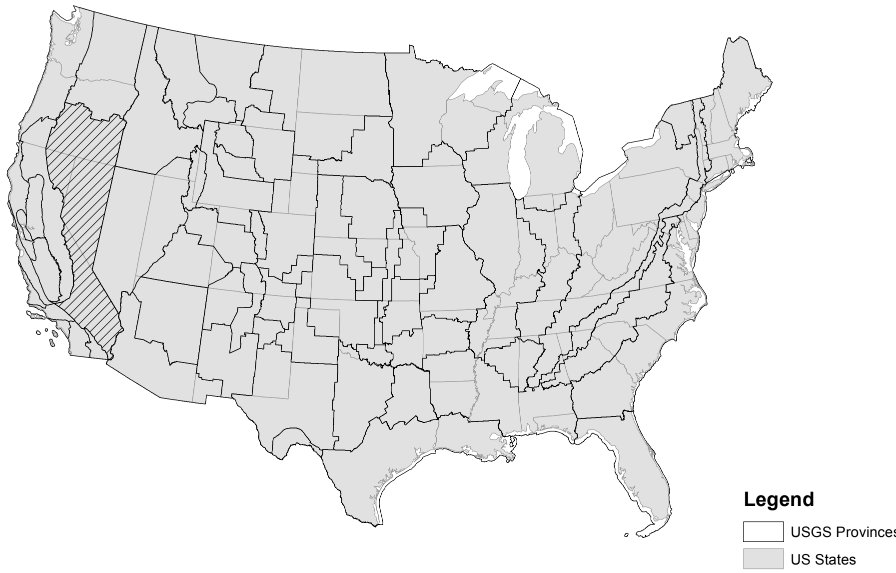

Table 1: Descriptive Statistics

Variable	Mean -	Max (St.,&Year)	Min (St.&Time)
Resource Rev.	.007	.117	.0003
	-	(WY, 1986)	(IL, 1962)
Non-resource Rev.	.121	.208	.043
	-	(NM, 1996)	(NJ, 1958)
Income Tax Rev.	.017	.046	0
	-	(DE, 1979))	-
Total Exp.	.119	.239	.042
	-	(WY, 1987)	(NJ, 1960)
Education Exp.	.039	.089	.007
	-	(NM, 1967)	(MA, 1958)
Savings	.008	.064	-.035
	-	(WY, 1982)	(CT, 1958))

Note. A number of states do not have, or have not had any individual or corporate income tax. For example, while Michigan, Illinois and West Virginia do have an income tax in place today, they did not in 1959.

Table 2: Non-Resource Revenue and Resource Revenue

Dependent Variable: Non-Resource Revenue/Personal Income	FE-W AK	FE	USGS-IV	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficiet (Std. Err.)
Constant	.179***	.188***	.204***	.204***	.194***
	(.002)	(.003)	(.012)	(.013)	(.007)
$\hat{r}$	.023	-.199***	-.531*	-.513**	-.383***
	(.017)	(.066)	(.273)	(.255)	(.125)
$\hat{r} \times Decrease$	-	-	-	-.048	.113**
	-	-	-	(.073)	(.047)
$\hat{r} \times Bush$	-	-	-	-	-.153
	-	-	-	-	(.255)
$\hat{r} \times Decrease \times Bush$	-	-	-	-	-.226***
	-	-	-	-	(.077)
R^2	.854	.879	-	-	-
N	2100	2058	2016	2016	2016
p-value 1st stage	-	-	.008	-	-
R^2 1st stage	-	-	.825	-	-
K-P p-value				.003	.010

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Non Resource Tax Revenue* is defined as non-resource tax revenue divided by personal income. FE includes both time and state fixed effects. *p-value 1st stage* corresponds to a t statistic for the coefficient on $\hat{r}$ in the first stage regression. K-P p-value is the corresponding p-value for the Kleibergen-Paap wald test statistic for underidentification.

Table 3: Income Tax Revenue and Resource Revenue

Dependent Variable: Income Tax Revenue/Personal Income					
	FE-W AK	FE	USGS-IV	USGS-IV	USGS-IV
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
	(Std. Err.)	(Std. Err.)	(Std. Err.)	(Std. Err.)	(Std. Err.)
Constant	.006***	.013***	.016***	.016***	.022***
	(.001)	(.001)	(.002)	(.002)	(.006)
$\hat{r}$	.018*	-.117***	-.177***	-.169***	-.143
	(.009)	(.034)	(.047)	(.047)	(.130)
$\hat{r} \times Decrease$	-	-	-	-.019	.032
	-	-	-	(.026)	(.022)
$\hat{r} \times Bush$	-	-	-	-	-.031
	-	-	-	-	(.123)
$\hat{r} \times Decrease \times Bush$	-	-	-	-	-.072***
	-	-	-	-	(.022)
R^2	.827	.891	-	-	-
N	2100	2058	2016	2016	2016
p-value 1st stage	-	-	.008	-	-
R^2 1st stage	-	-	.825	-	-
K-P p-value				.003	.010

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Income Tax Revenue* is defined as income tax revenue divided by personal income. FE includes both time and state fixed effects. *p-value 1st stage* corresponds to a t statistic for the coefficient on $\hat{r}$ in the first stage regression. K-P p-value is the corresponding p-value for the Kleibergen-Paap wald test statistic for underidentification.

Table 4: Total Expenditures and Resource Revenue

Dependent Variable: Total Expenditures/Personal Income					
	FE-W AK	FE	USGS-IV	USGS-IV	USGS-IV
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficiet
	(Std. Err.)	(Std. Err.)	(Std. Err.)	(Std. Err.)	(Std. Err.)
Constant	.171***	.166***	.840***	.179***	.167***
	(.002)	(.004)	(.103)	(.010)	(.006)
$\hat{r}$	.420***	.501***	.173	.124	.256**
	(.008)	(.079)	(.217)	(.204)	(.121)
$\hat{r} \times Decrease$	-	-	-	.129*	.313***
	-	-	-	(.070)	(.039)
$\hat{r} \times Bush$	-	-	-	-	-.157
	-	-	-	-	(.209)
$\hat{r} \times Decrease \times Bush$	-	-	-	-	-.256***
	-	-	-	-	(.075)
R^2	.893	.880	-	-	
N	2100	2058	2016	2016	2016
p-value 1st stage	-	-	.008	-	-
R^2 1st stage	-	-	.825	-	-
K-P p-value				.003	.010

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Total Expenditures* is defined as total expenditures divided by personal income. FE includes both time and state fixed effects. *p-value 1st stage* corresponds to a t statistic for the coefficient on $\hat{r}$ in the first stage regression. K-P p-value is the corresponding p-value for the Kleibergen-Paap wald test statistic for underidentification.

Table 5: Education Expenditures and Resource Revenue

Dependent Variable: Education Expenditures/Personal Income					
	FE-W AK	FE	USGS-IV	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficiet (Std. Err.)
Constant	.053***	.048***	.054***	.053***	.080***
	(.000)	(.002)	(.004)	(.004)	(.005)
$\hat{r}$	.068***	.165***	.042	.020	-.073
	(.007)	(.042)	(.095)	(.084)	(.117)
$\hat{r} \times Decrease$	-	-	-	.057	-.015
	-	-	-	(.044)	(.032)
$\hat{r} \times Bush$	-	-	-	-	.109
	-	-	-	-	(.115)
$\hat{r} \times Decrease \times Bush$	-	-	-	-	.102***
	-	-	-	-	(.038)
R^2	.887	.889	-	-	-
N	2100	2058	2016	2016	2016
p-value 1st stage	-	-	.008	-	-
R^2 1st stage	-	-	.825	-	-
K-P p-value				.003	.010

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Education Expenditures* is defined as education expenditures divided by personal income. FE includes both time and state fixed effects. *p-value 1st stage* corresponds to a t statistic for the coefficient on $\hat{r}$ in the first stage regression. K-P p-value is the corresponding p-value for the Kleibergen-Paap wald test statistic for underidentification.

Table 6: Public Savings and Resource Revenue

Dependent Variable: Public Savings/Personal Income					
	FE-W AK	FE	USGS-IV	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficiet (Std. Err.)
Constant	.007***	.021***	.022***	.024***	.027***
	(.001)	(.002)	(.003)	(.003)	(.003)
$\hat{r}$	.602***	.299***	.295***	.362***	.360***
	(.021)	(.030)	(.078)	(.061)	(.043)
$\hat{r} \times Decrease$	-	-	-	-.177***	-.199***
	-	-	-	(.020)	(.043)
$\hat{r} \times Bush$	-	-	-	-	.003
	-	-	-	-	(.058)
$\hat{r} \times Decrease \times Bush$	-	-	-	-	.030
	-	-	-	-	(.038)
R^2	.740	.622	-	-	-
N	2100	2058	2016	2016	2016
p-value 1st stage	-	-	.008	-	-
R^2 1st stage	-	-	.825	-	-
K-P p-value				.003	.010

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Public Savings* is defined as public savings divided by personal income. FE includes both time and state fixed effects. *p-value 1st stage* corresponds to a t statistic for the coefficient on $\hat{r}$ in the first stage regression. K-P p-value is the corresponding p-value for the Kleibergen-Paap wald test statistic for underidentification.

Table 7: Non-Resource Revenue and Resource Revenue

Dependent Variable: $\frac{\text{Non-Resource Revenue}}{\text{Non-resource-based personal Income}}$			
	FE-W AK	FE	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.068***	.144***	.862***
	(.021)	(.003)	(.093)
$\tilde{r}$	1.993	-.104	-.231**
	(.044)	(.072)	(.110)
R^2	.576	.886	-
N	2100	2058	2055
p-value 1st stage	-	-	.042
R^2 1st stage	-	-	.829

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Non Resource Revenue* is defined as non-resource tax revenue divided by non-resource-based personal income. FE includes both time and state fixed effects.

Table 8: Income Tax Revenue and Resource Revenue

Dependent Variable: $\frac{\text{Income Tax Revenue}}{\text{Non-resource-based personal Income}}$			
	FE-W AK	FE	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	-.021***	-.002*	.012***
	(.002)	(.001)	(.002)
$\tilde{r}$	.316***	-.105***	-.156***
	(.008)	(.029)	(.042)
R^2	.668	.890	-
N	2100	2058	2055
p-value 1st stage	-	-	.042
R^2 1st stage	-	-	.829

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Income Tax Revenue* is defined as income tax revenue divided by non-resource-based personal income. FE includes both time and state fixed effects.

Table 9: Total Expenditures and Resource Revenue

Dependent Variable: $\frac{\text{Total Expenditures}}{\text{Non-resource-based personal Income}}$			
	FE-W AK	FE	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.069***	.138***	.170***
	(.024)	(.004)	(.011)
$\tilde{r}$	2.564***	.579***	.316†
	(.041)	(.089)	(.193)
R^2	.618	.892	-
N	2100	2058	2016
p-value 1st stage	-	-	.010
R^2 1st stage	-	-	.829

Note. ***, **, *, † corresponds to 1%, 5%, 10% and 10.8% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Total Expenditures* is defined as total public expenditures divided by non-resource-based personal income. FE includes both time and state fixed effects.

Table 10: Education Expenditures and Resource Revenue

Dependent Variable: $\frac{\text{Education Expenditures}}{\text{Non-resource-based personal Income}}$			
	FE-W AK	FE	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.017**	.035***	.051***
	(.008)	(.002)	(.005)
$\tilde{r}$	.759***	.188***	.084
	(.012)	(.039)	(.092)
R^2	.619	.895	-
N	2100	2058	2016
p-value 1st stage	-	-	.010
R^2 1st stage	-	-	.829

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Education Expenditures* is defined as total education expenditures divided by non-resource-based personal income. FE includes both time and state fixed effects.

Table 11: Public Savings and Resource Revenue

Dependent Variable: $\frac{\text{Public Savings}}{\text{Non-resource-based personal Income}}$			
	FE-W AK	FE	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	-.0006	.005***	.015
	(.002)	(.001)	(.004)
$\tilde{r}$	.429***	.315***	.319***
	(.002)	(.026)	(.072)
R^2	.544	.630	-
N	2100	2058	2016
p-value 1st stage	-	-	.010
R^2 1st stage	-	-	.829

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. The dependent variable, *Public Savings* is defined as total public savings divided by non-resource-based personal income. FE includes both time and state fixed effects.

Table 12: Top Marginal Income Tax Rate and Resource Revenue

Dependent Variable: Top Marginal Income Tax Rate	
	Coefficient (Std. Err.)
Constant	1.77
	(1.187)
Endowment	-3.770
	(2.548)
R^2	.955
N	528

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. Both time and state fixed effects are included in the regression. Observations are restricted to the continental U.S.