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U.S. State Fiscal Policy and Natural Resources

By Alexander James*

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. Fifty-one years of U.S.-state level data are largely consistent with this theory. A baseline fixed effects model predicts that a $1.00 increase in resource revenue results in a $0.25 decrease in non-resource revenue, a $0.43 increase in spending and a $0.32 increase in savings. Instrumenting for resource revenue reveals that a positive revenue shock is largely saved and the rest is transferred back to residents in the form of lower non-resource tax rates.
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> *I will not propose to take the people's 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.

Of the seven U.S. states that currently do not have an individual income tax, three (Wyoming, Alaska and Texas) are resource rich.[1] More surprising is that in 2008, state government spending per resident was greater in Wyoming and Alaska than in any other state. In fact, per resident, spending in Alaska was greater than 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 predicts that a benevolent government will set an income tax rate to equate the marginal utility of private and public consumption.

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[1] The four other states without an income tax include Nevada, Washington, South Dakota and Florida. New Hampshire and Tennessee do not tax wage income, but tax other types of income including dividends and capital interest.

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 51 years of U.S.-state level public finance data. The empirical results are largely consistent with the theory. Specifically, a baseline fixed effects model suggests that a \$1.00 increase in resource revenue results in a \$0.25 decrease in non-resource revenue, a \$0.43 increase in government spending and a \$0.32 increase in public savings. Instrumenting for resource-based revenue using unproven reserves of natural resources reveals that an increase in resource-based government revenue is largely saved and the rest is transferred back to constituents in the form of lower non-resource tax rates. Interaction effects reveal some asymmetry in the fiscal response to positive and negative resource shocks. Specifically, a relatively large amount of a positive revenue shock is saved and very little is spent. Conversely, a negative resource shock is largely financed by reductions in public savings and expenditures and corresponding increases in non-resource tax rates.

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). According to Ross (2001), "The logic of the argument is grounded in studies of the evolution of democratic institutions in early modern England and France. Historians and political scientists have argued that the demand for representation in government arose in response to the sovereign's attempts to raise taxes." While this argument is popular in the development literature, empirical evidence of a negative relationship between resource and non-resource revenue is surprisingly 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 there is a 20% offset between hydrocarbon and non-hydrocarbon revenues. This paper utilizes a similar methodology to test whether there is indeed a negative relationship between resource and non-resource revenues, though, formally testing whether this has induced corruption at the U.S.-state level is beyond the scope of the paper.

Is there sufficient heterogeneity across U.S. states to motivate concerns of resource-induced political corruption? It is possible, though not obvious, that federal institutions are strong enough to mitigate any 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 levels of income and education attainment are significantly less corrupt.

Beyond induced political corruption, relaxing distortionary tax rates may enhance growth by attracting local businesses and private investments (Helms, 1985;

Kneller, Bleaney and Gemmell, 1999; Fisman and Svensson, 2007).[2] Conversely, there is evidence that public expenditures—especially those on public goods such as education and public infrastructure—positively affect growth (Helms, 1985; Kneller, Bleaney and Gemmell, 1999). More recently, Blankenau, Simpson and Tomljanovich (2007) find that education expenditures positively affect growth in developed countries only after controlling for government budget constraints. They interpret this result as evidence that education expenditures enhance growth while taxes that are levied in part to fund such government expenditures reduce growth.

This literature highlights two channels through which natural resources may create economic growth and development that have previously been overlooked in the development literature. Natural resources provide governments with the means to spend more while simultaneously taxing (non-resource factors) less. This may help explain the results of some recent studies that find an insignificant or positive relationship between natural resources and growth (e.g., Brunnschweiller and Bulte, 2008; James and James, 2011, Davis, 2011) in spite of the many documented channels through which natural resources harm growth (e.g., a Dutch Disease (Cordon and Neary, 1982; Matsuyama, 1992), resource-induced corruption (Leite and Weidmann, 1999) and under-investments in human capital (Gylfason, 2001)).

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.*

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 fairly unresponsive to changes in tax structure; a negative revenue shock simply results in a short run

[2] A consensus in the literature on the relationship between taxation and growth has not been reached. See for example Easterly and Rebelo (1993) who find a weak relationship between taxation and growth across countries.

federal deficit that is eventually balanced by future increases in revenues. See Payne (2003) for a nice review of this literature.

Extending the work of Bornhorst, Gupta and Thornton (2009) to the U.S.-state level offers a couple advantages. 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 outcomes more generally. Second, and perhaps most important, 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, r_2 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 $t = 1958, ..., 2008$. National trends in preferences for taxation and government spending are captured by time fixed effects, Z_t, while time-invariant, state-specific characteristics such as average population density, political preferences, wealth, unemployment, culture and institutional quality are captured by state fixed effects, S_i. Rates of government spending and taxation are defined as $\tilde{\tau}_{i,t} = T_{i,t}/y_{i,t}$, where T is either non-resource-government revenue, income tax revenue, total government expenditures, expenditures on education or public savings.[4] Consistent with the theoretical model, $y_{i,t}$ is private income

[3] For exhaustible resources ϕ is likely to be small as a government may expect to earn less from the resource in the future.

[4] Examining rates of government spending and taxation rather than levels is important because the level of resource revenue is likely to be (positively) correlated with levels of other fiscal variables. For

and $\hat{r}_{i,t}$ is resource-based government revenue relative to income. All regressions feature standard errors that are clustered at the state level. Public finance and income data are collected from the U.S. Census Bureau, Federal, State & Local Government data base.[5]

Alaska is a clear outlier and its inclusion in the data set significantly alters the results. This may be due to a number of things. The state government of Alaska is substantially more resource-dependent than other state governments. For example, in 1982, resource-based government revenue was approximately 50% 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 1985). The relationship between resource revenue and state fiscal policy may not be linear across such large variation in resource-revenue dependence. For example, if the state government of Alaska initially collects very little non-resource tax revenue, it can't lower tax rates by much more when faced with a large positive resource-revenue 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). Ex-post paying out Permanent Fund Dividends, the government of Alaska has less resource revenue to finance additional public expenditures or reductions in non-resource tax rates. The state government of Alaska effectively has an additional choice variable that no other state has. This may weaken the relationship between natural resources and state fiscal policy decisions that would otherwise exist. It should be noted that the state governments of Wyoming and New Mexico established the Permanent Mineral Trust Fund in 1974 and the Severance Tax Permanent Fund in 1973, respectively. 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 2.8% in 1969, 61.4% in 1970 and 7.5% 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 1.1% of income. It is

example, an increase in resource-based government revenue may be accompanied by an increase in private income, and hence an increase in income tax revenue as well. Put differently, one may expect to find that income tax revenue and severance tax revenue both increased in New Mexico from 1970 to 1980. The pertinent question remains whether there was a corresponding decrease in New Mexico's income tax rate.

[5]Public finance data is available at: www.census.gov/govs/local/.

worth noting that this number is significantly smaller than average non-resource revenue (12.5% of income). There is substantial variation in tax and spending rates across observations. For example, resource revenue ranges from 11.8% (Wyoming, 1985) to .03% (MA, 1959). 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 22% (Wyoming, 2000) to -4.3% (NM, 2008), respectively. Education expenditures generally account for a large amount of total government spending. Averaged across all observations, education expenditures are 4.1% of income, or 32% of total spending. Lastly, of note is the fact that income tax revenue relative to personal income is on average only about 1.8%. This is due in large part to the fact that seven states don't have a personal income tax, which draws 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.

Table 2 gives average values of resource-revenue dependence across states. Specifically, government resource-revenue dependence is defined as resource-based revenue expressed as a share of total revenue. As can be seen, most state governments are, on average, not highly dependent on natural resources. However, even for states that typically receive little resource revenue, there is substantial temporal variation. For example, while the state government of South Dakota is not, on average, resource-revenue dependent, during at least one year in the data set it received 15% of its revenue from natural resources. Similar patterns exist in states like Delaware, Alabama, Minnesota, Rhode Island, Oregon and New Hampshire. Other state governments, such as those in Wyoming, New Mexico, Alaska, Louisiana, Montana, Texas and Oklahoma are more consistently dependent on resource-based revenue. For example, the state government of Wyoming typically received 21.5% of its revenue from natural resources. Though, in 1985 it received nearly 43% of its revenue from natural resources.

As a starting point, I estimate the relationship between resource revenue and non-resource revenue by defining $T_{i,t}$ as total revenue that is not resource based. Resource revenue, $r_{i,t}$, 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, New Mexico and Alaska); and resource-based federal intergovernmental grants. The conditional results are given in Table 3. Dropping Alaska from the data set (column 2), the coefficient on resource revenue is negative (-.248) and significant at the 1% confidence level, implying that a \$1.00 increase in resource revenue results in approximately a \$0.25 decrease in non-resource revenue. In other words, governments transfer 25% of resource revenue back to tax payers in the form of lower non-resource tax rates. This result is similar to that found by Bornhorst, Gupta and Thornton (2009) who, using an international panel of data found 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.

Perhaps governments offset resource revenue shocks by adjusting other specific tax rates. For example, in response to a positive resource shock, a government may reduce income tax rates while leaving other tax rates unchanged. While this does not invalidate the preceding 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 non-resource-based tax revenue. This approach yields comparable results. Referring to column 2 in Table 4, the coefficient on resource revenue is negative (-.104) and significant at the 1% confidence level, implying that about a third of the resource revenue that is transferred back to tax payers comes in the form of lower income tax rates.

When faced with a positive revenue shock, do governments increase spending? If so, by how much? I answer this question by defining $T_{i,t}$ as total government expenditures. Referring to column 2 in Table 5, the coefficient on resource revenue is .428 and significant at the 1% confidence level, implying that about 43% of a positive revenue shock is spent. A valid concern here is that a resource boom may create additional expenditures for state governments directly. 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 expenditures. Given this, a government may increase spending during a resource boom simply because the mining process automatically requires it—not because law makers desire it. To address this, I 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 expenditures.[6] The baseline fixed effects results are given in column 2 in Table 6. The results suggest that a \$1.00 increase in resource revenue induces a \$0.146 increase in education expenditures (significant at the 1% confidence level).

This result is particularly interesting in the context of the vast resource-curse literature. In fact, the conventional wisdom is that resource-rich U.S. states spend significantly *less* on education than resource-poor states. For example, Papyrakis and Gerlagh (2007) find that natural resources retard economic growth, in part because of the negative effect of natural-resource endowments on education expenditures. Gylfason (2001) finds a similar pattern holds across countries. A supporting theory is that natural resources give people a false sense of security in their economic future and hence reduce incentives to invest in human capital. The contrasting results of this paper, since they are based on panel data, suggest that the results of these previous studies may be biased due to unobserved heterogeneity.

Because 25% of resource revenue is transferred back to constituents in the form

[6]A resource boom may attract people that require education services. In this case, a resource boom may lead to an increase in state government education costs. This consideration highlights the importance of weighting variables by the absolute size of the economy.

of lower, non-resource tax rates and 43% is used to finance additional expenditures, it follows that 32% of the resource revenue should be saved. 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 .322 and is significant at the 1% confidence level, confirming that approximately 32% of resource revenue is saved. While this result is unsurprising, it nonetheless affirms the integrity of the data and additionally provides a confidence interval for the relationship between resource revenue and public savings.

Further Analysis

Robustness Checks

The extraction of natural resources may be endogenous to state-specific environmental policies, tax rates and leasing agreements. Estimating equation (9) using OLS may then yield biased econometric estimates. For example, to finance additional expenditures, a government may increase non-resource tax rates (e.g., the income tax rate) while simultaneously permitting additional oil and gas drilling on public lands. This will create an upward bias in the relationship between resource revenue and both expenditures and non-resource tax rates.[7] Additionally, while a subnational analysis offers many advantages, state-level resource-based revenue may be endogenous to federal actions. For example, the federal government can relax or strengthen environmental standards or lease additional federal land for mineral extraction and exploration. While such policies are likely to be exogenous from a state government's perspective, remaining concerns of endogeneity are addressed by instrumenting for resource-based revenue.[8]

Resource revenue is instrumented for using state endowments of oil and natural gas. Specifically, the following equation is estimated in the first stage:

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

where $\text{Endowment}_{i,t}$ is the value of oil and gas 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 as variation in the fitted value of resource revenue in state i is solely explained by variation in Endowment—which is assumed to be exogenous.

[7]There is little variation in severance tax rates over time. However, governments can nonetheless increase the level of resource revenue it receives by, for example, leasing additional public land for the purpose of mineral exploration and extraction.

[8]Related to this concern, states with Balanced Budget Provisions in their constitutions may respond differently to revenue shocks than states without such provisions. However, provisions that are time invariant (such as those originally drafted in state constitutions) are controlled for using state fixed effects. Further, according to the National Conference of State Legislatures (NCSL), Balanced Budget Provisions are usually unenforceable and "it is the tradition of balancing the budget that has created a forceful political rule to do so." The NCSL goes on to echo this point by saying "It appears that the political convention that state budgets are supposed to be balanced is its own enforcement mechanism".

How should one measure exogenous resource endowments? One option is to use proved reserves of energy, the data for which is provided by the Energy Information Administration (EIA). A possible shortcoming of this approach is that EIA estimates of energy reserves partially reflect production levels, which are likely endogenous and so would invalidate the use of EIA energy reserves as an instrument. For example, while the state of New York is heavily endowed with shale gas, hydraulic fracturing is not currently permitted there. Therefore, production of natural gas in New York is "artificially" low. Given this, $\text{Endowment}_{i,t}$ is approximated for using data on undiscovered, technically recoverable stocks of oil and natural gas, the data for which is available from the United States Geological Survey (USGS).[9] 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 was employed to compute the percent of each province within each state. Interacting these percentages with provincial resource stock values and energy prices then gives a proxy of resource endowments.[10] Specifically, $\text{Endowment}_{i,t}$ is defined as,

$$\text{Endowment}_{i,t} = \frac{1}{\bar{y}_i} \sum_j \sum_n \text{Province}_{j,n} \times P_{n,t} \times \rho_{i,j}, \tag{11}$$

where $\bar{y}$ is personal income in state i, averaged from 1958 to 2008, $\text{Province}_{j,n}$ is the volume of resource n in province j, $P_{n,t}$ is the price of resource n at time t, which in this case is either oil or natural gas and $\rho_{i,j}$ is the percent of province j in state i.[11] See Figure 1 for a graphical description of USGS provinces. The shaded region in the figure is the Western Great Basin. In this particular case, 38% of the basin is in California, 32% is in Nevada and 29% is in Oregon. Unsurprisingly, resource-based government revenue is highly correlated with the international price of oil. Figure 2 plots the nominal price of oil and resource-based revenue (expressed as a share of state income and summed over all states) over time. The correlation is 0.57.

The USGS-IV baseline results, which are reported in the third column of Table's 3-7, generally compliment the previous findings, though there are some notable differences. First, the IV results suggest that an insignificant amount of resource

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

[10]All energy price data were collected from the EIA and can be found at eia.gov.

[11]Evaluating *Endowment* relative to the average value of state personal income significantly increases the strength of the instrument as states like Texas and California produce a large amount of both oil and gas, but the non-resource sectors of these respective economies are relatively large, such that the governments of these states are not highly resource dependent. This procedure does not endogenize the instrument as the average value of personal income is time invariant and thus exogenous to government responses to time-specific resource-revenue shocks.

revenue is used to finance additional expenditures (total or specifically on education). Second, whereas the fixed effects model predicts that 10% of resource revenue is used to fund reductions in the income tax rate, the IV results suggest this number is closer to 20%. Third, approximately 75% of a revenue shock is saved. Comparing the IV results to the OLS ones provides some evidence that governments increase the production of natural resources for the purpose of funding additional expenditures. These findings are somewhat surprising and reveal that governments respond quite conservatively to exogenous revenue shocks. In fact, most of the revenue generated by a natural-resource shock is saved and the rest is transferred back to constituents in the form of lower non-resource tax rates.

Instrumenting for resource revenue addresses concerns of endogeneity and reverse causality corresponding to the explanatory variable. However, it does not address the potentially 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, $\hat{r}_{i,t}$, resource-based private income, and hence total income (the sum of resource and non-resource income), $y_{i,t}$. This may induce a negative correlation between $\hat{r}_{i,t}$ and non-resource government revenue (expressed as a share of income) as non-resource income is not taxed by non-resource tax rates. In light of this, additional variations of equation (9) are estimated in which the main explanatory variable (resource revenue) and all left-hand-side variables are expressed as shares of non-resource personal income.[12] The results of these additional model specifications are given in the last column of Tables 3-7. For brevity, only the IV results are given for this model specification. A full set of results are available from the author upon request. The results largely echo the previous findings, with a couple exceptions. Specifically, a \$1.00 increase in resource revenue results in a \$0.15 increase in expenditures (significant at the 10% confidence level), a result more in line with the OLS estimation. Additionally, while this specification indicates a positive but insignificant amount of resource revenue is used to finance reductions in non-resource tax rates, the corresponding result for the income tax rate holds.

A related concern is that rates of taxation and public expenditure are endogenous to the size of the overall economy. Put differently, a resource boom that increases income generally but does not increase income tax revenue will implicitly result in a decrease in the average income tax rate (income tax revenue relative to income). Before addressing this potential shortcoming, it is worth exploring whether the data supports the basic premise of the concern—namely that the rates at which governments tax, spend and save are negatively correlated with the overall size of the economy. To this end, I include personal income as a regressor in equation (9). I then re-estimate the main estimation equation for all

[12] Data on personal income earned from the energy mining industry was collected from the Bureau of Economic Analysis Regional Data Base and is available at: http://www.bea.gov/regional. Non resource revenue is then computed by subtracting income earned in the energy sector from total personal income.

$T_{i,t}$. A negative and significant coefficient on income is indicative of a prevailing division bias. The results are reassuring as the coefficient on personal income is insignificant in all model specifications. Further, while the relationship between personal income and the average income tax rate is quite insignificant (p-value = .69), the coefficient on personal income is positive, suggesting that if anything, an increase in income results in a higher income tax rate, not a lower one. The same is true when looking at the average non-resource tax rate and total expenditures. The relationships between both the savings rate and education expenditures and income are negative (but again, highly insignificant).[13]

While the preceding results are reassuring, I nonetheless address remaining concerns attributed to the weighting of left-hand-side variables by estimating the relationship between resource-based revenue and actual legislated marginal income tax rates and sales tax rates. While there are some disadvantages associated with examining marginal income tax rates,[14] there are also a couple advantages. First, the previous results suggest that there is indeed a negative and robust relationship between income tax rates and resource-based revenue. Examining the relationship between marginal income tax rates and resource revenue therefore acts as a robustness check on this previous finding. Second, there is significant variation in marginal income tax rates over relatively short periods of time. For example, from 2000 to 2008, the top marginal income tax rate in California increased from .093 to .103, an 11% increase; in Maryland it increased from .048 to .057, a 19% increase; and in New Mexico it decreased from .820 to .53, a 35% decrease.

The Tax Foundation provides data for marginal income tax rates and sales tax rates, delineated at the U.S.-state level for the time period 2000 to 2010.[15] This data was merged to that used for the earlier estimations yielding a data set consisting of 432 observations (9 years (2000 - 2008) and 48 continental states). While there is one sales tax for each state and year, there are multiple income tax rates depending on a person's level of annual gross income. I therefore estimate the relationship between resource revenue and the highest, lowest and average marginal income tax rates.

The results, which are given in Table 8, reinforce the previous findings. Consider first the relationship between resource-based revenue and marginal income tax rates. The fixed effects model indicates that an increase in resource revenue reduces the average marginal income tax rate. This is largely due to a corresponding reduction in the top marginal income tax rate as the bottom marginal

[13]One may find these results to be unsurprising. As income increases, so should income tax revenue. The same is not true for the main right-hand-side variable, resource revenue expressed as a share of income. Here, an increase in the denominator, $y_{i,t}$, may result in a decrease in resource revenue relative to income, $r_{i,t}/y_{i,t}$. This is indeed the case: there is a negative and significant relationship between $\hat{r_{i,t}}/y_{i,t}$ and $y_{i,t}$, confirming the need for a valid instrument.

[14]Marginal income tax rates are tiered such that the value of income tax revenue that is collected depends on both marginal tax rates and the designation of tax brackets. A state government can theoretically adjust the value of the income tax revenue it receives by adjusting tax brackets while leaving marginal tax rates unchanged. This will add noise to the estimation and decrease the reliability of the estimates. The results of this model should therefore be viewed with caution.

[15]This data can be found at: taxfoundation.org

tax rate is insignificantly (but still negatively) correlated with resource revenue. However, these results are not robust to instrumentation. While the magnitudes of coefficients generally become larger (the coefficients become more negative), the increased standard errors make it difficult to reject the null hypothesis of no effect.[16]

Similar results are found when looking at the relationship between resource revenue and state sales tax rates. For both the fixed effects and IV specifications, the coefficient on resource revenue is negative and significant at the 5% confidence level. Specifically, in the IV specification the coefficient on resource revenue is -.18. This implies that a 1% point increase in resource revenue (expressed relative to income) results in a .0018 decrease in the sales tax. Given the average sales tax is 4.8%, this amounts to about a 3.7% reduction.

Asymmetric Fiscal Responses

Is the relationship between resource revenue and fiscal policy symmetric for positive and negative changes in resource revenue? A relevant concern is that the negative relationship between resource revenue and non-resource tax rates is due only to instances when governments financed reductions in resource revenue by raising non-resource tax rates. Bornhorst, Gupta and Thornton (2009) address this concern by interacting resource revenue with indicator variables for periods of rising and falling resource revenue. I follow a similar 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 split the data into two sets—one for periods of rising resource revenue and another for periods of falling resource revenue—and re-estimate all of the estimation equations.

Unlike Bornhorst, Gupta and Thornton (2009) I find some evidence of asymmetry in the fiscal response to positive and negative resource-revenue shocks. Referring to columns 2 and 3 in Table 9, the IV estimations reveal that a \$1.00 increase in resource revenue reduces non-resource revenue by about \$0.24 and the rest (about \$0.80), is saved. Though, in response to a \$1.00 decrease in resource revenue, governments increase non-resource revenue by \$0.35 and decrease total expenditures and savings by \$0.33 and \$0.32, respectively. These results reinforce the earlier conclusion that governments respond rather conservatively to resource shocks. Governments save a large majority of the "extra" revenue generated during a resource boom but compensate for reductions in resource revenue by raising non-resource tax rates (like the income tax rate) and by decreasing spending.

[16]Similar results are found after dropping those states that did not have an income tax during the period 2000 to 2008 (Texas, Wyoming, Nevada, Washington and Florida).

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 save. Fifty-one years of U.S. state-level data are consistent with this theory. Interaction effects reveal some asymmetry in the fiscal response to positive and negative resource shocks. Specifically, a $1.00 increase in resource revenue reduces non-resource revenue by $0.25 and increases savings by $0.83. Though, a $1.00 decrease in resource revenue increases non-resource revenue by $0.35 and decreases expenditures by $0.34. An examination of resource revenue and actual, legislated marginal income and sales tax rates echo these findings. The results are generally robust to a variety of model specifications and the instrumentation of resource-based government revenue.

The development and public finance literature has argued that distortionary taxes, such as income taxes, may dis-incentivize investment and reduce growth. This literature also documents a positive relationship between government expenditures—especially those on public goods such as education and public infrastructure—and economic growth. While formally linking natural resources to growth via fiscal policy outcomes is beyond the scope of this paper, the results suggest this may be an important determinant of growth in resource-rich economies. Indeed, despite the numerous documented channels through which natural resources can impede economic growth (e.g., a Dutch Disease or resource-induced political corruption) recent work in this area, at both the U.S.-state and international levels, suggests the negative relationship between resource dependence and growth is not as robust as once thought (Brunnschweiller and Bulte, 2008; James and James, 2011; Davis, 2011).

Finally, this paper concludes with a cautionary note to a handful of state governments of resource-poor states which 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, like South Carolina and Nebraska, cannot do.

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Figure 1. Geological Provinces

Note: The shaded region is the Western Great Basin.

Table 1—Descriptive Statistics

Variable	Mean -	Max (St.,&Year)	Min (St.&Time)
Resource Rev.	.011	.118	.0003
	-	(WY, 1985)	(MA, 1959)
Non-resource Rev.	.125	.350	.043
	-	(WY, 2000)	(NJ, 158)
Income Tax Rev.	.018	.046	0
	-	(DE, 1979))	-
Total Exp.	.127	.239	.042
	-	(WY, 1987)	(NJ, 1960)
Education Exp.	.041	.092	.007
	-	(VT, 2007)	(MA, 1958)
Savings	.009	.220	-.043
	-	(WY, 2000)	(NM, 2008)

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.

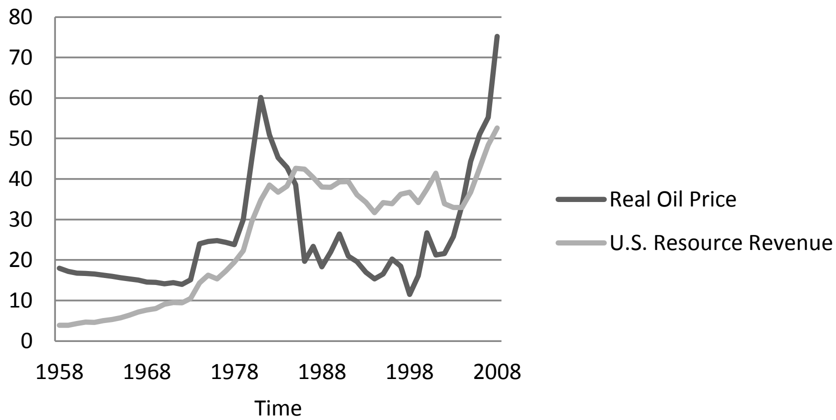

Figure 2. Geological Provinces

Note: Nominal prices were converted to real ones using 2000 as the base year. U.S. resource revenue has been weighted by the average price of oil relative to the average value of resource revenue.

Table 2—Government Resource-Revenue Dependence

State	Mean	Max	Min	State	Mean	Max	Min
Alaska	.391	.809	.040	Montana	.107	.257	.041
Alabama	.038	.122	.011	North Carolina	.025	.034	.016
Arkansas	.032	.056	.016	North Dakota	.103	.235	.046
Arizona	.027	.049	.010	Nebraska	.047	.084	.024
California	.026	.044	.013	New Hampshire	.057	.143	.009
Colorado	.039	.066	.017	New Jersey	.032	.079	.011
Connecticut	.037	.095	.014	New Mexico	.202	.424	.102
Delaware	.060	.156	.014	Nevada	.031	.054	.011
Florida	.029	.061	.009	New York	.025	.044	.009
Georgia	.022	.036	.010	Ohio	.018	.039	.006
Hawaii	.040	.073	.018	Oklahoma	.103	.219	.038
Iowa	.024	.040	.009	Oregon	.060	.133	.019
Idaho	.046	.070	.028	Pennsylvania	.021	.039	.006
Illinois	.027	.048	.007	Rhode Island	.052	.137	.006
Indiana	.026	.049	.009	South Carolina	.026	.062	.012
Kansas	.032	.066	.010	South Dakota	.080	.150	.034
Kentucky	.050	.105	.013	Tennessee	.021	.043	.008
Louisiana	.183	.316	.067	Texas	.125	.257	.039
Massachusetts	.030	.067	.005	Utah	.044	.073	.021
Maryland	.025	.045	.011	Virginia	.031	.054	.014
Maine	.037	.075	.014	Vermont	.041	.072	.011
Michigan	.024	.044	.008	Washington	.024	.038	.014
Minnesota	.042	.107	.012	Wisconsin	.025	.048	.012
Missouri	.031	.074	.008	West Virginia	.040	.091	.008
Mississippi	.037	.069	.018	Wyoming	.215	.429	.033

Note: Values of resource-based government revenue are expressed as shares of total government revenue. Average values are averaged for each state from 1958 to 2008.

Table 3—Non-Resource Revenue and Resource Revenue

Dependent Variable: Non-Resource Revenue/Personal Income				
	FE-W AK	FE	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.165***	.178***	.128***	.102***
	(.003)	(.003)	(.002)	(.002)
$\hat{r}$	.006	-.248***	-.275**	-.083
	(.020)	(.061)	(.104)	(.108)
R^2	.841	.861	-	-
N	2550	2499	2448	2448
p-value 1st stage	-	-	.000	.000
F 1st stage	-	-	431	300
R^2 1st stage	-	-	.815	.811

Note: ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. All regressions include both time and state fixed effects. *p-value 1st stage* corresponds to the t statistic for the coefficient on $\hat{r}$ in the first stage regression.

Table 4—Income Tax Revenue and Resource Revenue

Dependent Variable: Income Tax Revenue/Personal Income				
	FE-W AK	FE	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.005***	.012***	.025***	.028***
	(.001)	(.002)	(.000)	(.000)
$\hat{r}$	.017*	-.104**	-.218***	-.186***
	(.010)	(.039)	(.036)	(.031)
R^2	.829	.890	-	-
N	2550	2499	2448	2448
p-value 1st stage	-	-	.000	.000
F 1st stage	-	-	431	300
R^2 1st stage	-	-	.815	.811

Note: ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. All regressions include both time and state fixed effects. *p-value 1st stage* corresponds to the t statistic for the coefficient on $\hat{r}$ in the first stage regression.

Table 5—Total Expenditures and Resource Revenue

Dependent Variable: Total Expenditures/Personal Income				
	FE-W AK	FE	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.181***	.181***	.142***	.124***
	(.002)	(.004)	(.002)	(.001)
$\hat{r}$	.396***	.428***	-.032	.154*
	(.006)	(.063)	(.099)	(.086)
R^2	.895	.880	-	-
N	2550	2499	2448	2448
p-value 1st stage	-	-	.000	.000
F 1st stage	-	-	431	300
R^2 1st stage	-	-	.815	.811

Note: ***, **, *, corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. All regressions include both time and state fixed effects. *p-value 1st stage* corresponds to the t statistic for the coefficient on $\hat{r}$ in the first stage regression.

Table 6—Education Expenditures and Resource Revenue

Dependent Variable: Education Expenditures/Personal Income				
	FE-W AK	FE	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.056***	.052***	.040***	.041***
	(.001)	(.002)	(.000)	(.000)
$\hat{r}$	.063***	.146***	-.033	.021
	(.006)	(.036)	(.045)	(.044)
R^2	.871	.870	-	-
N	2550	2499	2448	2448
p-value 1st stage	-	-	.000	.000
F 1st stage	-	-	431	300
R^2 1st stage	-	-	.815	.811

Note: ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. All regressions include both time and state fixed effects. *p-value 1st stage* corresponds to the t statistic for the coefficient on $\hat{r}$ in the first stage regression.

Table 7—Public Savings and Resource Revenue

Dependent Variable: Public Savings/Personal Income				
	FE-W AK	FE	USGS-IV	USGS-IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	-.016***	-.002	-.014***	-.021***
	(.002)	(.003)	(.002)	(.001)
$\hat{r}$	.608***	.322***	.756***	.760***
	(.021)	(.038)	(.084)	(.075)
R^2	.685	.602	-	-
N	2550	2499	2448	2448
p-value 1st stage	-	-	0.000	0.000
F 1st stage	-	-	431	300
R^2 1st stage	-	-	.815	.811

Note: ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Standard errors are clustered at the state level. All regressions include both time and state fixed effects. *p-value 1st stage* corresponds to the t statistic for the coefficient on $\hat{r}$ in the first stage regression.

Table 8—Marginal Income Tax Rates and Resource Revenue

	Avg Inc Rate		Top Inc Rate		Bottom Inc Rate		Sales	
	FE	IV	FE	IV	FE	IV	FE	IV
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Constant	.022**	.028	.034*	.049	.011	.007	.047***	.052***
	(.010)	(.022)	(.018)	(.036)	(.010)	(.008)	(.002)	(.005)
$\hat{r}$	-.385**	-.480	-.588*	-.834	-.181	-.122	-.093**	-.181**
	(.180)	(.373)	(.307)	(.614)	(.175)	(.137)	(.041)	(.083)
R^2	.978	-	.968	-	.985	-	.985	.970
N	432	432	432	432	432	432	432	432
p-value 1st stage	-	.003	-	.003	-	.003	-	.003
F 1st stage	-	9.88	-	9.88	-	9.88	-	9.88
R^2 1st stage	-	.966	-	.966	-	.966	-	.966

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.

TABLE 9—PERIODS OF RISING AND FALLING RESOURCE REVENUE

	All	Increase	Decrease
Dependent Variable:	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Coefficient (Std. Err.)
Non Res. Rev.	-.275**	-.244**	-.346***
	(104)	(.106)	(.128)
Inc. Tax Rev.	-.218***	-.197***	-.216***
	(.028)	(.035)	(.044)
Total Exp.	-.032	-.077	.336***
	(.099)	(.105)	(.124)
Education Exp.	-.033	-.056	.132*
	(.045)	(.044)	(.076)
Savings	.756***	.833***	.317***
	(.084)	(.069)	(.109)
N	2448	1311	1137
p-value 1st stage	.000	.000	.000
F 1st stage	431	644	96
R^2 1st stage	.815	.836	.836

Note: ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Each coefficient is estimated using a separate regression. Standard errors are clustered at the state level. All regressions reflect IV estimations and feature time and state fixed effects.