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Cassidy, Traviss

University of Alabama

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Traviss Cassidy†

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Abstract

Conventional wisdom in the policy community holds that volatile fiscal transfers to local governments will cause volatile local spending, due to policy myopia. I test the degree to which local governments are forward-looking by exploiting unusual variation in intergovernmental grants in Indonesia. A national reform permanently increased the general grant, and the increase was larger for less densely populated districts. Hydrocarbon-rich districts experienced transitory shocks to shared resource revenue. Districts responded to the permanent revenue shock by increasing investment in lumpy public goods. By contrast, districts smoothed their expenditure responses to the transitory revenue shocks, opting not to adjust lumpy public goods. The results suggest that local governments respond to changes in permanent public income over a time horizon of three to five years. I discuss implications for countercyclical fiscal policy and research on taxation and accountability.

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†Department of Economics, Finance, and Legal Studies, University of Alabama; tmcassidy@cba.ua.edu.

1 Introduction

> *Large and unpredictable transfers of natural resource revenues can destabilize a local economy. Cycles of boom and bust also harm economic growth, as governments are likely to spend on ostentatious projects during booms and not plan appropriately for downturns* (Natural Resource Governance Institute, 2016, p. 11).

A common view in the policy community holds that local governments engage in short-sighted policymaking. Under this view, volatile fiscal transfers to local governments, such as shared natural resource revenue, will lead to volatile local expenditure, as politicians ramp up spending when revenue rises but fail to anticipate the subsequent fall in revenue. As a result, large projects started during boom years may never be finished, wasting public resources and contributing to a local resource curse (Cust and Viale, 2016; van der Ploeg, 2011).

Are local governments really short-sighted, or do they correctly distinguish between temporary and permanent changes in revenue when planning future expenditure? The optimal design of intergovernmental grants will depend crucially on which view of government is correct. In particular, if local governments are myopic, then central governments should smooth revenue on behalf of local governments or go to great lengths to facilitate smoothing at the local level. This would require a massive restructuring of intergovernmental grant systems around the world—especially in the dozens of countries with derivation-based systems which transfer a portion of natural resource revenue back to the region of origin.

This paper tests the degree to which local governments are forward-looking by exploiting unusual policy variation in Indonesia. I examine local government responses to the country's two largest intergovernmental grants. The first is a general grant that has stable disbursements over time, with the exception of a single permanent increase due to a national reform. A change in the allocation formula for the grant caused less densely populated districts to experience larger permanent increases in the grant. The second grant is shared revenue from local oil and gas production, which exhibits significant transitory variation in hydrocarbon-rich areas.

The two grants provide a unique window into local policymaking. A government that maximizes citizen welfare over a time horizon of several years will recognize that a permanent one-dollar increase in the general grant has a larger impact on the intertemporal budget constraint than a transitory one-dollar increase in oil and gas revenue. Consequently, investments in lumpy public goods, which must exceed a minimum threshold, will be more responsive to permanent changes in revenue than to transitory changes. The expenditure response to the general grant will be front-loaded due to these upfront investments. By contrast, the government will smooth spending out of the oil and gas revenue, adjusting the provision of non-lumpy public goods. A myopic government that only maximizes welfare in the current period will be equally sensitive to the general grant and the oil and gas revenue, as it perceives the permanent shock to be a series of transitory shocks.

Exploiting the novel features of my empirical setting, I construct three tests of forward-looking behavior. First, I test for differential time paths of expenditure in response to the two grants. Second, I back out the government's time horizon using the number of years it takes to spend a one-dollar transitory increase in revenue. Finally, I test whether the grants have different effects on lumpy public goods but similar effects on non-lumpy items.

Consistent with the theory, the permanent shock to the general grant produced a front-loaded expenditure response and led to greater provision of lumpy public goods and services, such as public schools, health facilities, and health personnel. By contrast, transitory fluctuations in oil and gas revenue produced a smoothed expenditure response and had little impact on lumpy public goods and services. The two grants had similar effects on road quality, which depends on less lumpy maintenance expenditure, suggesting that lumpiness, rather than graft, drives the differential responses of structures and personnel to the two grants.

The empirical results are consistent with local governments responding to changes in permanent public income over a time horizon of three to five years. This conclusion contrasts sharply with the commonly held view that local governments are myopic. The results are especially surprising given that they are obtained in a low-income setting, in which local governments often face stronger political-economy forces and liquidity constraints—both of which contribute to policy myopia.

Besides providing unique policy variation, the Indonesian setting offers additional advantages. First, there are a large number of local governments—over 300—with spending authority similar to that of U.S. state governments. Second, national regulations deprive local governments of any control over income-tax or property-tax policy. This eliminates an important margin of response to revenue shocks—tax cuts.[1] When tax instruments are unavailable, the local government's time horizon approximately equals the time it takes for an additional dollar of revenue to translate into an additional dollar of spending.

Despite Indonesia's distinctive features, the results hold lessons for other countries, for two reasons. First, many countries have intergovernmental grants that are similar to the ones studied in this paper. Equalization grants like Indonesia's general grant are used in countries from all parts of the income distribution, including Canada, China, Germany, India, and the United Kingdom. Natural resource revenue sharing likewise is popular and can be found in over 30 countries, most of which are located in Latin America or Africa (Natural Resource Governance Institute, 2016, p. 8).

Second, across the developing world, central governments have devolved greater spending responsibilities to local governments without devolving revenue-collection responsibilities to a similar degree, making intergovernmental grants especially important (Gadenne and Singhal, 2014). The results show that inexperienced local governments can use their newfound authority well by pursuing forward-looking policy.

This paper contributes to several related literatures in public finance and development.

[1] U.S. state governments cut taxes in response to increases in natural resource revenue (James, 2015).

First, it is related to the literature on the so-called flypaper effect, the empirical regularity that local governments have a greater propensity to spend out of non-matching grants than out of local private income (Hines and Thaler, 1995; Inman, 2008). When testing for a flypaper effect, researchers ask how much additional local spending results from increasing grants by one dollar. Rarely do they distinguish between permanent and transitory increases in grants.[2] I build on this literature by showing that the permanence of a grant increase determines how the additional spending is distributed over time. Knowing the timing of fiscal responses to grants is important for conducting countercyclical fiscal policy in a federation.

Second, this paper builds on the literature that exploits exogenous variation in grant allocations to estimate the causal effects of grants. A key concern with the older literature is that the distribution of funds likely depends on local preferences for public good provision, so that the observed relationship between spending and grant revenue may not reflect the causal effect of grants (Knight, 2002). To avoid this problem, recent research has identified features of intergovernmental grant policy that induce exogenous variation in grant allocations.[3] Compared to most of these studies, I exploit relatively large exogenous shocks to grants: the general grant reform permanently increased the grant by 46 percent on average and more than doubled the grant for 16 percent of districts.

Third, an older literature examines whether the dynamic responses of local governments to local revenue are consistent with intertemporal utility maximization over an infinite horizon (Holtz-Eakin and Rosen, 1991, 1993; Holtz-Eakin, Rosen, and Tilly, 1994; Dahlberg and Lindström, 1998). Rather than testing the null hypothesis that governments are infinitely forward-looking, I directly infer the government's time horizon from its fiscal responses to grant revenue shocks.

Finally, this research is related to the development literature that examines whether intergovernmental transfers actually improve conditions for their target populations. In some cases significant portions of targeted transfers have been captured by local politicians (Reinikka and Svensson, 2004), while in others general-purpose transfers have led to wasteful spending, corruption, and at best modest improvements in public goods (Monteiro and Ferraz, 2012; Caselli and Michaels, 2013; Brollo, Nannicini, Perotti, and Tabellini, 2013). Motivated by these results, researchers have examined whether increases in local tax revenue lead to better outcomes than increases in transfers, due to an accountability channel (Borge, Parmer, and Torvik, 2015; Gadenne, 2017; Martínez, 2017). This literature employs survey data on public goods, such as the number of schools, that are relatively easy to measure and often require lumpy investment. My results highlight a novel methodological challenge facing this literature: if tax revenue is more persistent than grant revenue, taxes will have a larger estimated impact on public goods, even when the two revenue streams are subject to the same level of accountability.

[2] Two exceptions are Zou (1994) and Buettner and Wildasin (2006).

[3] See, e.g., Gordon (2004), Baicker (2005), Dahlberg, Mörk, Rattsø, and Ågren (2008), Lutz (2010), Litschig and Morrison (2013), Gennari and Messina (2014), Lundqvist (2015), Dahlby and Ferede (2016), and Liu and Ma (2016).

The results of this paper are most similar to those of Besfamille, Jorrat, Manzano, and Sanguinetti (2019), who estimate the fiscal responses of provincial governments to two grants in Argentina: shared federal tax revenue and shared oil and gas revenue. The authors find that provinces partially smooth expenditure out of both grants, but smoothing is greater in response to the oil and gas revenue, which is more volatile. Their findings are thus consistent with my results on fiscal outcomes.

The paper proceeds as follows. Section 2 presents a model of public expenditure, Section 3 provides institutional background on Indonesia, Section 4 describes the data, Section 5 explains the identification strategy, Section 6 presents the empirical results, and Section 7 concludes.

2 Model

This section develops a simple model of public expenditure on durable and nondurable goods. It is similar to the model of Obstfeld and Rogoff (1996, pp. 96–98), with three modifications. First, the government's time horizon is finite. This assumption could be justified on behavioral grounds (district heads fail to consider outcomes in the distant future) or political grounds (district heads are limited to two five-year terms and care only about citizen welfare while in office). Second, investment in durables is lumpy. This assumption captures the fact that publicly provided durable goods, such as schools or other structures, often must satisfy a minimum size requirement. Third, public spending is financed solely by intergovernmental grants. This assumption approximately holds in Indonesia, where district governments are prohibited from imposing taxes on property or income.

Several testable implications emerge from the model. First, permanent and transitory shocks to grant revenue produce different responses in total expenditure. In particular, a one-time, permanent increase in grant revenue by one dollar causes total expenditure to increase by more than one dollar in the year of the shock, and less than one dollar in subsequent years. By contrast, a one-time, transitory increase in grant revenue by one dollar increases total expenditure by an equal amount, less than one dollar, in the year of the shock and subsequent years. Second, the size of the spending response to the transitory revenue shock is decreasing in the length of the government's time horizon. Third, permanent and transitory shocks to grant revenue have different effects on the composition of public expenditure. While permanent shocks are likely to increase consumption of both durable and nondurable public goods, transitory shocks are more likely to increase consumption of nondurable goods only. The above results hold when durables investment is "lumpy enough." When investment is not lumpy, permanent and transitory revenue shocks have identical per-dollar effects.

2.1 The Environment

Suppose the local government provides a nondurable good, C, and a durable good, D. The durable good evolves according to the equation of motion, $D_t = (1-\delta)D_{t-1} + I_t$, where I_t is current investment in the durable good and δ is the depreciation rate. Let p_t denote the price of durable-good investment in units of the nondurable good in period t. Investment is "lumpy": the government may choose any level of "maintenance" investment up to the point of maintaining the entire durables stock from the previous period, but any increase in the durables stock must exceed a minimum size threshold, $\underline{I}$.[4] Total government spending in period t, G_t, is the sum of C_t and $p_t I_t$. The local government has access to a risk-free bond with exogenous rate of return r. Federal grants are the local government's only source of revenue. Let A_t denote the government's stock of net assets, and let F_t denote federal grant revenue in period t. Assets evolve according to the equation of motion, $A_{t+1} = (1+r)(A_t + F_t - C_t - p_t I_t)$.

2.2 The Government's Problem

The local government acts as if it faces a finite time horizon of T periods, starting in period 0 and ending in period $T-1$. The intertemporal budget constraint in starting period t is

$$\sum_{t=0}^{T-1} \frac{C_t + p_t I_t}{(1+r)^t} \leq A_0 + \sum_{t=0}^{T-1} \frac{F_t}{(1+r)^t}.$$

The representative citizen has Cobb-Douglas preferences over durables and nondurables consumption. This assumption rules out changes in expenditure shares due to changes in the size of the budget, making it possible to study how the interaction between the lumpiness constraint and the size of the revenue shock influences the composition of spending. Let $\beta \in (0,1)$ denote the representative citizen's discount factor. The government has perfect foresight and maximizes the representative citizen's utility over the finite time horizon,

$$\sum_{t=0}^{T-1} \beta^t \big(\gamma \log C_t + (1-\gamma) \log D_t\big),$$

subject to the intertemporal budget constraint, the investment constraint, and the equation of motion for durables.[5] I assume that $\gamma \in (0,1)$ so that the citizen wants to consume both goods.

Assuming that the initial stock of durables, D_{-1}, and the investment threshold, $\underline{I}$, are both small enough that the investment constraint does not bind, the necessary conditions for an

[4] Formally, the investment constraint is $I_t \in [0, \delta D_{t-1}] \cup [\delta D_{t-1} + \underline{I}, \infty)$, where $\underline{I}$ is the minimum size of new structures. Note that the investment constraint rules out selling any portion of the durables stock. This assumption is inconsequential if the initial stock of durables is small enough.

[5] The model abstracts from private consumption in order to focus attention on the government's optimal expenditure plan. As there is no taxation in the model, adding private consumption would not change any of the results below as long as citizen preferences for private consumption and public consumption were separable.

optimum yield the two Euler equations

$$C_{t+1} = \beta(1+r)C_t,$$
$$\frac{\gamma p_t}{C_t} = \frac{1-\gamma}{D_t} + \beta(1-\delta)\frac{\gamma p_{t+1}}{C_{t+1}}.$$

Combining the Euler equations yields the condition

$$\frac{(1-\gamma)C_t}{\gamma D_t} = p_t - \frac{1-\delta}{1+r}p_{t+1} \equiv \iota_t, \tag{1}$$

which states that the marginal rate of substitution between nondurables consumption and durables consumption equals the user cost of durables.

In order to simplify the dynamics of the solution, which will aid in the comparative statics exercise below, I make a number of parametric assumptions. First, assume that the citizen's discount rate equals the interest rate ($\beta = 1/(1+r)$), so that desired nondurables consumption is constant over time. Next, assume that the price of investment is constant over time: $p_t = p$, hence $\iota_t = p(r+\delta)/(1+r) \equiv \iota$. The citizen thus will want to consume the durable good and the nondurable good in constant proportion over time. Combining the first two assumptions, the citizen will desire a constant level of durables consumption over time. Finally, assume that the depreciation rate is zero ($\delta = 0$). Together, the assumptions imply that all durables investment will occur in the first period—investment in subsequent periods is unnecessary to maintain a constant stock of durables, because there is no depreciation.[6]

Define permanent public income to be

$$Y^P = \frac{r}{1+r-(1+r)^{1-T}}\left(A_0 + pD_{-1} + \sum_{t=0}^{T-1}\frac{F_t}{(1+r)^t}\right),$$

which is the constant resource flow that can be sustained over the government's time horizon (Flavin, 1981). In this model permanent public income is a function of initial financial wealth, the resale value of the initial stock of durables, and the present discounted value of grant revenue. The Euler equations, combined with the simplifying assumptions, imply that $C_{t+1} = C_t$ and $D_t = (\gamma\iota)^{-1}(1-\gamma)C_t$. Substituting these two equations into the intertemporal budget constraint yields

$$C_t = \gamma \cdot \frac{1+r-(1+r)^{1-T}}{1+r-\gamma(1+r)^{1-T}} \cdot Y^P, \quad D_t = \frac{1-\gamma}{\iota} \cdot \frac{1+r-(1+r)^{1-T}}{1+r-\gamma(1+r)^{1-T}} \cdot Y^P$$

for $t \in \{0, \ldots, T-1\}$. Thus durables and nondurables consumption are both constant fractions of permanent public income over the time horizon.

[6]Positive depreciation could be incorporated into the model without changing the qualitative nature of the results, as long as δ were small enough. With positive depreciation, investment in periods 2 and later would be positive, yet smaller than investment in period 1.

2.3 Response to a Permanent Revenue Shock

Now consider how the government responds to two different revenue shocks, starting from the interior optimum described above. The permanent shock raises revenue by one dollar in every period, while the transitory shock raises revenue by one dollar in the first period only. Thus I hold fixed the period-0 value of the shock while varying its present discounted value.

First consider a permanent increase in grant revenue by one unit: $\mathrm{d}F_t = 1$ for $t \in \{0, \ldots, T-1\}$. Permanent public income increases by one unit: $\mathrm{d}Y^P = 1$. Assuming the revenue increase is large enough to push the government to a new interior optimum with positive investment in period 0, the consumption response to the permanent revenue shock is given by

$$\mathrm{d}C_t^{Perm} = \gamma \cdot \frac{1+r-(1+r)^{1-T}}{1+r-\gamma(1+r)^{1-T}}, \quad \mathrm{d}D_t^{Perm} = \frac{1-\gamma}{\iota} \cdot \frac{1+r-(1+r)^{1-T}}{1+r-\gamma(1+r)^{1-T}}$$

for $t \in \{0, \ldots, T-1\}$. Durables and nondurables consumption immediately increase in period 0 and remain fixed at their new levels for the remainder of the time horizon. Because the initial stock of durables, D_{-1}, is predetermined and $I_0 = D_0 - D_{-1}$, period 0 investment rises by $\mathrm{d}I_0{}^{Perm} = \mathrm{d}D_0^{Perm}$. Therefore the response of total public expenditure in period 0 is

$$\mathrm{d}G_0^{Perm} = \mathrm{d}C_0^{Perm} + p\mathrm{d}I_0^{Perm} = \frac{1+r-\gamma}{r} \cdot \frac{1+r-(1+r)^{1-T}}{1+r-\gamma(1+r)^{1-T}}.$$

Thus when there are at least two time periods, total expenditure increases in the first period by more than the increase in permanent income ($\mathrm{d}G_0^{Perm} > 1$) due to the increase in upfront investment in durables. Because the revenue increase leaves investment unchanged in the ensuing periods,

$$\mathrm{d}G_t^{Perm} = \mathrm{d}C_t^{Perm} = \mathrm{d}C_0^{Perm} < 1$$

for $t \in \{1, \ldots, T-1\}$.

To summarize, an increase in permanent grant revenue by one unit in period 0 increases public expenditure by more than one unit in period 0 and less than one unit in periods 1 through $T-1$. The total expenditure response is thus "front loaded." Both durables and nondurables consumption increase in response to the permanent one-unit increase in grant revenue.

2.4 Response to a Transitory Revenue Shock

Next consider a temporary increase in grant revenue by one unit in period 0: $\mathrm{d}F_0 = 1$, and $\mathrm{d}F_t = 0$ for $t \in \{1, \ldots, T-1\}$. Assuming there are at least two time periods, the increase in permanent revenue, $\mathrm{d}Y^P = r/\left(1+r-(1+r)^{1-T}\right)$, is less than one and is decreasing in the length of the time horizon, T. Three responses are possible depending on the parameter values.

Case 1. $\underline{I} \leq \frac{1-\gamma}{\iota} \cdot \frac{r}{1+r-\gamma(1+r)^{1-T}}$.

In the first case the investment constraint does not bind, because the increase in durables consumption that the government would choose in the absence of the investment constraint, $\mathrm{d}D_t^{Temp} = \mathrm{d}D_t^{Perm} \cdot \mathrm{d}Y^P$, exceeds $\underline{I}$. The government adjusts durables and nondurables consumption to a new interior solution, so $\mathrm{d}C_t^{Temp} = \mathrm{d}C_t^{Perm} \cdot \mathrm{d}Y^P$ and $\mathrm{d}G_t^{Temp} = \mathrm{d}G_t^{Perm} \cdot \mathrm{d}Y^P$ for $t \in \{0, \dots, T-1\}$. The spending response per unit of additional revenue is identical to the case of the permanent revenue shock.

Case 2. $\frac{1-\gamma}{\iota} \cdot \frac{r}{1+r-\gamma(1+r)^{1-T}} < \underline{I} \leq \tilde{I}$*, where* $\tilde{I}$ *satisfies*

$$\gamma \log\big(C_{-1} + \mathrm{d}Y^P(1 - p\tilde{I})\big) + (1-\gamma)\log(D_{-1} + \tilde{I}) = \gamma \log(C_{-1} + \mathrm{d}Y^P) + (1-\gamma)\log D_{-1},$$

and C_{-1} *and* D_{-1} *are the pre-shock levels of nondurables and durables consumption, respectively.*

In the second case the investment constraint binds, yet $\underline{I}$ is small enough that the government chooses strictly positive investment in durables, setting $I_0 = \underline{I}$. The representative citizen is indifferent between (i) investing $\tilde{I}$ in durables and adjusting nondurables consumption to satisfy the lifetime budget constraint, and (ii) setting investment equal to zero and spending the entire revenue increase on nondurables consumption. For $\underline{I}$ less than $\tilde{I}$, the citizen would prefer a positive level of investment in durables.

Case 3. $\underline{I} > \tilde{I}$*, where* $\tilde{I}$ *is defined as in Case 2.*

In the final case the investment constraint binds, and investment is zero. The minimum size requirement, $\underline{I}$, is high enough that the citizen would rather spend the entire revenue increase on nondurables rather than invest at least $\underline{I}$ in durables. In this case $\mathrm{d}G_t^{Temp} = \mathrm{d}C_t^{Temp} = \mathrm{d}Y_t^P$ and $\mathrm{d}D_t^{Temp} = 0$ for $t \in \{0, \dots, T-1\}$.

To summarize, a transitory increase in grant revenue by one unit could lead to three possible outcomes. If the minimum investment size, $\underline{I}$, is small enough, the government will increase consumption of both durables and nondurables in proportion with the change in permanent income. In this case the per-dollar effects of permanent and transitory revenue shocks will be the same. For slightly larger values of $\underline{I}$, the government will invest the minimum required amount and adjust nondurables consumption to balance the budget. If the minimum size is large enough, the government will spend the entire revenue increase on nondurables consumption. Compared to a permanent revenue shock, a transitory revenue shock will produce a response skewed toward nondurables consumption if the minimum size of nondurables investment is large enough. In this case the total spending response evenly spreads the extra revenue across the time horizon.

2.5 Extensions

The model makes several simplifying assumptions for the purpose of tractability. The appendix discusses how the results might be altered by incorporating supply bottlenecks, liquidity constraints, or uncertainty into the model.

An important omission from the model is bureaucratic delay. Red tape may prevent local governments from immediately responding to grant revenue shocks. District governments in Indonesia often receive grant funds late in the fiscal year, face significant delays in the process of getting budgets approved by the provincial authorities, and have difficulty procuring goods and services in a timely manner. Administrative bottlenecks imply that the fiscal responses predicted by the model may occur with a lag.

2.6 Econometric Predictions

To aid in the interpretation of the regression estimates, it is helpful to map the predictions of the theoretical model to the parameters of a linear econometric model. Consider the equation

$$G_{dt} = \sum_{k=0}^{K} \beta_k F_{d,t-k} + \sum_{k=0}^{K} \delta_k H_{d,t-k} + U_{dt},$$

where G_{dt} is total expenditure, F_{dt} is grant revenue subject to permanent shocks, and H_{dt} is grant revenue subject to transitory shocks, all in per-capita terms, for district d in year t. Suppose that $K \geq T - 1$, so that the lag structure of the regression captures the district government's response over the entire time horizon. A permanent increase in F by one unit raises spending ℓ years later by $\sum_{k=0}^{\ell} \beta_k$, while a transitory increase in H by one unit raises spending ℓ years later by δ_ℓ. The sum $\sum_{k=0}^{\ell} \delta_k$ gives how much of the one-unit transitory increase in H is spent from the year of the shock to ℓ years after the shock. The cumulative spending responses, $\sum_{k=0}^{\ell} \beta_k$ and $\sum_{k=0}^{\ell} \delta_k$, thus summarize how much spending each grant stimulated, as well as the timing of that spending.

First consider a permanent shock to F. The theoretical model predicts that $\beta_0 = \mathrm{d}G_0^{Perm} > 1$ and $\sum_{k=0}^{\ell} \beta_k = \mathrm{d}G_1^{Perm} < 1$ for $\ell \geq 1$. That is, there is a large initial spending response due to upfront investments in lumpy goods, followed by a smaller response composed of spending on non-lumpy items. As discussed in the previous section, red tape associated with getting investment projects approved may delay the initial investment response relative to the desired path of spending. We therefore focus on two qualitative predictions of the model: (1) the cumulative spending response to F will, at some point, exceed unity ($\sum_{k=0}^{\ell} \beta_k > 1$ for some ℓ), and (2) the cumulative spending response to F will eventually fall ($\sum_{k=0}^{\ell+1} \beta_k < \sum_{k=0}^{\ell} \beta_k$ for some ℓ).

Now consider a transitory shock to H under the assumption that Case 3 holds, i.e., the government only adjusts spending on nondurables. Theory predicts that $\delta_k = \mathrm{d}G_0^{Temp} < 1$ for $k \in \{0, \ldots, K\}$ and $\delta_k = 0$ for $k > K$. The model therefore makes two qualitative predictions: (1) the cumulative spending response to H will never exceed unity ($\sum_{k=0}^{\ell} \delta_k \leq 1$ for all ℓ), and (2) the cumulative spending response to H will be weakly monotonic over time ($\sum_{k=0}^{\ell} \delta_k \leq \sum_{k=0}^{\ell+1} \delta_k$ for all ℓ).

Finally, the theory predicts that nondurables consumption will increase more in response to a permanent increase in F than it will to a transitory increase in H. The differential response to permanent and transitory revenue shocks is especially likely to appear in measures of long-lived structures, such as schools and health facilities. We test the above predictions ahead.

3 Institutional Background

3.1 Decentralization in Indonesia

The resignation of Suharto as president of Indonesia in 1998 marked the end of three decades of highly centralized authoritarian rule and paved the way for dramatic political and economic reforms. Indonesia now ranks as one of the most decentralized countries in the developing world (Shah, Qibthiyyah, and Dita, 2012). There are three levels of subnational government in Indonesia: province, district, and village. Indonesia currently has 34 provinces. The number of districts has grown from 336 in 2001 to 514 in 2014, due to district splitting. (See Fitrani, Hofman, and Kaiser, 2005; Burgess, Hansen, Olken, Potapov, and Sieber, 2012; Bazzi and Gudgeon, 2018, for details.) Districts are categorized as either rural districts (*kabupaten*) or municipalities (*kota*). Expenditure responsibilities are the same for both types of district.

The "Big Bang" fiscal decentralization reforms of 2001 devolved vast expenditure authority to provincial and (especially) district governments (World Bank, 2003). The share of total expenditures managed by subnational governments rose from 24 percent in the mid-1990s to 36 percent in 2011, with district governments accounting for most subnational spending. Indonesia's level of expenditure decentralization exceeds the OECD average and is higher than every East Asian country except China (World Bank, 2007). However, own-source revenue accounts for only nine percent of total subnational revenue, necessitating large fiscal transfers from the central government (World Bank, 2007; Shah et al., 2012). Own-source revenue mostly consists of business license fees, hotel and restaurant taxes, and utility fees. Districts are prohibited from introducing income or property taxes (World Bank, 2007).

Following decentralization, subnational borrowing has been minimal, for three reasons. First, the central government has banned foreign borrowing by districts and must pre-approve domestic borrowing (Blöndal, Hawkesworth, and Choi, 2009). Second, many district governments have poor credit ratings. Finally, district governments have had difficulty spending all of their transfer revenue in a timely fashion, leading to a buildup of reserves (World Bank, 2007, p. 127–128). Current revenue and reserves typically suffice to finance large capital projects. Districts deposit their considerable savings in (domestic) commercial banks and typically do not invest in central government certificates of deposit (SBI) or treasuries (Lewis and Oosterman, 2009).

3.2 General Grant

The largest source of financing for most district governments is a federal grant known as the General Allocation Fund (*Dana Alokasi Umum*), or "general grant" for short, which accounts for around 56 percent of district revenue. The general grant is an equalization grant, intended to equalize the capacity to provide local public goods across regions. Equalization grants have the potential to promote equity by targeting areas populated by households with low earning potential. In real-world contexts, such as in Canada, such grants often distort household location decisions and fall short of equity goals (Albouy, 2012). Researchers and policymakers have argued that Indonesia's general grant is insufficiently equalizing and promotes inefficient spending on the civil service wage bill (Hofman, Kadjatmiko, Kaiser, and Sjahrir, 2006; World Bank, 2007).

Districts have complete discretion over how to spend the general grant. The total budget for the grant depends on long-term forecasts of factors determining the central government's budget health, such as the price of oil (World Bank, 2007). The allocation formula has two components: the basic allocation and the fiscal gap. The basic allocation consists of a lump-sum portion and a portion that is a function of the civil service wage bill. The fiscal gap is calculated as the difference between expenditure needs and fiscal capacity. The formula for the general grant is

$$\text{General Grant} = \text{Basic Allocation} + \text{Expenditure Needs} - \text{Fiscal Capacity}.$$

Expenditure needs are calculated as a weighted sum of indices related to population, land area, poverty, and cost of construction. Section 5 discusses the expenditure-needs formula in greater detail.

Since 2002, fiscal capacity has been defined as the weighted sum of imputed own-source revenue, shared tax revenue, and shared natural resource revenue:

$$\begin{aligned}\text{Fiscal Capacity} = a \cdot (\text{Imputed Own-Source Revenue}) + b \cdot (\text{Shared Tax Revenue}) \\ + c \cdot (\text{Shared Natural Resource Revenue}).\end{aligned}$$

Own-source revenue is imputed based on a regression of actual own-source revenue on regional GDP (World Bank, 2007). From 2002 to 2011, the value of a has varied between 0.5 and 1, b has varied between 0.73 and 1, and c has varied between 0.5 and 1. The fiscal gap component accounts for around half of the general grant budget.

The general grant allocation is determined on a yearly basis. For the first two-thirds of the sample period, general grant disbursements followed a "hold-harmless" rule which ensured that general grant receipts would not fall below the previous year's receipts. The hold-harmless rule froze the general grant amount for many resource-rich districts which otherwise would have received much lower disbursements according to the formula (World Bank, 2007, p. 121).

3.3 Shared Oil and Gas Revenue

Districts containing natural resources receive Shared Natural Resource Revenue (*Sumber Daya Alam*), which depends on the revenue collected from resource production that occurs in the district and province. Oil and natural gas are by far the largest sources of natural resource revenue in Indonesia. Figure A.1 in the appendix shows that Indonesia's oil production peaked in the early 1980s and has steadily declined since 1991. Gas production was roughly zero until 1977, when it began steadily increasing. Over the sample period, oil production steadily declined while gas production slightly increased, albeit with significant transitory variation. The oil price increased by about 87 percent and the gas price fell by about 50 percent, and both prices exhibited significant volatility. Consequently, the value of oil production increased, and the value of gas production decreased, over the sample period.

According to the sharing rule, 15.5 percent of oil revenue collected within a district is redistributed to subnational governments: 3.1 percent goes to the provincial government, 6.2 percent goes to the producing district, and the remaining 6.2 percent is evenly divided among the other districts located in the same province. The sharing rule for natural gas is more generous to subnational governments: 6.1 percent goes to the provincial government, 12.2 percent goes to the producing district, and another 12.2 percent is divided equally among the other districts in the province. Despite the less generous sharing rule, shared oil revenue on average exceeds shared gas revenue due to the higher value of oil production. Disbursements are to be made on a quarterly basis (Law No. 33/2004), though in practice the transfers often arrive late in the fiscal year (World Bank, 2007, p. 128). Districts have complete discretion over how to spend the shared oil and gas revenue.[7]

Both the general grant and shared oil and gas revenue are unconditional, non-matching, and subject to the same level of central-government oversight. Hence, they differ only in their time-series variation.

3.4 Political Institutions

The post-Suharto reforms included significant political decentralization. Starting in 1999, local parliaments were democratically elected through a proportional representation system. The district heads ("mayors") previously appointed by Suharto were allowed to finish their five-year terms, after which time each local parliament appointed a new district head. The political system was reformed yet again with the introduction of direct elections for district heads starting in 2005. Incumbent mayors were allowed to finish their terms before direct elections were held. For idiosyncratic reasons, terms of Suharto mayors expired in different

[7] In 2009 the central government slightly increased the amount of oil and gas revenue shared with subnational governments, earmarking this additional revenue for education (Law No. 33/2004). As a result, after 2009 around three percent of the district's oil grant, and two percent of the district's gas grant, was earmarked. This earmarking is unlikely to play any role in district spending decisions, as earmarked funds are extremely small relative to total education spending, which represents one third of the district budget on average.

years, so that the terms of indirectly appointed mayors also expired at different times. As a result, direct elections were introduced in a staggered manner with exogenously determined timing (Skoufias, Narayan, Dasgupta, and Kaiser, 2014).

4 Data

Each year district mayors are required to report on the district's finances to the Ministry of Finance (*Kementerian Keuangan*). Data on federal grants come from reports by the Ministry of Finance.[8] Data on other revenue sources, as well as expenditure disaggregated by economic classification and function, come from the Ministry of Finance and the World Bank's Indonesia Database for Policy and Economic Research (INDO-DAPOER).[9] INDO-DAPOER provides data on revenue and expenditure broken down by economic classification up to either 2012 or 2013, depending on the variable. I add data from 2013–2014 using budget reports from the Ministry of Finance. I also replace missing or obviously incorrect values in INDO-DAPOER using the Ministry of Finance data. Expenditure by function is available from INDO-DAPOER through 2012.[10] The final dataset includes grant revenue, other sources of revenue, and expenditure by economic classification for the years 2001–2014, and expenditure by function for the years 2001–2012. All fiscal variables are measured in constant 2010 IDR 1 million (approximately USD 100) per capita.

INDO-DAPOER also provides information on district characteristics, such as land area and population. Data on public good provision come from the Village Potential Statistics (*Pendataan Potensi Desa*, or PODES) survey waves of 2000, 2003, 2005, 2008, 2011, and 2014. The surveys act as a village census and thus are meant to cover every village.[11] Data on oil and gas reserves come from the proprietary UCube database maintained by Rystad Energy (2016), an international oil and gas consulting company.[12]

To ensure that all districts in the sample operate under comparable institutional settings, I omit provinces that have a special administrative or fiscal arrangement with the central government.[13] Of the remaining districts, only those that existed as of 2005 or earlier are included in the sample. This restriction is necessary because the identification strategy exploits a policy reform in 2006. The final sample for the analysis of public finance outcomes includes 372 districts from 29 provinces.

[8]The reports are available at http://www.djpk.depkeu.go.id/.

[9]INDO-DAPOER is located at http://databank.worldbank.org/data/reports.aspx?source=1266.

[10]Some data on expenditure by function in 2013 and 2014 are available from INDO-DAPOER for a limited set of districts, however I omit these years to avoid bias due to selective attrition.

[11]Due to a massive tsunami in 2004, the 2005 wave lacks data on districts on the island of Nias (Nias, Nias Utara, Nias Barat, Nias Selatan, and Gunung Sitoli).

[12]For details on the UCube database, see https://www.rystadenergy.com/Products/EnP-Solutions/UCube.

[13]These provinces are DI Yogyakarta, which has special autonomy status; DKI Jakarta, whose districts are managed by the province; Nanggroe Aceh Darussalam, which has special autonomy status and receives special autonomy funds; and Papua and Papua Barat, which both receive special autonomy funds.

The analysis of village-level public good outcomes is based on a balanced panel of over 41,000 villages matched across the PODES waves and located within the same 372 districts and 29 provinces included in the public finance sample. The sample excludes villages with data that appear miscoded or indicate an incorrect merge.[14] Around one quarter of villages split into multiple villages over the period 2000–2014. To maintain a consistent unit of observation in the public goods sample, I aggregate village outcomes up to 2000 borders. The sample excludes villages that were involved in an amalgamation during the sample period (roughly three percent of villages).

5 Identification Strategy

I first consider fiscal responses to the general grant and shared oil and gas revenue. The structural equation for fiscal outcome Y is

$$Y_{dit} = \sum_{k=0}^{K} \beta_k GenGrant_{di,t-k} + \sum_{k=0}^{K} \delta_k OilGasRev_{di,t-k} + \alpha_d + \lambda_{it} + \varepsilon_{dit}, \tag{2}$$

where d indexes districts, i indexes islands, and t indexes years. The model allows for district fixed effects, α_d, and island × year effects, λ_{it}.[15] I report standard errors that are robust to heteroskedasticity and two-way clustering at the district and province × year levels to account for within-district serial correlation and cross-district correlation within the same province and year (Cameron, Gelbach, and Miller, 2011). The within-district correlation is due to the persistence of district-specific grant shocks and unobserved shocks over time. The cross-district correlation arises from the fact that, in any given year, non-producing districts located in the same province receive the same amount of oil and gas revenue.

As discussed in Section 2.6, the hypothesis that the general grant induces a front-loaded expenditure response can be summarized by two conditions: (1) $\sum_{k=0}^{\ell} \beta_k > 1$ for some ℓ, and (2) $\sum_{k=0}^{\ell+1} \beta_k < \sum_{k=0}^{\ell} \beta_k$ for some ℓ. Likewise, the hypothesis that the oil and gas revenue causes a smoothed fiscal response can be summarized by two conditions: (1) $\sum_{k=0}^{\ell} \delta_k \leq 1$ for all ℓ, and (2) $\sum_{k=0}^{\ell} \delta_k \leq \sum_{k=0}^{\ell+1} \delta_k$ for all ℓ.

Next I consider the effects of the two grants on local public goods and services. The structural equation for village outcome Y is

$$Y_{vdis} = \beta\, \overline{GenGrant}_{dis} + \delta\, \overline{OilGasRev}_{dis} + \alpha_d + \lambda_{is} + \varepsilon_{vdis}, \tag{3}$$

[14] First, I drop villages with reported annual population growth of more than 25 percent or less than −25 percent in any time period. Second, I drop villages with reported population growth of at least 10 percent followed immediately by a population decline of at least 10 percent, or vice versa. Finally, I drop villages with implausibly large changes in public goods from one survey year to the next. To minimize the influence of outliers, I also drop villages with population below the 2nd percentile or above the 98th percentile in any year.

[15] Following the Indonesian Statistical Bureau, I code seven island groups: Sumatra, Java, Nusa Tenggara, Kalimantan, Sulawesi, Maluku, and Papua.

where v indexes villages and s indexes time periods spanned by the PODES survey years. The variable $\overline{GenGrant}_{dis}$ is the average annual general grant revenue during period s, and $\overline{OilGasRev}_{dis}$ is defined similarly. The outcome Y_{vdis} is a flow variable, such as the number of doctors per capita employed at the end of period s, or the average annual change in the stock of health clinics per capita over period s. For period s starting in year t_0 and ending in year t_1, the average annual general grant revenue and the average annual change in the stock of health clinics per capita are calculated as

$$\overline{GenGrant}_{dis} = \frac{1}{t_1 - t_0} \sum_{t=t_0+1}^{t_1} GenGrant_{dit}, \quad Y_{vdis} = \frac{1}{t_1 - t_0}(H_{vdit_1} - H_{vdit_0}),$$

where H_{vdit} is the stock of health clinics per capita in year t.[16] The regressions use as many time periods as possible, subject to the availability of data on the outcomes. The theoretical predictions are $\beta > \delta$ for lumpy public goods and $\beta = \delta$ for non-lumpy public goods.

Both fiscal transfers could be endogenous in equations (2) and (3). The general grant is likely endogenous because it is a function of the civil service wage bill and fiscal need. Shared oil and gas revenue is potentially less problematic, but it could be endogenous if oil and gas production is affected by the local business environment, local economic shocks, conflict, or other unobservables that also affect district public-good outcomes. Furthermore, deviations of the two grants from the allocations prescribed by their respective formulas could reflect the relative political bargaining power of the district, introducing another source of endogeneity. In order to consistently estimate the coefficients of interest, I exploit sources of exogenous variation in the grants, explained below.

5.1 General Grant

To estimate the effect of the general grant, I exploit variation induced by a large policy reform. The central government of Indonesia considers forecasts of its long-run budget health in determining how much money to allocate to the general grant. A key parameter in these forecasts is the assumption about the future price of oil. In 2006 the total general grant budget increased by 44 percent after the central government adjusted the oil price assumption from USD 30 per barrel to USD 60 per barrel (Agustina, Ahmad, Nugroho, and Siagian, 2012). The central government also adjusted the formula for expenditure needs in 2006, resulting in a larger share of the general grant budget going to less densely populated districts. Thus while most districts saw an increase in general grant revenue in 2006, the least densely populated districts saw the largest increases. Districts rich in oil and gas resources should have experienced a decline in general grant funds according to the formula. However, a hold-harmless provision froze the general grant allocation in place for these resource-abundant districts.

[16] Note that $\frac{1}{t_1-t_0}(H_{vdit_1} - H_{vdit_0}) = \frac{1}{t_1-t_0}\sum_{t=t_0+1}^{t_1}(H_{vdi,t} - H_{vdi,t-1})$, the average annual change in H_{vdit} from t_0 to t_1.

Formally, the change in general grant revenue per capita received by district d from 2005 to 2006 is given by

$$GenGrant_{di,2006} - GenGrant_{di,2005} \approx \theta + \pi AreaPC06_{di} \times NonOilGas_{di} + Remainder_{di},$$

where $\pi > 0$, $AreaPC06$ is land area per capita in 2006, and $Remainder_{di}$ is much smaller than $\pi AreaPC06_{di}$ in absolute magnitude (World Bank, 2007). The indicator variable $NonOilGas_{di}$ equals one for districts not located in a province with significant oil and gas endowments, and zero otherwise.[17] This variable captures the fact that the reform was binding only for districts that did not have significant resource revenue. See the appendix for more details on the general grant formula and a derivation of the above approximation.

Changes to the general grant in the pre-reform period (2001–2005) and post-reform period (2007–2014) were modest. As a result, general grant revenue per capita in district d and year t can be approximated as

$$GenGrant_{dit} \approx \theta + \pi AreaPC06_{di} \times NonOilGas_{di} \times 1(t \geq 2006) + Remainder_{dit},$$

where $1(t \geq 2006)$ equals one in years 2006 and later, and zero in years prior to 2006. Both the increase in the total budget for the general grant and the change in the allocation formula were announced in 2004 (Law No. 33/2004).

Figure 1 graphs average general grant revenue per capita over time separately for three groups of districts divided according to area per capita in 2006. Panel (a) includes districts located in provinces with an insignificant oil and gas endowment per capita, while Panel (b) includes districts located in the six provinces with highly significant oil and gas endowments per capita. In each figure, average general grant revenue per capita for districts exceeding the 75th percentile in land area per capita (among all districts) is shown with a solid blue line. The green long dashes apply to districts between the 50th and 75th percentiles in land area per capita, while yellow short dashes indicate districts below the 50th percentile and land area per capita. From 2001–2005, districts with greater area per capita received a larger general grant allocation in per capita terms. Over this period, both the level of general grant per capita in each group as well as the differences in general grant allocations between groups remained approximately constant over time. Starting in 2006, districts in resource-poor provinces with below-50th percentile land area per capita experienced only a small increase in general grant per capita. By contrast, districts in the third quarter of the distribution saw a moderate increase in general grant per capita, and districts in the top quarter experienced a massive increase in general grant per capita. The relative distribution of general grant revenue per capita by

[17] In the sample the oil-and-gas-rich provinces are Riau, Kepulauan Riau, Jambi, Sumatera Selatan, Kalimantan Timur, and Kalimantan Utara. See Figure A.2 in the appendix for the distribution of oil and gas revenue and endowments per capita across provinces. Note that while Kalimantan Utara was officially formed in 2012, as of 2014 its districts received shared oil and gas revenue as if they were still part of their former province of Kalimantan Timur. The appendix figures therefore combine the two provinces.

land area did not change much over time in provinces rich in oil and gas resources. The policy reform of 2006 thus provides significant cross-district variation in the size of a permanent shock to the general grant within provinces that lack significant oil and gas resources.

Figure 1 establishes that, in provinces with insignificant oil and gas resources, districts with greater land area per capita experienced a larger increase in general grant revenue per capita starting in 2006 than more densely populated districts. Consequently, the interaction term $AreaPC06_{di} \times NonOilGas_{di} \times 1(t \geq 2006)$ is a relevant instrument for general grant revenue per capita that summarizes the variation due to the reform in the most parsimonious way possible.

Because district population growth is relatively slow, land area per capita is approximately time invariant.[18] Therefore, the fixed-effects model allows for the possibility that the level of outcomes, such as spending or public goods, could depend on land area per capita. The exclusion restriction requires only that the direct effect of land area per capita on district outcomes be the same on average in the periods 2001–2005 and 2006–2014. Intuitively, this means that outcomes in districts with different levels of population density would have followed parallel paths over time in the absence of the general grant reform.

Even if the relationship between land area per capita and local preferences for spending were time-invariant, one may worry that the timing or overall size of the reform could be endogenous to the political or economic demands of less densely populated districts in resource-poor provinces. For example, members of the national legislature representing less densely populated districts may have pushed for the reform in order to help their own reelection prospects or the prospects of incumbents in the district legislatures. The timing of the reform is inconsistent with this story, however, as elections for both the national and district legislatures took place in 1999, 2004, 2009, and 2014. That is, the reform took effect three years prior to the next legislative elections, casting doubt on the claim that the timing of the reform was the result of political calculus.

Alternatively, members of the national legislature may have wanted to improve the re-election prospects of incumbent mayors in less densely populated districts. If this were the case, then one would expect to see a disproportionate number of mayoral elections taking place in less densely populated districts in resource-poor provinces in 2006. In reality, among resource-poor provinces, the average land area per capita of districts with mayoral elections in 2005 is statistically indistinguishable from the average land area per capita of districts with mayoral elections in 2006, 2007, or 2008.[19] Thus, there is little reason to believe that the timing or overall size of the general grant reform were motivated by political considerations.

[18] Median annual population growth is 1.4 percent.

[19] Results available upon request.

5.2 Shared Oil and Gas Revenue

For the purpose of natural resource revenue sharing, district territory includes sea territory that extends up to four nautical miles from the coastal shoreline (Law 22/1999). Government revenue collected from oil production within a district is divided as follows: 84.5 percent goes to the central government, 3.1 percent goes to the provincial government, 6.2 percent goes to the producing district, and the remaining 6.2 percent is divided equally among the non-producing districts located in the same province as the producing districts. Government revenue collected from gas production within a district is divided as follows: 69.5 percent goes to the central government, 6.1 percent goes to the provincial government, 12.2 percent goes to the producing district, and the remaining 12.2 percent is divided equally among the non-producing districts located in the same province as the producing districts.

Let O_{dpt} and G_{dpt} denote oil and gas revenues produced in district d, located in province p, in year t. Shared oil and gas revenue per capita is

$$OilGasRev_{dpt} = \frac{1}{Pop_{dpt}} \left(0.062 \cdot O_{dpt} + 0.122 \cdot G_{dpt} + \frac{0.062}{N_{pt} - 1} \sum_{j \neq d} O_{jpt} + \frac{0.122}{N_{pt} - 1} \sum_{j \neq d} G_{jpt} \right),$$

where Pop_{dpt} is the population of district d in year t, and N_{pt} is the number of districts in province p in year t. Using the Rystad UCube database, I calculate the total amount of economically recoverable oil and gas resources as of 2000 (and known in 2000), prior to fiscal decentralization. I denote these measures as $Endow_{dt}^{Oil}$ and $Endow_{dt}^{Gas}$. The only reason the endowment measures could vary over time is because district borders sometimes change.[20] Using the sharing rule, I define the variable

$$EndowPC_{dpt} = \frac{1}{Pop_{dpt}} \left(0.062 \cdot Endow_{dpt}^{Oil} + 0.122 \cdot Endow_{dpt}^{Gas} + \frac{0.062}{N_{pt} - 1} \sum_{j \neq d} Endow_{jpt}^{Oil} + \frac{0.122}{N_{pt} - 1} \sum_{j \neq d} Endow_{jpt}^{Gas} \right),$$

which represents oil and gas endowment per capita to which district d has a claim for revenue-sharing purposes.

Despite the formula established by law, the time variation in central government disbursements of shared oil and gas revenue does not match the time variation in the value of resource production. Panel (a) of Figure 2 graphs total oil and gas revenue shared with the districts against the weighted value of oil and gas production, where the value of oil production is given a weight of 0.062 and the value of gas production is given a weight of 0.122 as per the sharing formula. The weighted value of production should be roughly proportional to the

[20] Fitrani et al. (2005) find no consistent relationship between natural resources and the likelihood of a district split from 1998–2004.

central government's revenue base from oil and gas production. The two time series do not closely track each other, indicating that the central government frequently deviates from the revenue-sharing rule on a discretionary basis.[21]

The distribution of oil and gas revenue is highly skewed, with only six provinces—Jambi, Sumatera Selatan, Riau, Kepulauan Riau, Kalimantan Timur, and Kalimantan Utara—receiving significant amounts of revenue. (See the appendix.) Panel (b) of Figure 2 graphs average oil and gas revenue separately for districts in the top five percent in terms of oil and gas endowment, districts between the 90th and 95th percentiles, and districts in the bottom 90 percent. Oil and gas revenue is significant only for the top 10 percent of districts in terms of endowment. Furthermore, districts in the top five percent in terms of endowment experience very sharp increases and decreases in oil and gas revenue from one year to the next. Cross-district variation in resource endowments, combined with variation in aggregate shared oil and gas revenue over time, provide exogenous variation in the size and timing of transitory shocks to oil and gas revenue. Accordingly, I construct an instrument for oil and gas revenue per capita by interacting aggregate shared oil and gas revenue (excluding own district revenue) with predetermined oil and gas endowment per capita in 2000, $AggOilGasRev_{(-d)t} \times EndowPC_{dit}$.[22]

The validity of the instrument rests on the assumption that there are no omitted factors that covary with aggregate shared oil and gas revenue over time and differentially affect districts according to their oil and gas endowment. One concern is that better-managed districts may attract more oil and gas exploration, which in turn increases known endowment (Cust and Harding, 2017; Cassidy, 2018; Arezki, van der Ploeg, and Toscani, 2019). The instrument avoids contamination along these lines by measuring endowment known as of 2000, prior to fiscal decentralization. Before the decentralization reforms, the central government was the sole actor in negotiating with oil and gas companies. As a result, incentives to explore for oil and gas were roughly uniform across the archipelago prior to 2001.[23] It is therefore plausible that the predetermined endowment is uncorrelated with the unobserved quality of governance.

A second concern is that district-level oil and gas production may be correlated with the instrument, leading to estimates that conflate the effects of production and shared revenue. However, aggregate shared oil and gas revenue is not synchronized with aggregate oil and gas production—or its lags—over time. (See Figure 2.) As already mentioned, the central government apparently deviates from the revenue-sharing rule on a discretionary basis. Indeed, the largest shock to shared oil and gas revenue occurred in 2006, the same year the central government made large changes to its grant budget in response to an upwardly revised oil

[21]Lags of weighted oil and gas production also do not closely track total shared oil and gas revenue.

[22]Excluding own district oil and gas revenue from the calculation of aggregate shared oil and gas revenue avoids a potential source of bias in the event that district oil and gas revenue is endogenous. Including own district oil and gas revenue in the calculation makes little difference for the estimates, however. This is likely because the number of districts is large and no district accounts for more than 10 percent of total oil and gas revenue.

[23]Separatist violence in Aceh and Papua has disrupted resource extraction in the past. These regions are excluded from the sample.

price forecast. This policy change was exogenous from the standpoint of district governments and unrelated to trends in oil and gas production.

5.3 Magnitude and Persistence of Grant Shocks

Specifications (2) and (3), as well as the theoretical model, are motivated by two hypothetical grant shocks which have equal initial-period values but differ in their persistence. Results in the appendix establish that this thought experiment is a good approximation of the actual variation observed in the sample.

Figure A.4 in the appendix compares the distribution of the absolute two-year change in the general grant during 2005–2007 to the distribution of all two-year changes in the oil and gas revenue. The main finding is that the absolute magnitude of the shocks to the two grants are reasonably similar for districts with significant exposure to the shocks.

The appendix also formally examines the time-series properties of the two grants. The within-district coefficient of variation of the oil and gas revenue (1.465) is 4.5 times greater than that of the general grant (0.317), confirming that the oil and gas revenue is significantly more volatile than the general grant. Autoregressions reported in Table A.1 in the appendix confirm that the general grant is much more persistent over time than the oil and gas revenue.

To summarize, the initial-period shock to the two grants is similar in magnitude, on average, for districts with high exposure to the grant shocks. Furthermore, the general grant is less volatile and more persistent than the oil and gas revenue. The sample variation exploited in the empirical analysis thus mirrors the variation posited in the theoretical model. See the appendix for further discussion.

6 Results

6.1 Fiscal Outcomes

This section presents the estimates of district fiscal responses to the two grants. Panel A of Table 1 provides summary statistics for the district-level variables. District population averages around 560 thousand and ranges from about 30 thousad to 5.3 million. Fiscal variables are measured in constant 2010 IDR 1 million (approximately USD 100) per capita. USD 100 per capita is approximately the average increase in the general grant experienced by districts above the 75th percentile in land area per capita, and it would also be a "typical" yearly fluctuation in oil and gas revenue for a district above the 95th percentile in terms of endowment. (See Figures 1 and 2.) USD 100 per capita is large relative to district income, representing 7 percent of average non-oil-and-gas GDP per capita (USD 1,453) and 35 percent of average oil-and-gas GDP per capita (USD 289). On average district revenue is around USD 210 per capita. Total revenue varies significantly across districts, ranging from USD 36 to around USD 2,400 per capita.

Panel (a) of Figure 3 plots total spending over time for districts in resource-poor provinces and divided into three groups according to land area per capita in 2006. Trends in total spending were similar across the three groups prior to the general grant reform. This provides suggestive evidence in support of the identifying assumption that districts with different levels of land area per capita would have followed parallel trends in the absence of the reform. Starting in 2006, total spending increased significantly more for districts with a high land area per capita than districts with a low land area per capita.

Panel (b) of Figure 3 plots total spending over time for districts divided into three groups according to their oil and gas endowment in 2000. The most richly endowed districts spend considerably more than resource-poor districts over the sample period, and the spending gap between resource-rich and resource-poor districts grows over time—likely due to the increase in oil and gas revenue starting in 2006. Spending in the most richly endowed districts has a hump shape from 2001–2004, reflecting a response to the large increase in shared resource revenue at the start of decentralization followed by a delayed response to the ensuing decline in oil and gas revenue. Spending in these districts grows again, particularly sharply in 2008 following the large oil and gas revenue increase in 2006, before falling sharply in 2010. Overall the time path of spending in resource-rich districts is much smoother than the time path of total shared oil and gas revenue (dotted line).

Table 2 presents the first-stage results. To make the first-stage estimates readable, land area per capita is measured in tens of square kilometers per capita, and total shared oil and gas revenue is measured in 2010 IDR trillions. The first instrument, $AreaPC06 \times NonOilGas \times 1(Year \geq 2006)$, has a positive effect on general grant revenue per capita that is significant at the one-percent level. The magnitude and statistical significance of this first-stage effect is insensitive to the inclusion of the second instrument, $AggOilGasRev \times EndowPC$, which has an insignificant effect on general grant revenue per capita. The second instrument has a positive effect on oil and gas revenue per capita that is significant at the one-percent level. Similarly, this first-stage effect is insensitive to the inclusion of the first instrument, which has an insignificant effect on oil and gas revenue per capita. In the second-stage regressions, the Sanderson and Windmeijer (2016) F statistic, which tests for weak identification of individual coefficients on the endogenous variables, is typically 20 or greater for the general grant and 50 or greater for the oil and gas revenue, indicating that the structural parameters are strongly identified.

Table 3 presents estimates of the effects of the two grants on the main alternative sources of revenue. Panel A presents the ordinary least squares estimates, and Panel B presents the two-stage least squares estimates. In column one, both the OLS and 2SLS estimates suggest that the grants have little effect on own-source revenue.

In column two, the OLS results suggest that increasing the general grant by one dollar per capita raises special allocation grants (*Dana Alokasi Khusus*, or DAK)—earmarked transfers given by the central government on a discretionary basis—by 11 cents per capita. The point estimate is significant at the one-percent level. However, the 2SLS estimate is one-fifth the size of the OLS estimate and is insignificant. One reason for the discrepancy could be that both the general and special grants are targeted towards poorer districts, and the OLS estimate is biased upwards as a result. Alternatively, district governments that effectively bargain with the central government could increase both the general and special grants, producing upwardly biased OLS estimates. The estimated impact of oil and gas revenue on special allocation grants is small—the OLS estimate is 0.03 and the 2SLS estimate is 0.00—and statistically insignificant.

Finally, the estimates in column 3 suggest that the two grants have no impact on shared tax revenue. In particular, both grants have an estimated coefficient of 0.00 when estimated by 2SLS. Overall, there is no indication that the grants crowd out or crowd in other revenue sources.

Table 4 presents the 2SLS estimates of the cumulative expenditure responses to the two grants, broken down by economic classification. The estimates provide tests of the predictions outlined in Section 2.6. I report the OLS results, which are likely to be biased, in the appendix and focus the discussion on the 2SLS results.

Column 1 of Table 4 provides the results for total expenditure per capita. In response to a permanent increase in the general grant by \$1, total spending increases by \$0.45 that same year, \$1.30 one year later, \$1.88 two years later, and \$1.34 three years later. Thus the spending response exceeds unity one and two years after the shock, confirming the first prediction for the general grant. These responses are not statistically different from unity, though the response after two years is nearly statistically different from unity ($p = 0.122$). The second prediction is also confirmed, as the spending response falls by \$0.54 from two to three years after the shock. This decrease is statistically different from zero ($p = 0.008$).

The ensuing rows of column 1 of Table 4 provide the total expenditure response to oil and gas revenue. Out of a \$1 transitory increase in oil and gas revenue, \$0.18 is spent that same year, \$0.73 is spent after one year, and \$1.03 is spent after two years, and \$1.01 is spent after three years. The responses after two and three years are not statistically different from unity ($p = 0.936$ and $p = 0.987$, respectively). The cumulative spending responses therefore never exceed unity, confirming the first prediction for oil and gas revenue. The cumulative spending response also monotonically rises each year before leveling off at unity starting two years after the shock. The results therefore confirm the second prediction as well.

The evidence so far confirms the predictions that are specific to each grant. Do the spending responses to the two grants differ from each other? Panel (a) of Figure 4 plots the total expenditure responses to the two grants. The response to the general grant is hump-shaped, peaking two years after the shock and then falling. By contrast, the spending response to the oil and gas revenue is more gradual, climbing each year before leveling off. Column 1 of Table 4 tests whether these two spending paths are statistically different from each other. The response after one year is \$0.57 higher for the general grant, and the difference is statistically significant ($p = 0.050$). After two years the disparity is even greater at \$0.85, though this difference is statistically insignificant. The joint hypothesis that the cumulative spending responses to the two grants are equal in all periods is soundly rejected ($p = 0.008$). Overall, the evidence suggests that the paths of the spending responses to the two grants are qualitatively and quantitatively different.

Columns 2 through 4 of Table 4 report the responses of capital, goods and services, personnel, and "other" expenditure. Interestingly, practically the entire response of capital expenditure to the general grant occurs with a one-year delay, while there is a larger contemporaneous response of goods and services and personnel. The reason could be that the latter two categories may be associated with fewer bureaucratic delays compared to capital expenditure.

Table 5 presents 2SLS estimates of the expenditure responses broken down by function. These estimates are based on a smaller sample, because spending by function is only available until 2012. Interestingly, the education, health, and infrastructure expenditure responses to the general grant largely occur with a delay before subsequently declining, which is consistent with red tape delaying upfront investment in structures. By contrast, the general grant induces an immediate and temporary increase in spending on administration, which may be adjusted more quickly by hiring more bureaucrats. Consistent with the results for total expenditure, the responses to the oil and gas revenue generally increase monotonically over time and do not exhibit a hump shape.

So far, the evidence on fiscal responses is consistent with the theoretical model, suggesting that the permanent increase in the general grant induced a front-loaded spending response in order to overcome an investment threshold. The spending increase in response to a transitory increase in oil and gas revenue is instead spread fairly evenly across four years.

The theoretical model also predicts that the two grants will have different effects on the *share* of expenditure devoted to different spending categories. In particular, the assumption of homothetic preferences together with the lumpiness constraint imply that a large increase in permanent income should not affect expenditure shares, while a small increase in permanent income should decrease the share of spending on lumpy items and increase the share of spending on non-lumpy items. Tables 6 and 7 report the effects of the two grants on the share of expenditure devoted to different categories. Focusing on the 2SLS results, the general grant has small and statistically insignificant effects on the expenditure shares of capital, goods and services, and personnel. By contrast, an increase in oil and gas revenue by 100 USD per capita reduces the capital expenditure share by 8 percentage points, and this effect is significant at the five-percent level. Oil and gas revenue also positively impacts the expenditure shares of goods and services and personnel, though these effects are statistically insignificant. The results on expenditure shares lend further support for the theoretical model.

6.1.1 Flypaper Effect

A voluminous literature finds that local governments increase spending more in response to an increase in unconditional grant revenue than to an equally sized increase in local private income (Inman, 2008). The result is an anomaly under the assumption that policy reflects the preferences of the median voter in the locality (Hines and Thaler, 1995). To address this literature, Table A.6 in the appendix reports results from flypaper-style regressions which add oil-and-gas GDP and non-oil-and-gas GDP to the regression. The flypaper effect is extremely large—the marginal propensity to spend out of non-oil-and-gas GDP is only around 0.01, or one cent for every dollar of income, while the marginal propensity to spend out of each grant is at least one.[24] This is unsurprising given district governments' limited ability to tax local income. The propensity to spend out of non-oil-and-gas GDP exceeds the propensity to spend out of oil-and-gas GDP. The latter even appears to be negative, albeit statistically insignificant.

6.2 Public Goods and Services

This section presents estimates of the effects of the two grants on the provision of public schools, health facilities, health personnel, and road quality. I focus on these public goods due to data availability and the fact that district governments are responsible for either provision (education and health) or financing (local roads) of these goods.[25]

Panel B of Table 1 provides summary statistics for the village-level variables. The average village population is around 3,410. On average there are 0.94 public schools per 1,000 villagers, and the number of public primary schools is over six times the number of public secondary schools.[26] Villages average 0.17 primary health care centers (known as *puskesmas*), 0.11 doctors, and 0.54 midwives per 1,000 villagers. The main village road is made of asphalt—as opposed to gravel, dirt, or other materials—in 70 percent of villages. The annual change in public schools and health care centers is 0.01 of either sign on average. A typical district in Indonesia contains hundreds of villages. In the sample of villages successfully merged across all waves of the village census, the average number of villages per district is 204. I measure each grant variable in terms of average annual revenue over the inter-survey period, in units of constant 2010 IDR 1 million (approximately USD 100) per capita.

Table 8 displays estimates of the effects of the two grants on public goods and services (β and δ in equation (3)). Panel A presents the OLS estimates, and Panel B presents the 2SLS

[24]For the OLS results, we can reject the hypotheses that each grant produces the same total spending response as each type of GDP at the one-percent level. The 2SLS estimates are less precise—the smaller sample size due to GDP data being available only until 2013 exacerbates the problem. The spending response to oil and gas revenue is statistically distinguishable from the response to GDP at the 10-percent level, though the difference between the responses to the general grant and GDP just misses statistical significance.

[25]Village governments play a lead role in the upgrading and maintenance of local infrastructure, such as roads, bridges, and piped water systems. Districts contribute to the financing of village infrastructure projects and procure engineers, but in most cases village governments initiate and implement the projects (World Bank, 2010).

[26]Here I define "public schools" as the sum of primary and secondary public schools.

estimates. The first column contains the results for the sum of public primary and secondary schools, while columns 2 and 3 present the results for public primary schools and public secondary schools, respectively. The OLS results indicate that increasing the general grant by USD 100 per capita raises the annual change in public schools per 1,000 villagers by 0.006. This means that permanently raising the general grant by USD 100 per capita in the nine-year, post-reform period (2006–2014) has the cumulative effect of increasing the stock of public schools per 1,000 villagers by 0.054, almost six percent of the sample mean. The estimate is statistically insignificant, however. Columns 2 and 3 show that the effect of the general grant on public schools is driven by the effect on secondary schools, which is statistically significant at the one-percent level. The effect of oil and gas revenue on public schools is −0.003 and is statistically insignificant.

The 2SLS estimates for public schools are larger in magnitude. According to these estimates, an increase in the general grant of USD 100 per capita raises the annual change in schools per 1,000 villagers by 0.028, and this effect is significant at the one-percent level. The corresponding effect of oil and gas revenue is only 0.007 and is statistically insignificant. Once again, the estimates suggest that the impact of the general grant on public schools is concentrated on secondary schools. The effect of the general grant is economically quite large. Permanently raising the general grant by USD 100 per capita in the post-reform period increases the stock of public schools per 1,000 villagers by 0.252, which is 27 percent of the sample mean. The 2SLS estimates for the two grants are statistically different from each other at the five-percent and one-percent levels, respectively, for all public schools and public secondary schools.

Columns 4–6 of Table 8 present estimates of the impact of the grants on health facilities and personnel. Similar to the results on public schools, the 2SLS estimates of the effect of the general grant are all larger than the OLS results by a factor of roughly two or more. According to the 2SLS estimates, increasing the general grant by USD 100 per capita raises the annual change in health care centers per 1,000 villagers by 0.084, which implies an economically large effect. Permanently raising the general grant by USD 100 per capita in the post-reform period increases the stock of health care centers per 1,000 villagers by 0.756, which is four times the sample mean. Note, however, that the 95-percent confidence interval is wide, ranging from 0.002 to 0.166. The corresponding point estimate for oil and gas revenue is 0.020 and is statistically insignificant. The effects of the two grants on health care centers are statistically different from one another at the five-percent level. The general grant also significantly increased the number of health personnel: increasing the general grant by USD 100 per capita raises the number of doctors and midwives per 1,000 villagers by 0.036 and 0.199, respectively, representing a 33 percent increase in doctors and a 37 percent increase in midwives relative to their respective sample means. Both effects are significant at the five-percent level. The effects of oil and gas revenue on health personnel are an order of magnitude smaller and are statistically indistinguishable from zero. For both doctors and midwives, we reject the hypothesis that the two grants have the same effect on health personnel at the one-percent level.

Column 7 of Table 8 presents estimates of the impact of the grants on road quality. The outcome equals one if the main village road is paved with asphalt, and zero otherwise. Importantly, the outcome measures the quality of an existing road, not the construction of a new road. According to the OLS estimates, increasing the general grant by USD 100 per capita raises the probability of the main road being made of asphalt by 0.015. This effect is statistically insignificant. The corresponding estimate for oil and gas revenue is 0.043 and is significant at the 10-percent level. We fail to reject the hypothesis that the two OLS estimates are equal. The 2SLS estimate of the effect of the general grant is much larger at 0.063 and is statistically significant at the five-percent level. This effect represents a nine-percent increase relative to the sample mean. The 2SLS estimate for oil and gas revenue is of a similar magnitude—0.053—and is significant at the five-percent level. This effect is eight percent of the sample mean. Once again, we fail to reject the hypothesis that the two grants have the same effect on road quality.

Three lessons emerge from this subsection. First, the general grant induced larger increases in lumpy public goods and services, per dollar of revenue, than the oil and gas revenue. The general grant caused increases in every lumpy category of public goods and services—durable structures and personnel—and these increases were both economically large and statistically distinguishable from the effect of oil and gas revenue. By contrast, the oil and gas revenue had small and statistically insignificant effects on lumpy public goods and services. Thus, the results confirm the theoretical prediction that permanent revenue shocks will have a greater impact on public goods that require lumpy investment than transitory revenue shocks. Of course, health personnel do not require such an investment. However, adding an additional doctor or midwife requires incurring an upfront fixed cost associated with committing funds toward paying a salary for a year or more. Such a transaction is lumpy compared to, say, raising doctor wages by a small amount. The lumpiness of the personnel hiring decision is magnified by the fact that public workers in Indonesia enjoy significant job security.[27] Hiring a worker entails a significant financial commitment.

Second, the two grants had similar effects on road quality. Road maintenance in one year does not commit the government to maintenance in future years and thus represents a less lumpy outcome. The fact that both grants increase road quality to a similar degree indicates that lumpiness, rather than graft, drives the differential responses of structures and personnel to the two grants.

Finally, the discrepancy between the OLS and 2SLS estimates is typically much larger for the general grant than for oil and gas revenue, suggesting that endogeneity concerns are more important for the general grant. This is important for researchers to keep in mind when evaluating the effects of the general grant, which is the most important source of funding for district governments in Indonesia.

[27]In field interviews, public-sector midwives in Yogyakarta said that they could earn significantly more in the private sector but stayed in the public sector due to job security (UNFPA Indonesia, 2014, p. 47).

6.3 Threats to Validity

One potential concern is that the results for the general grant could simply reflect catch-up growth by more remote, less developed regions. The instrument captures variation in the general grant driven by the increased importance of land area per capita in the allocation formula in the years 2006 and later. If more densely populated districts were experiencing different time trends in outcomes than less densely populated districts for reasons other than the general grant reform, the 2SLS estimates would be asymptotically biased. While districts with different levels of land area per capita may differ in their level of public goods and services, the identifying assumption is that they would have followed parallel trends over time in the absence of the reform. While this assumption is untestable, it produces a corollary which is testable: the partial effect of land area per capita on outcomes should be constant over time prior to the reform.

To test this prediction, I estimate the equation

$$\begin{aligned} Y_{vdis} = & \sum_{j \in \mathcal{J}} \theta_j AreaPC06_{di} \times NonOilGas_{di} \times 1(s=j) \\ & + \sum_{j \in \mathcal{J}} \gamma_j EndowPC_{di} \times 1(s=j) + \phi_d + \rho_{is} + u_{vdis}, \end{aligned}$$

where $\mathcal{J}$ is the set of time periods s for which data on Y exist.[28] The (omitted) reference period is 2004–2005. The parameters $\{\theta_j\}_{j\in\mathcal{J}}$ capture how outcomes vary over time according to the district's exposure to the general grant reform. Likewise, the parameters $\{\gamma_j\}_{j\in\mathcal{J}}$ reflect how exposure to fluctuations in oil and gas revenue affects outcomes over time. Each parameter represents the partial effect of grant exposure in a time period relative to its effect in 2004–2005, the time period prior to the general grant reform. Panel (a) of Figure 5 plots estimates of $\{\theta_j\}_{j\in\mathcal{J}}$, and Panel (b) plots estimates of $\{\gamma_j\}_{j\in\mathcal{J}}$. As shown in the figure, we fail to reject the hypothesis that exposure to the general grant reform had the same impact on outcomes in the period 2001–2003 as it did in the period 2004–2005 at the 95-percent level. This result implies that districts with varying levels of exposure to the general grant reform were on parallel trends prior to the reform, lending credence to the causal interpretation of the main results for public goods and services.

7 Conclusion

Indonesia's fiscal decentralization reforms produced large increases in unconditional grants to district governments. The manner in which these grants were delivered depended on district characteristics: districts with greater land area per capita and few natural resources saw a larger permanent increase in general grant revenue starting in 2006. Districts that were richly

[28] $EndowPC_{di}$ is average endowment over the sample period.

endowed with oil and natural gas saw little variation in the general grant over this period, but they experienced large swings in the oil and gas revenue that factored heavily into their budgets. Thus, while one set of districts experienced a one-time, permanent increase in grant revenue, another faced frequent transitory shocks to grant revenue. The responses to these two grants reveal the degree to which local governments are forward-looking.

Theory predicts that both the timing and the composition of the spending response to a revenue shock depend on whether the shock was permanent or transitory—as long as the time horizon is at least two years. A permanent increase in revenue by one dollar is more likely to allow the government to overcome a minimum size requirement for investment in durable goods, such as schools, leading to a front-loaded total spending response. A transitory increase in revenue by one dollar, on the other hand, has a smaller impact on permanent public income and is less likely to allow the government to overcome the up-front investment constraint, skewing spending towards nondurables which can be varied continuously.

The empirical results confirm that local governments respond to a permanent increase in grant revenue by front-loading expenditure and increasing the provision of lumpy public goods. Transitory shocks to grant revenue elicit smoother fiscal responses and have little impact on lumpy public goods. The results are consistent with local governments operating with a time horizon of three to five years.

The results of this paper are informative for policymakers in central governments, which have the option of changing intergovernmental grant allocations on a temporary or permanent basis. Central governments often use grants to promote their own fiscal goals. Grant policy also matters for economic outcomes. The permanence of a grant reform could matter for aggregate output responses, for at least two reasons. First, it influences the timing of the fiscal response, and output multipliers vary according to labor market slackness (Michaillat, 2014). Second, it influences the composition of the fiscal response, and different types of public expenditure have different output multipliers (Boehm, 2019).

This paper also makes an important methodological point: the estimated effects of local revenue on lumpy public goods will depend on the nature of the identifying variation in revenue. The finding that local tax revenue raises public good provision more than grants in a particular context need *not* imply that governments are held more accountable for how they spend tax revenue. Rather, it could be the result of tax revenue being subject to more persistent shocks, in combination with forward-looking government policymaking. This is a realistic concern, as previous studies have exploited tax-revenue shocks generated by investments in tax administration (Gadenne, 2017) and upward revisions to assessed property values (Martínez, 2017). Both interventions cause persistent increases in tax revenue. By contrast, shocks to intergovernmental grants can be transitory or persistent, depending on the context. A necessary step toward isolating the accountability effects of taxation is to establish that tax and non-tax revenue are subject to similar types of shocks.[29]

[29] In Gadenne (2017), grants and taxes have similar within-municipality coefficients of variation.

To what extent are the results of this paper informative for other countries? The relative unimportance of local taxation in Indonesia contrasts sharply with the federal systems in many high-income countries, such as the United States. The results may therefore be more applicable to developing countries, where local taxation is less important (Gadenne and Singhal, 2014). Certainly, the *absolute* level of the expenditure response to grant revenue should be lower when there is scope for cutting local taxes, and indeed this is the case (Hines and Thaler, 1995; Inman, 2008). Nonetheless, the results of this paper may be predictive of the *relative* responses to permanent and transitory shocks to local government revenue. National reforms often produce both types of shocks to local taxes. In the United States, the Tax Reform Act of 1986 broadened the definition of taxable income, permanently increasing state tax revenue in states that used the federal definition of taxable income (Ladd, 1993). The same reform also increased the tax rate on capital gains. This caused a spike in capital-gains realizations right before the higher rate was to take effect, resulting in a transitory increase in state tax revenue (Auten, 1999). Future research should examine how local governments respond to permanent and transitory shocks to revenue in contexts with significant local taxation.

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8 Tables

Table 1: Summary Statistics

	Mean	Std. Dev.	Min.	Max.	Obs.
Panel A: District-Level Variables					
Total Revenue per Capita	2.11	1.89	0.36	23.71	4,836
Own-Source Revenue per Capita	0.14	0.19	0.00	3.63	4,819
Special Allocation Revenue per Capita	0.13	0.17	0.00	3.30	4,726
Shared Tax Revenue per Capita	0.15	0.20	0.00	4.96	4,660
Total Expenditure per Capita	2.05	1.84	0.01	22.52	4,622
Capital Expenditure per Capita	0.56	0.77	0.00	11.05	4,651
Goods & Services Expenditure per Capita	0.40	0.43	0.00	7.45	4,657
Personnel Expenditure per Capita	0.91	0.57	0.01	6.69	4,670
Other Expenditure per Capita	0.16	0.24	0.00	5.46	4,619
Education Expenditure per Capita	0.53	0.33	0.00	3.10	3,910
Administration Expenditure per Capita	0.64	0.76	0.01	11.18	3,991
Infrastructure Expenditure per Capita	0.35	0.59	0.00	10.76	3,906
Health Expenditure per Capita	0.16	0.15	0.00	1.80	3,909
Agriculture Expenditure per Capita	0.09	0.11	0.00	1.12	3,892
General Grant Revenue per Capita	1.19	0.87	0.00	7.95	5,004
Oil & Gas Revenue per Capita	0.17	0.66	0.00	10.17	5,004
AreaPC06 $\times$ Non-Oil/Gas $\times$ Year $\geq$ 2006	0.10	0.27	0.00	2.72	5,004
Agg. Oil & Gas Rev. $\times$ Endow. per Capita	0.22	0.79	0.00	10.30	5,004
Non-Oil/Gas GDP per Capita	14.53	16.18	0.63	262.21	4,652
Oil/Gas GDP per Capita	2.89	24.59	0.00	563.51	4,652
Population (Millions)	0.56	0.59	0.03	5.33	5,025
Panel B: Village-Level Variables					
Public Schools per 1,000 People	0.94	0.71	0.00	11.86	204,488
Public Primary Schools per 1,000 People	0.81	0.57	0.00	8.82	204,488
Public Secondary Schools per 1,000 People	0.13	0.32	0.00	7.91	204,488
Primary Health Care Centers per 1,000 People	0.17	0.36	0.00	6.98	163,073
Doctors per 1,000 People	0.11	0.32	0.00	8.86	204,488
Midwives per 1,000 People	0.54	0.69	0.00	10.71	204,488
Main Road Made of Asphalt	0.70	0.46	0.00	1.00	201,956
Avg. Δ Public Schools per 1,000 People	−0.01	0.14	−3.50	3.14	204,488
Avg. Δ Public Primary Schools per 1,000 People	−0.01	0.12	−2.35	2.77	204,488
Avg. Δ Public Secondary Schools per 1,000 People	0.01	0.08	−2.31	2.04	204,488
Avg. Δ Primary Health Care Centers per 1,000 People	0.01	0.12	−2.45	2.33	163,073
Population (Thousands)	3.41	2.62	0.22	17.83	204,488
Villages per District (Hundreds)	2.04	1.13	0.01	4.57	204,488

Notes. All fiscal and GDP variables are measured in constant 2010 IDR 1 million ($\approx$ USD 100) per capita. Village-level variables are measured per 1,000 villagers.

Table 2: First Stage: General Grant and Oil and Gas Revenue

	General Grant p.c.		Oil & Gas Revenue p.c.	
	(1)	(2)	(3)	(4)
AreaPC06 × Non-Oil/Gas × Year ≥ 2006	0.67***	0.66***		0.00
	(0.17)	(0.17)		(0.02)
Agg. Oil & Gas Rev. × Endow. per Capita		−0.07	0.79***	0.79***
		(0.05)	(0.07)	(0.07)
Observations	5,004	5,004	5,004	5,004
District clusters	372	372	372	372
Prov. × year clusters	384	384	384	384

Notes. Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Effects of the Grants on Alternative Revenue Sources

Panel A: OLS

	Revenue per Capita		
	(1) Own-Source	(2) Special Allocation	(3) Shared Taxes
General Grant p.c.	0.02*	0.11***	0.01
	(0.01)	(0.02)	(0.03)
Oil & Gas Revenue p.c.	0.02	0.03*	0.07
	(0.02)	(0.02)	(0.05)
Observations	4,705	4,705	4,549
District clusters	372	372	372
Prov. × year clusters	384	384	384
Test: coefs equal	0.924	0.004	0.271

Panel B: 2SLS

	Revenue per Capita		
	(1) Own-Source	(2) Special Allocation	(3) Shared Taxes
General Grant p.c.	0.01	0.02	0.00
	(0.03)	(0.06)	(0.04)
Oil & Gas Revenue p.c.	0.01	−0.00	0.00
	(0.02)	(0.03)	(0.02)
Observations	4,705	4,705	4,549
District clusters	372	372	372
Prov. × year clusters	384	384	384
F-stat. Gen. Grant	17.1	17.1	17.8
F-stat. Oil & Gas Rev.	80.4	80.4	65.8
Test: coefs equal	0.865	0.745	0.980

Notes. Panel A presents OLS estimates, and Panel B presents 2SLS estimates. Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Expenditure Responses by Economic Classification (2SLS)

	Cumulative Response: Expenditure per Capita				
	(1) Total	(2) Capital	(3) Goods & Services	(4) Personnel	(5) Other
General Grant p.c.					
0 Years later	0.45	0.06	0.23	0.11	0.07
	(0.34)	(0.75)	(0.18)	(0.10)	(0.13)
1 Year later	1.30***	0.55***	0.35**	0.23**	0.11
	(0.25)	(0.16)	(0.17)	(0.09)	(0.11)
2 Years later	1.88***	0.48	0.28*	0.15*	0.20*
	(0.57)	(0.29)	(0.16)	(0.09)	(0.11)
3 Years later	1.34***	0.47	0.28*	0.26	0.24
	(0.43)	(0.32)	(0.15)	(0.18)	(0.16)
Oil & Gas Revenue p.c.					
0 Years later	0.18	0.15	−0.00	0.01	0.03
	(0.16)	(0.10)	(0.07)	(0.06)	(0.05)
1 Year later	0.73***	0.42**	0.10	0.15**	0.10
	(0.22)	(0.17)	(0.09)	(0.07)	(0.11)
2 Years later	1.03***	0.41***	0.12	0.13	0.14
	(0.39)	(0.15)	(0.09)	(0.09)	(0.13)
3 Years later	1.01**	0.45**	0.16	0.17	0.17
	(0.49)	(0.21)	(0.12)	(0.13)	(0.19)
Test: Equal responses, 0 years	0.278	0.895	0.247	0.159	0.783
Test: Equal responses, 1 year	0.050	0.617	0.195	0.317	0.993
Test: Equal responses, 2 years	0.179	0.745	0.404	0.782	0.738
Test: Equal responses, 3 years	0.522	0.925	0.524	0.527	0.740
Test: Equal responses, all years	0.008	0.905	0.665	0.626	0.828
Observations	3,590	3,630	3,630	3,640	3,596
District clusters	372	372	372	372	372
Prov. × year clusters	306	306	306	306	306

Notes. This table reports 2SLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Expenditure Responses by Function (2SLS)

	Cumulative Response: Expenditure per Capita				
	(1) Education	(2) Administration	(3) Infrastructure	(4) Health	(5) Agriculture
General Grant p.c.					
0 Years later	0.08	1.15***	−0.41	−0.02	0.03
	(0.10)	(0.32)	(0.65)	(0.02)	(0.05)
1 Year later	0.17*	0.37	0.41	0.10***	0.06*
	(0.10)	(0.44)	(0.26)	(0.02)	(0.03)
2 Years later	−0.07	0.35	0.37**	0.06*	0.11**
	(0.12)	(0.26)	(0.19)	(0.03)	(0.05)
3 Years later	0.07	0.34	0.34	0.08**	0.08**
	(0.11)	(0.35)	(0.23)	(0.04)	(0.03)
Oil & Gas Revenue p.c.					
0 Years later	0.02	−0.03	0.16	−0.01	0.01
	(0.03)	(0.19)	(0.22)	(0.02)	(0.01)
1 Year later	0.09	−0.36	0.53	0.01	0.03
	(0.06)	(0.33)	(0.36)	(0.04)	(0.02)
2 Years later	0.19***	−0.28	0.50**	0.02	0.03
	(0.07)	(0.45)	(0.26)	(0.05)	(0.02)
3 Years later	0.25***	−0.28	0.74**	0.02	0.04
	(0.10)	(0.64)	(0.37)	(0.08)	(0.04)
Test: Equal responses, 0 years	0.641	0.004	0.485	0.720	0.688
Test: Equal responses, 1 year	0.538	0.140	0.814	0.144	0.348
Test: Equal responses, 2 years	0.132	0.184	0.752	0.478	0.201
Test: Equal responses, 3 years	0.324	0.313	0.418	0.531	0.452
Test: Equal responses, all years	0.196	0.041	0.358	0.096	0.738
Observations	2,893	2,948	2,893	2,892	2,879
District clusters	372	372	372	372	372
Prov. × year clusters	249	249	249	249	249

Notes. This table reports 2SLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Expenditure Share Responses by Economic Classification (2SLS)

	Cumulative Response: Expenditure Share (%)			
	(1) Capital	(2) Goods & Services	(3) Personnel	(4) Other
General Grant p.c.				
0 Years later	−1.30	1.54	−0.77	1.26
	(8.01)	(2.94)	(4.14)	(2.78)
1 Year later	0.81	2.34	−3.63	−1.07
	(3.77)	(1.92)	(2.57)	(2.40)
2 Years later	−2.78	0.82	−2.06	0.49
	(4.63)	(1.94)	(3.07)	(2.26)
3 Years later	−2.03	2.00	−2.75	2.92
	(4.30)	(2.25)	(2.95)	(3.00)
Oil & Gas Revenue p.c.				
0 Years later	−0.64	−0.50	1.06	0.52
	(1.19)	(0.50)	(0.70)	(0.54)
1 Year later	−3.25*	0.26	1.73	1.01
	(1.91)	(0.97)	(1.12)	(1.12)
2 Years later	−6.16**	0.43	2.09	2.04
	(2.55)	(1.07)	(1.58)	(1.44)
3 Years later	−8.37**	1.88	2.47	3.55
	(3.56)	(1.54)	(2.20)	(2.32)
Test: Equal responses, 0 years	0.928	0.488	0.627	0.764
Test: Equal responses, 1 year	0.286	0.308	0.060	0.374
Test: Equal responses, 2 years	0.431	0.843	0.199	0.478
Test: Equal responses, 3 years	0.092	0.958	0.090	0.807
Test: Equal responses, all years	0.347	0.725	0.347	0.182
Observations	3,577	3,576	3,586	3,542
District clusters	372	372	372	372
Prov. × year clusters	306	306	306	306

Notes. This table reports 2SLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Expenditure Share Responses by Function (2SLS)

	Cumulative Response: Expenditure Share (%)				
	(1) Education	(2) Administration	(3) Infrastructure	(4) Health	(5) Agriculture
General Grant p.c.					
0 Years later	2.43	3.74	−2.24	−0.88	0.46
	(2.58)	(7.83)	(7.09)	(0.61)	(0.83)
1 Year later	−0.23	−9.41	2.42	−0.11	−0.08
	(1.97)	(6.66)	(4.25)	(0.86)	(0.59)
2 Years later	0.39	−9.30*	0.15	−0.13	−0.02
	(2.46)	(5.63)	(4.46)	(1.01)	(0.86)
3 Years later	0.07	−7.36	1.06	−0.15	−0.08
	(2.72)	(7.38)	(4.88)	(1.12)	(0.85)
Oil & Gas Revenue p.c.					
0 Years later	1.00**	−1.47	−2.57	−0.32	−0.20*
	(0.49)	(1.93)	(1.79)	(0.26)	(0.11)
1 Year later	1.57	−4.87	−2.43	−0.27	−0.46**
	(1.15)	(4.06)	(2.87)	(0.51)	(0.21)
2 Years later	3.37**	−5.50	−6.26**	−0.58	−0.52*
	(1.48)	(5.92)	(3.04)	(0.63)	(0.30)
3 Years later	3.92*	−6.58	−7.12	−0.45	−0.52
	(2.15)	(7.92)	(4.78)	(1.02)	(0.45)
Test: Equal responses, 0 years	0.603	0.481	0.965	0.384	0.415
Test: Equal responses, 1 year	0.422	0.436	0.284	0.857	0.541
Test: Equal responses, 2 years	0.312	0.623	0.210	0.693	0.585
Test: Equal responses, 3 years	0.269	0.926	0.154	0.833	0.593
Test: Equal responses, all years	0.564	0.505	0.498	0.680	0.789
Observations	2,680	2,735	2,680	2,679	2,666
District clusters	372	372	372	372	372
Prov. × year clusters	249	249	249	249	249

Notes. This table reports 2SLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Second Stage: Public Goods and Services

Panel A: OLS

	Average Annual Change in Stock per Capita				Personnel per Capita		Main Road
	(1) All Public Schools	(2) Public Primary Schools	(3) Public Secondary Schools	(4) Health Care Centers	(5) Doctors	(6) Midwives	(7) Asphalt
Avg. General Grant p.c.	0.006	−0.004	0.010***	0.023*	0.024***	0.121***	0.015
	(0.005)	(0.003)	(0.003)	(0.012)	(0.006)	(0.033)	(0.010)
Avg. Oil & Gas Revenue p.c.	−0.003	−0.003	0.000	−0.005	−0.003	−0.032	0.043*
	(0.004)	(0.004)	(0.003)	(0.019)	(0.007)	(0.035)	(0.023)
Observations	204,488	204,488	204,488	163,073	204,488	204,488	201,956
District clusters	372	372	372	372	372	372	372
Prov. × year clusters	137	137	137	109	137	137	137
Test: Coefficients equal	0.127	0.938	0.036	0.198	0.002	0.001	0.220

Panel B: 2SLS

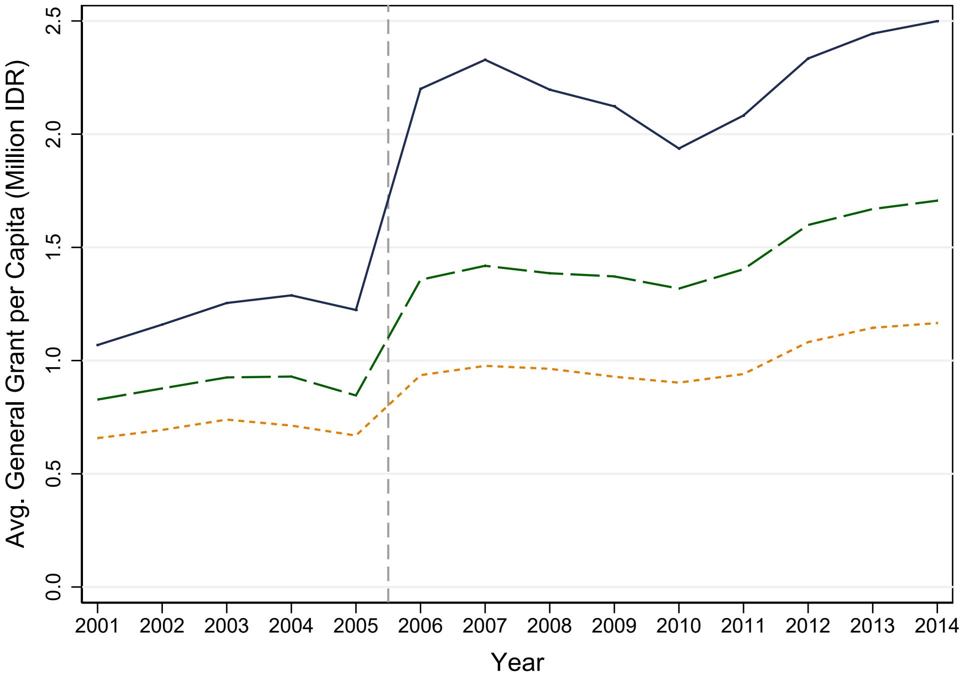
	Average Annual Change in Stock per Capita				Personnel per Capita		Main Road
	(1) All Public Schools	(2) Public Primary Schools	(3) Public Secondary Schools	(4) Health Care Centers	(5) Doctors	(6) Midwives	(7) Asphalt
Avg. General Grant p.c.	0.028***	0.005	0.023**	0.084**	0.036**	0.199**	0.063**
	(0.009)	(0.013)	(0.010)	(0.042)	(0.015)	(0.085)	(0.031)
Avg. Oil & Gas Revenue p.c.	0.007	0.003	0.004	0.020	−0.009	−0.001	0.053**
	(0.007)	(0.007)	(0.006)	(0.029)	(0.008)	(0.046)	(0.026)
Observations	204,488	204,488	204,488	163,073	204,488	204,488	201,956
District clusters	372	372	372	372	372	372	372
Prov. × year clusters	137	137	137	109	137	137	137
F-stat. Gen. Grant	25.4	25.4	25.4	29.9	25.4	25.4	21.7
F-stat. Oil & Gas Rev.	72.6	72.6	72.6	62.7	72.6	72.6	70.5
Test: Coefficients equal	0.021	0.817	0.008	0.026	0.000	0.006	0.749

Notes. Panel A presents OLS estimates, and Panel B presents 2SLS estimates. In columns 1–3 and 5–7, the sample includes the time periods 2001–03, 2004–05, 2006–08, 2009–11, and 2012–14. In column 4 the time periods are 2001–03, 2004–05, 2006–11, and 2012–14, due to missing data on health care centers in 2008. The outcomes in columns 1–4 are measured as the average annual change in the stock of the public good per 1,000 villagers over the time period. The outcomes in columns 5–6 are measured as the number of health personnel per 1,000 villagers at the end of the time period. The outcome in column 7 is an indicator variable equal to one if the village main road is made of asphalt, and zero otherwise. The grant variables are measured as the average annual revenue in constant 2010 IDR 1 million (≈ USD 100) per capita at the district level. Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

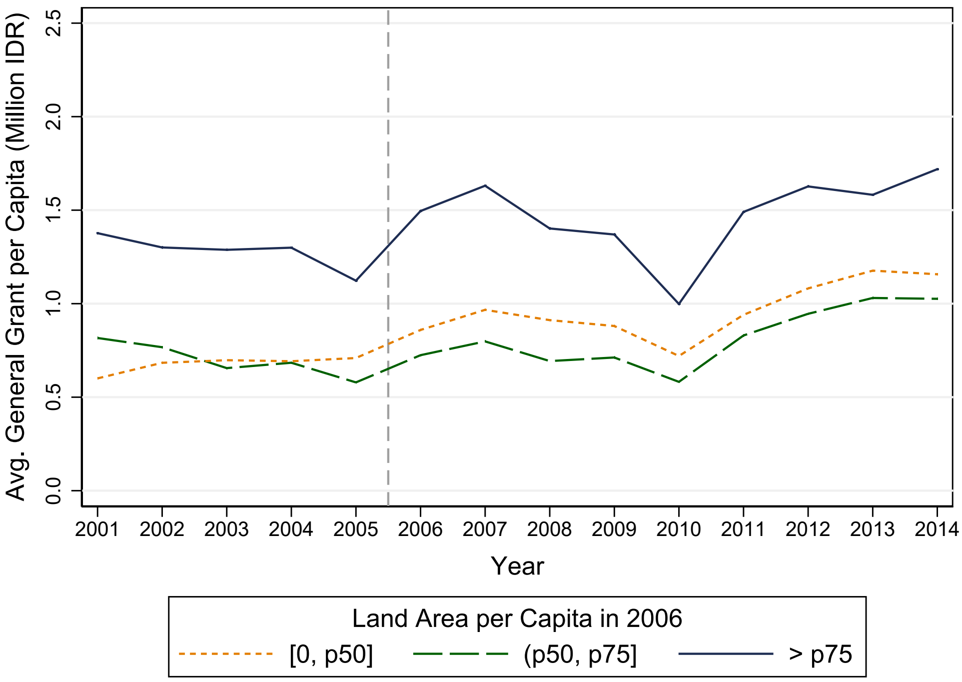
9 Figures

Figure 1: General Grant Revenue per Capita by Land Area per Capita

(a) Non-Oil/Gas Provinces



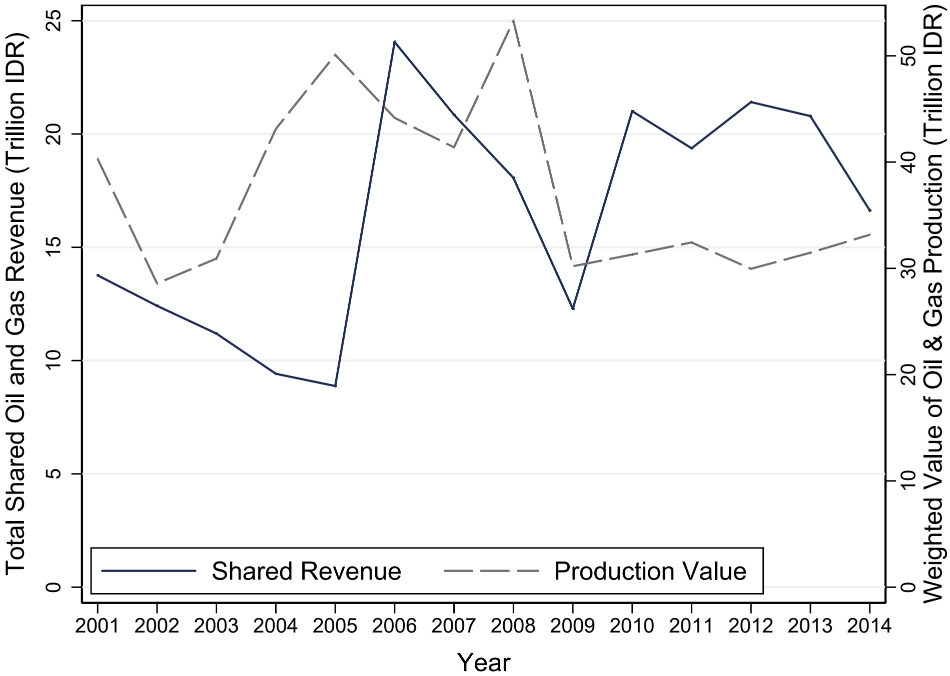
(b) Oil/Gas Provinces



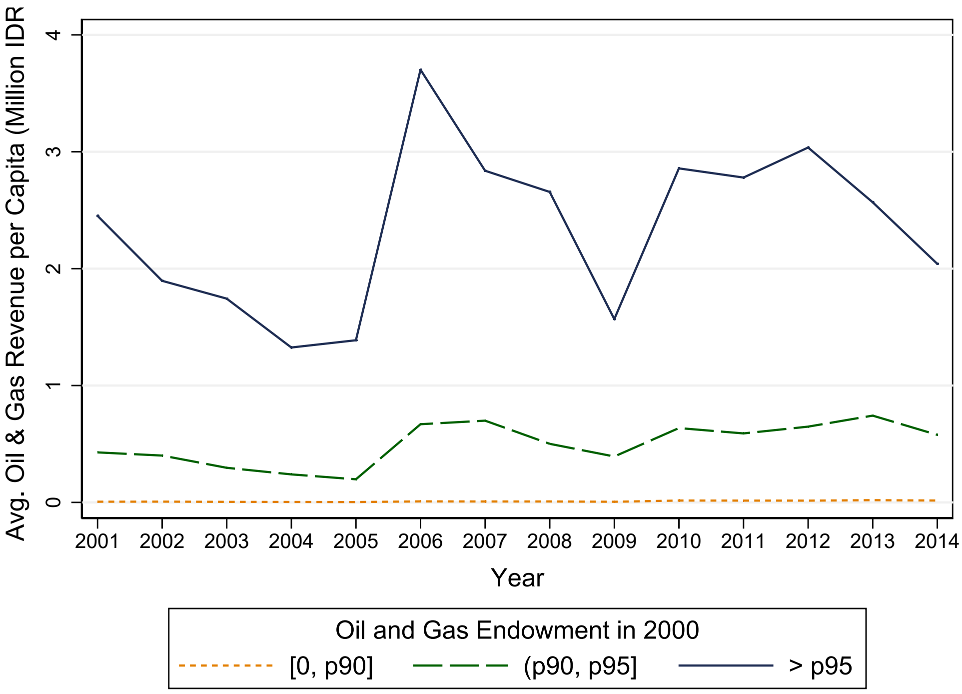
Notes. This figure plots average general grant revenue in constant 2010 IDR per capita (millions) for districts divided into three groups according to land area per capita in 2006. Panel (a) uses districts located in non-oil-and-gas provinces, and Panel (b) uses districts located in oil and gas provinces. Oil and gas provinces are those that receive a non-trivial amount of oil and gas revenue per capita: Riau, Kepulauan Riau, Jambi, Sumatera Selatan, Kalimantan Timur, and Kalimantan Utara. The gray dashed line indicates the timing of the general grant reform.

Figure 2: Shared Oil and Gas Revenue and Value of Production

(a) Aggregate Shared Oil and Gas Revenue and Weighted Value of Production



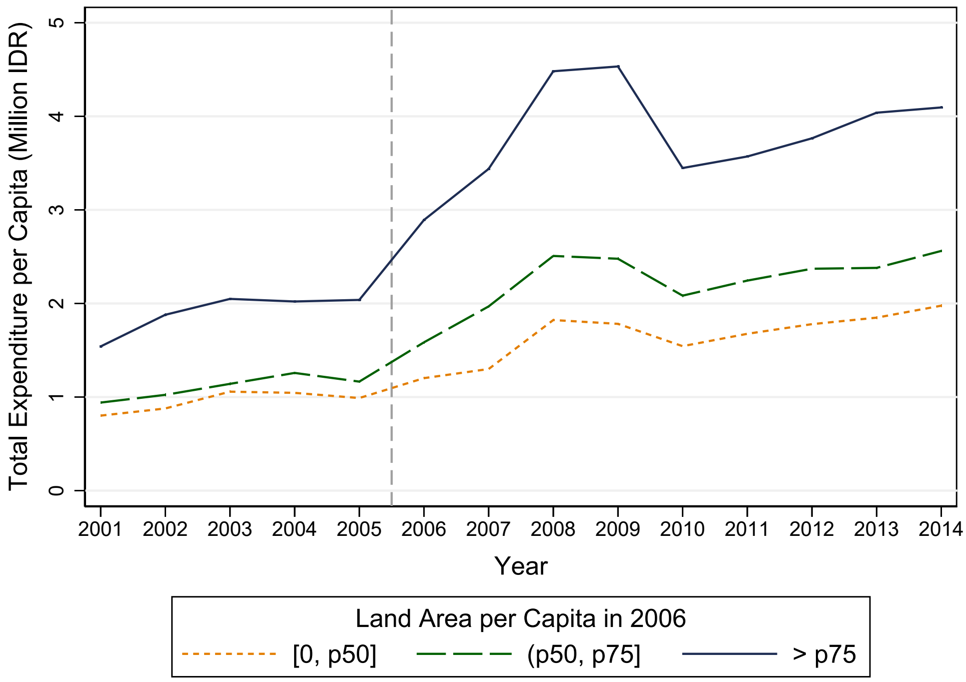
(b) Average Shared Oil and Gas Revenue per Capita by Endowment



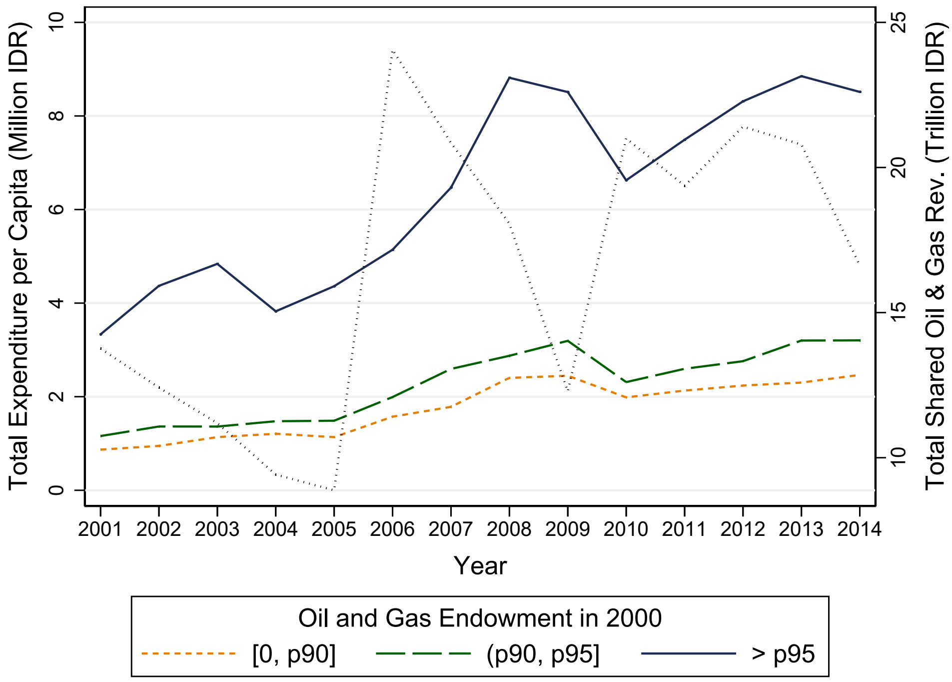
Notes. Panel (a) plots total oil and gas revenue shared with districts (solid line) and the weighted value of oil and gas production (dashed line), defined using the weights from the central government's revenue-sharing rule: $0.06 \cdot P_t^{oil} \cdot Q_t^{oil} + 0.12 \cdot P_t^{gas} \cdot Q_t^{gas}$. Both series are expressed in constant 2010 IDR (trillions). Panel (b) plots average oil and gas revenue in constant 2010 IDR per capita (millions) for districts divided into three groups according to oil and gas endowment.

Figure 3: Total Expenditure Responses to the Two Grants

(a) Total Expenditure per Capita by Area per Capita, Non-Oil/Gas Provinces

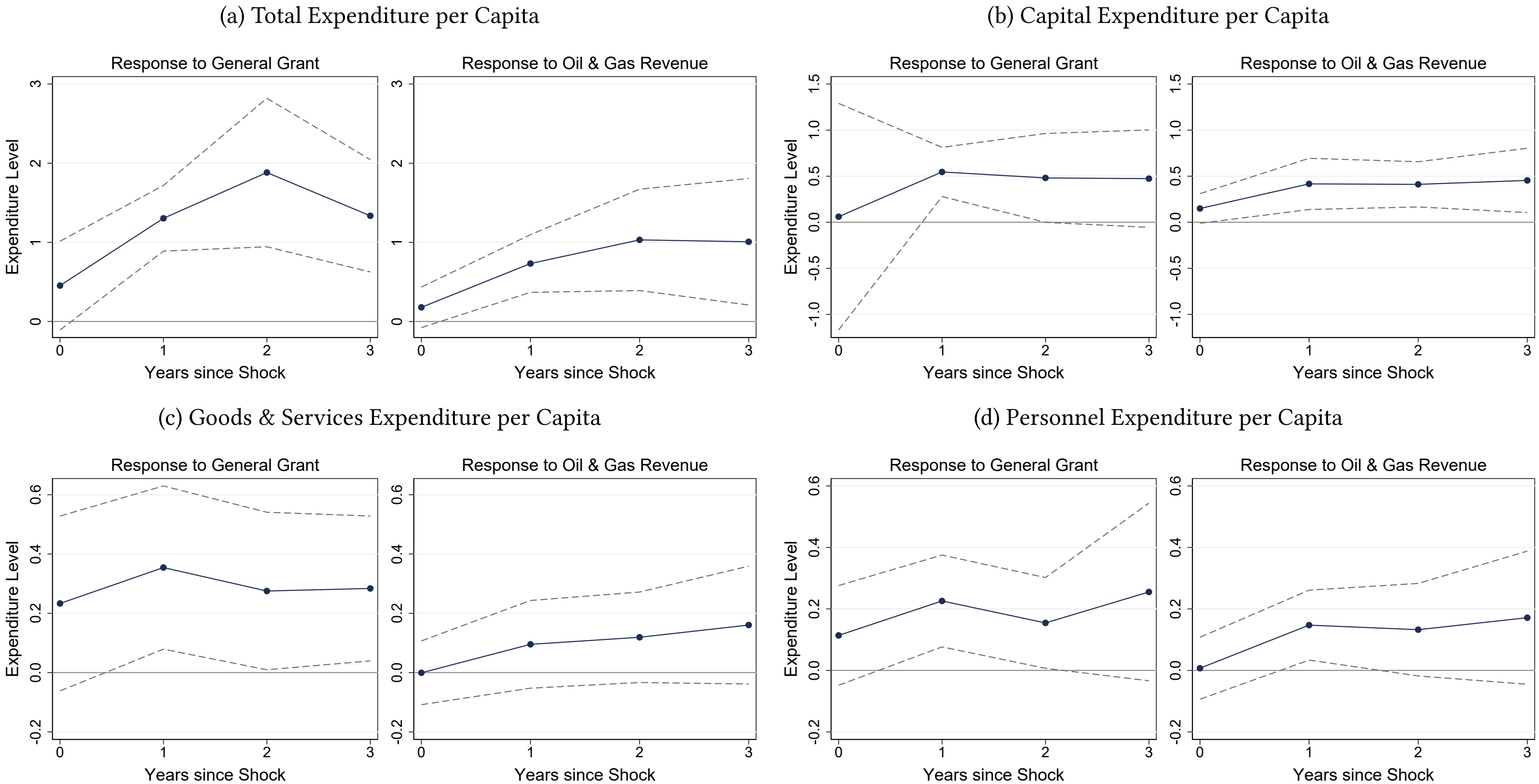


(b) Total Expenditure per Capita by Oil and Gas Endowment



Notes. Panel (a) plots average total expenditure in constant 2010 IDR per capita (millions) for districts divided into three groups according to land area per capita in 2006. The sample excludes the six provinces with significant oil and gas revenue per capita—Riau, Kepulauan Riau, Jambi, Sumatera Selatan, Kalimantan Timur, and Kalimantan Utara. The gray dashed line indicates the timing of the general grant reform. Panel (b) plots average total expenditure in constant 2010 IDR per capita (millions) for districts divided into three groups according to oil and gas endowment in 2000.

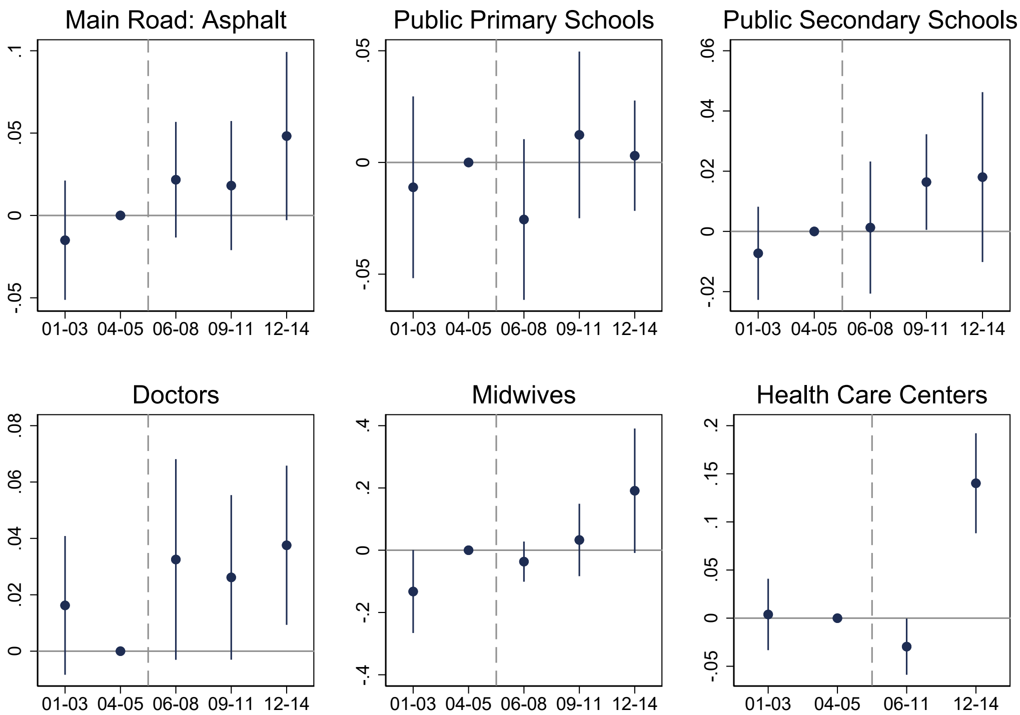
Figure 4: Cumulative Expenditure Responses to $1 Increase in Grant per Capita



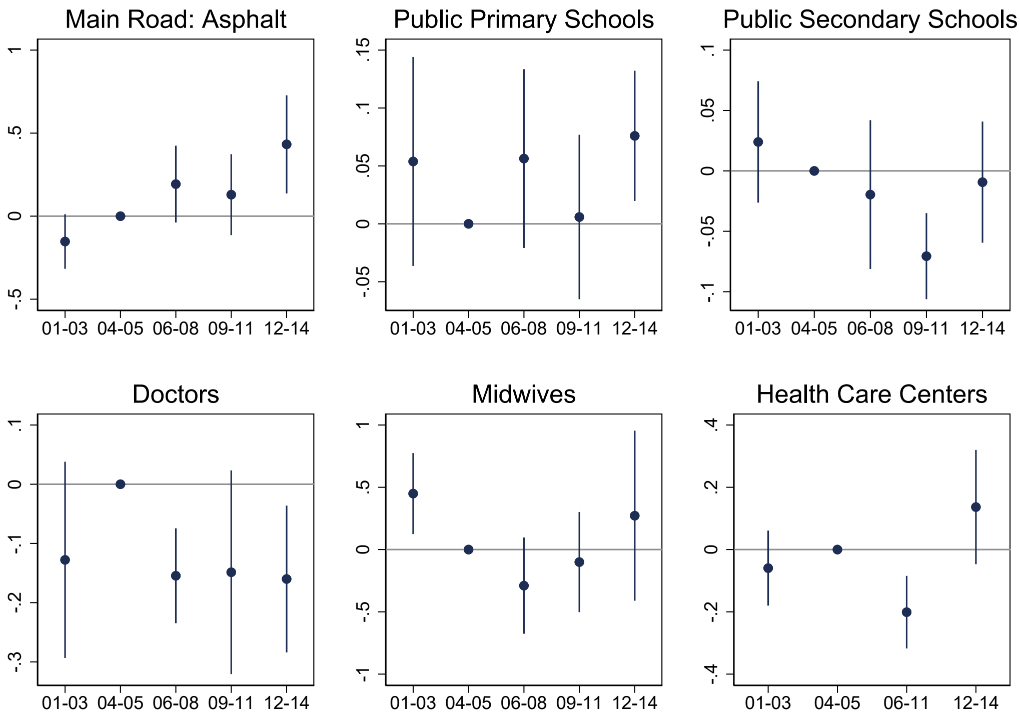
Notes. This figure plots 2SLS estimates and 90-percent confidence intervals of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$).

Figure 5: The Effect of Grant Exposure on Public Goods and Services over Time

(a) The Effect of Land Area per Capita by Time Period



(b) The Effect of Oil and Gas Endowment by Time Period



Notes. This figure displays point estimates and 95-percent confidence intervals from the regression $Y_{vdis} = \sum_{j \in \mathcal{J}} \theta_j AreaPC06_{di} \times NonOilGas_{di} \times 1(s = j) + \sum_{j \in \mathcal{J}} \gamma_j EndowPC_{di} \times 1(s = j) + \phi_d + \rho_{is} + u_{vdis}$, where $\mathcal{J}$ is the set of years for which data on Y exist, and $EndowPC_d$ is average endowment over the sample period. The (omitted) reference year is $s = 2005$. Panel (a) plots $\{\theta_j\}_{j \in \mathcal{J}}$, and Panel (b) plots $\{\gamma_j\}_{j \in \mathcal{J}}$.

A Appendix (For Online Publication)

A.1 Discussion of Extensions to Theoretical Model

This section briefly discusses several extensions to the theoretical model.

A.1.1 Supply Bottlenecks

First, the local government could face constraints in the supply of non-traded inputs to durables investment. The model assumes that the government can freely purchase any quantity of the investment goods at the fixed price p_t. This would be the case if the investment goods were purchased on world markets. In reality, inputs such as building materials may be non-traded, and their supply may be constrained by the current stock of public goods (van der Ploeg and Venables, 2013). As a consequence, the government may face an upward-sloping supply curve for investment goods. Suppose now that the price of investment is $p_t + \psi I_t/2$, so that the marginal cost of investment is increasing and linear in the level of investment. Then equation (1) is modified to become

$$\frac{(1-\gamma)C_t}{\gamma D_t} = \iota_t + \psi(D_t - (1-\delta)D_{t-1}) - \frac{1-\delta}{1+r}\psi(D_{t+1} - (1-\delta)D_t), \tag{A.1}$$

where ι_t is the user cost of durables in the absence of supply bottlenecks. The new user cost of durables, given by the right-hand side of (A.1), is increasing in current durables consumption due to supply bottlenecks, and decreasing in planned future durables consumption. The latter is due to the fact that the higher is future durables consumption, the more current consumption lowers the future investment cost by increasing the stock carried over to the next period.

Supply bottlenecks (i) increase the ratio of nondurables consumption to durables consumption in every period, (ii) increase the steady-state ratio of nondurables consumption to durables consumption (unless $\delta = 0$), and (iii) smooth the adjustment of durables consumption in response to revenue shocks. The stock of durables will not immediately jump to its new level when grant revenue changes. As a result, the total spending response to the permanent grant shock will be less front-loaded than in the baseline case. On the other hand, the lumpiness constraint may limit the degree to which the government can smooth the adjustment of durables.

A.1.2 Liquidity Constraints

Second, district governments may be liquidity constrained. Indeed, since decentralization was enacted, lending to district governments has been minimal (World Bank, 2007, p. 128). Liquidity constraints would lead to lower government spending in all periods—both when the constraints bind and when they do not. This is because the prospect of liquidity constraints binding in the future lowers current consumption (Zeldes, 1989).

In theory, liquidity constraints should also influence how governments respond to revenue shocks. In a simple model of consumption, liquidity constraints raise the marginal propensity to consume (MPC) and cause the MPC to be higher for small income shocks than for large income shocks. Liquidity constraints also lead to a higher MPC for negative income shocks than for positive income shocks (Christelis, Georgarakos, Jappelli, Pistaferri, and van Rooij, 2019). This asymmetric response implies that district governments should react more strongly to oil and gas revenue than to the general grant, biasing the results *away* from the predictions of the model with lumpy investment.

In practice, district governments accumulated substantial reserves in the years immediately following decentralization, suggesting that liquidity constraints were not a significant issue during most of the sample period. Reserves were especially high for the districts that benefited the most from the general grant and the oil and gas revenue, and hence were most exposed to the grant shocks (World Bank, 2007, p. 127). Figure A.3 shows that reserves per capita were much higher in the oil-and-gas-rich provinces of Kalimantan Timur, Riau, and Kepulauan Riau than in other provinces. The provinces of Kalimantan Tengah and Kepulauan Bangka-Belitung also had significant reserves, having benefited from a generous allocation of the general grant. It therefore seems reasonable to assume that liquidity constraints were not binding for the districts that experienced the largest shocks to the two grants.

A.1.3 Uncertainty

Third, districts may face uncertainty about future grant revenue. This would create a demand for precautionary saving, lowering current consumption relative to expected future consumption (Leland, 1968).[30] Whether the precautionary-saving motive influences how the government responds to a grant-revenue shock depends on how the shock affects the overall risk faced by the government. In a model in which the government can tax private income at any rate, Vegh and Vuletin (2015) show that the government's spending response to a permanent positive shock to grant revenue is larger, the weaker is the correlation between grant revenue and private income. The reason is that the shock increases the grant share of total income, which is assumed to be less than one half, diversifying the government's "portfolio."[31] The diversification effect is probably less relevant for Indonesia, where district governments cannot set tax rates on income and property. The central government sets and administers these taxes and rebates a portion back to the district. On average shared tax revenue accounts for only 11 percent of the district budget, and own-source revenue from business license fees, hotel and restaurant taxes, and utility fees accounts for nine percent of the budget. By contrast, grant revenue accounts for at least 71 percent of the district budget on average (World Bank, 2007, p. 120). In the Indonesian context a permanent increase in uncertain grant revenue may very

[30] That is, assuming the utility function has strictly positive third derivatives.

[31] The authors do not consider transitory shocks, though they claim that their main results would not change if shocks were assumed to be temporary.

well increase the total risk of public revenue, reducing the marginal propensity to spend out of public resources.

A.2 Details on the General Grant Reform

From 2002–2005 the expenditure-needs formula was

$$AvgExp \cdot (0.4 \cdot PopIndex_d + 0.1 \cdot PovGapIndex_d + 0.1 \cdot AreaIndex_d + 0.4 \cdot CostIndex_d),$$

where $AvgExp$ is average expenditure of all district governments, $PopIndex_d$ is the population of district d divided by average district population, and the other indices are defined analogously. Starting in 2006, the formula was

$$\begin{aligned} AvgExp \cdot (0.3 \cdot PopIndex_d + 0.1 \cdot 1/HDI_d + 0.15 \cdot GDPIndex_d \\ +0.15 \cdot AreaIndex_d + 0.3 \cdot CostIndex_d), \end{aligned}$$

where HDI stands for Human Development Index. The expenditure-needs formula changed in three ways. First, $AvgExp$ increased as a result of the budget expansion. Second, the poverty gap index was replaced by the (inverse of) the human development index and the regional GDP per capita index.[32] This change had little effect on equalization (World Bank, 2007). Third, the weights of the population, area, and cost indices changed. In particular, greater weight was giving to less densely populated districts. Rural districts tend to be poorer than urban districts in Indonesia. As a result, in 2006 the general grant increased for most districts, and the increase was much larger for poor, rural districts (World Bank, 2007). Furthermore, the policy change was persistent, as the expenditure-needs formula changed very little from 2006–2011 (Shah et al., 2012).[33] Holding fixed the Basic Allocation and Fiscal Capacity, the change in the per capita general grant allocation to district d from 2005 to 2006 is given by

$$\begin{aligned} \frac{GenGrant_{d,06}}{Pop_{d,06}} - \frac{GenGrant_{d,05}}{Pop_{d,05}} &= \left(0.3 \cdot \frac{AvgExp_{06}}{AvgPop_{06}} - 0.4 \cdot \frac{AvgExp_{05}}{AvgPop_{05}}\right) \\ &+ \left(0.15 \cdot \frac{AvgExp_{06}}{AvgArea} \cdot \frac{Area_d}{Pop_{d,06}} - 0.1 \cdot \frac{AvgExp_{05}}{AvgArea} \cdot \frac{Area_d}{Pop_{d,05}}\right) \\ &+ \left(0.3 \cdot \frac{AvgExp_{06}}{Pop_{d,06}} \cdot \frac{Cost_{d,06}}{AvgCost_{06}} - 0.4 \cdot \frac{AvgExp_{05}}{Pop_{d,05}} \cdot \frac{Cost_{d,05}}{AvgCost_{05}}\right) \\ &+ \left(0.1 \cdot \frac{AvgExp_{06}}{Pop_{d,06}} \cdot \frac{1}{HDI_{d,06}} + 0.15 \cdot \frac{AvgExp_{06}}{Pop_{d,06}} \cdot \frac{GDP_{d,06}}{AvgGDP_{06}} \right. \\ &\quad \left. - 0.1 \cdot \frac{AvgExp_{05}}{Pop_{d,05}} \cdot \frac{PovGap_{d,05}}{AvgPovGap_{05}}\right). \end{aligned}$$

[32] The latter index is the regional GDP per capita relative to the average district GDP per capita.

[33] In 2010 and 2011 the weight on the area index changed to 0.1325 and 0.135, respectively, and the weights on the inverse HDI index and the GDP index increased slightly.

A useful approximation to the above expression obtains under the assumption of zero district population growth, zero change in the relative cost of construction across districts, and zero change in the relative poverty gap across districts.[34] Under these assumptions, the change in per capita general grant allocation can be expressed in terms of the total general grant budgets in 2005 and 2006 and district characteristics measured in 2006:

$$\begin{aligned}\frac{GenGrant_{d,06}}{Pop_{d,06}} - \frac{GenGrant_{d,05}}{Pop_{d,05}} \approx & \frac{(0.3 \cdot AvgExp_{06} - 0.4 \cdot AvgExp_{05})}{AvgPop_{06}} \\ & + \frac{(0.15 \cdot AvgExp_{06} - 0.1 \cdot AvgExp_{05})}{AvgArea} \cdot \frac{Area_d}{Pop_{d,06}} \\ & + \frac{(0.3 \cdot AvgExp_{06} - 0.4 \cdot AvgExp_{05})}{Pop_{d,06}} \cdot \frac{Cost_{d,06}}{AvgCost_{06}} \\ & + \Bigg(0.1 \cdot \frac{AvgExp_{06}}{Pop_{d,06}} \cdot \frac{1}{HDI_{d,06}} + 0.15 \cdot \frac{AvgExp_{06}}{Pop_{d,06}} \cdot \frac{GDP_{d,06}}{AvgGDP_{06}} \\ & \quad - 0.1 \cdot \frac{AvgExp_{05}}{Pop_{d,06}} \cdot \frac{PovGap_{d,06}}{AvgPovGap_{06}}\Bigg).\end{aligned}$$

The second term on the right-hand side accounts for a large fraction of the cross-district variation in the general grant allocation change. The quantity $(0.15 \cdot AvgExp_{06} - 0.1 \cdot AvgExp_{05})$ is large and positive due to the overall general grant budget increase. This term is scaled by relative area per capita, $Area_d/(AvgArea \cdot Pop_{d,06})$. The change in general grant revenue received by district d from 2005 to 2006 can be approximated as

$$\frac{GenGrant_{d,06}}{Pop_{d,06}} - \frac{GenGrant_{d,05}}{Pop_{d,05}} \approx \theta + \pi \frac{Area_d}{Pop_{d,06}} + Remainder_d.$$

The above expression yields the approximate change in general grant revenue per capita for districts for which the reform to the expenditure-needs formula was binding. The formula dictated that districts rich in natural resources, which had substantial "fiscal capacity" according to the formula, should have experienced a decline in general grant revenue over this period. Instead, a hold-harmless provision froze the general grant amount for such districts over this period.

A.3 Magnitude of Grant Shocks

Figure A.4 displays histograms of the absolute two-year change in revenue for each of the two grants. I use two-year changes instead of one-year changes to account for the small amount of persistence in the oil and gas revenue shocks. The general grant shock is measured over the period 2005–2007, while the oil and gas revenue shock is measured over all two-year periods, starting with 2001–2003. Panel (a) shows the results for the entire sample of districts. Both

[34] District annual population growth averaged 1.3 percent over the sample period, and median annual population growth was 1.4 percent.

shocks are skewed to the right, and the skew is greater for the oil and gas revenue. The mean of the general grant shock (0.54) greatly exceeds the mean of the oil and gas revenue shock (0.07), which is unsurprising as only a small fraction of districts receive significant amounts of oil and gas revenue.

The empirical results will, to a great degree, reflect the responses of a subsample of districts that are highly exposed to the grant shocks. It is therefore useful to consider the distribution of grant shocks for these districts. Panel (b) displays the general grant shock histogram for districts exceeding the 75th percentile of land area per capita in 2006 and not located in oil-and-gas-rich provinces, as well as the oil and gas revenue shock histogram for districts exceeding the 95th percentile in oil and gas endowment. For these two subsamples, the mean of the general grant shock (1.11) is very similar to the mean of the oil and gas revenue shock (1.03). The confidence interval for the general grant shock even includes the mean of the oil and gas revenue shock. (Note, however, that the rightward skew is still greater for the oil and gas revenue shock.) Thus, the per-period value of shocks to the general grant and oil and gas revenue are reasonably similar for districts with significant exposure to the shocks.

A.4 Time-Series Properties of the Grants

Institutional details and graphical evidence indicate that over-time variation in the general grant is dominated by a single permanent shock, while over-time variation in the oil and gas revenue is dominated by transitory shocks. This subsection compares the time-series properties of the two grants in a more rigorous fashion by employing two quantitative measures: volatility and persistence.

First, I measure the volatility of each grant using the within-district coefficient of variation, defined as the within-district sample standard deviation divided by the overall sample mean.[35] The working hypothesis is that the oil and gas revenue is more volatile than the general grant. The within-district coefficient of variation of the oil and gas revenue (1.465) is 4.5 times greater than that of the general grant (0.317), confirming that the oil and gas revenue is significantly more volatile than the general grant.

Next, I estimate the persistence of each grant over time using autoregressions. In principle one could apply time-series estimators to aggregate values of the two grants. However, because the dataset contains few time periods (14 years) and many districts, a dynamic panel model is more appropriate. I specify the model

$$Grant_{dit} = \sum_{j=1}^{J} \alpha_j Grant_{di,t-j} + \eta_d + \psi_{it} + \nu_{dit} \tag{A.2}$$

[35]Formally, define the within-district sample variance as $\tilde{S}_x = \sum_d \sum_t (x_{dt} - \overline{x}_{d\cdot})^2/(N - D)$, where $\overline{x}_{d\cdot} = \sum_t x_{dt}/T_d$, T_d is the number of time periods observed for district d, $N = \sum_d T_d$ is the total number of observations, and D is the number of districts. Define the overall sample mean as $\overline{\overline{x}} = \sum_d \sum_t x_{dt}/N$. Then the within-district coefficient of variation is $\sqrt{\tilde{S}_x}/\overline{\overline{x}}$.

separately for each grant variable, where η_d is a district fixed effect and ψ_{it} is an island-by-year effect. The sum of the autoregressive coefficients, $\sum_{j=1}^{J} \alpha_j$, indicates the persistence of the process. The working hypothesis is that the general grant is more persistent than the oil and gas revenue.

Table A.1 presents estimates of the coefficients in equation (A.2) for $J = 1$ and $J = 3$. Panel A presents the results for the general grant, and Panel B presents the results for the oil and gas revenue. For both grants we reject the presence of a unit root.[36] Columns 1 and 2 report "OLS levels" estimates that account for island-by-year effects but do not account for district fixed effects. Estimated persistence is biased upwards due to the positive correlation between η_d and lags of $Grant$ (Bond, 2002). Therefore, one may view the estimates as an upper bound on the true persistence (asymptotically). Estimated persistence of the general grant ranges from 0.997 to 1.018, while estimated persistence of the oil and gas revenue ranges from 0.883 to 0.938. Thus, the general grant appears to be more persistent than the oil and gas revenue, however these estimates are likely to be substantially biased.

Columns 3 and 4 report the "within-groups" estimates—commonly called "fixed-effects" estimates—which account for island-by-year effects and district fixed effects. Estimated persistence is biased downwards due to the negative correlation between, e.g., the transformed $Grant_{di,t-1}$ and the transformed v_{dit} (Bond, 2002). This asymptotic bias is of order $1/T$, where T is the number of time periods, so the bias declines as the number of time periods grows (Nickell, 1981). Still, the bias is likely to be non-negligible with $T = 14$. Therefore, one may view the within-groups estimates as a lower bound on the true persistence (asymptotically). Estimated persistence of the general grant ranges from 0.537 to 0.569, and these estimates are quite precise. The persistence of the oil and gas revenue is lower, ranging from 0.067 to 0.237, where the former estimate is statistically indistinguishable from zero. Overall, the general grant appears to be much more persistent than the oil and gas revenue, according to the within-groups estimates, which are likely to be biased downwards for both grants.

Columns 5 and 6 present system GMM estimates, which deal with Nickell bias and are consistent as the number of districts grows and the number of time periods is fixed.[37] According to these estimates, the persistence of the general grant ranges from 0.934 to 0.958. The point estimates for the persistence of the oil and gas revenue are very small, albeit imprecise, ranging from 0.007 to 0.143. Thus, the GMM estimates of the persistence of the oil and gas revenue fall below the within-groups estimates, however both GMM estimates are very imprecise. While no single estimate of persistence in Table A.1 is without flaw, all three estimators point to the same conclusion: the general grant is more persistent than the oil and gas revenue.[38]

[36] This result is based on the unit-root test by Harris and Tzavalis (1999), which assumes persistence is the same across panels and is valid for a fixed number of time periods. We are also able to reject the presence of a unit root in expenditure. (Results available upon request.)

[37] System GMM was developed by Holtz-Eakin, Newey, and Rosen (1988), Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). I follow the recommendations of Roodman (2009) and Bazzi and Clemens (2013) and "collapse" the instrument matrix to avoid the problem of many weak instruments.

[38] One may also estimate an AR(1) model, $Y_t = \alpha + \beta Y_{t-1} + U_t$, where Y_t is average revenue per capita in year t.

How does the empirical persistence of the grants compare to the persistence of the theoretical grant revenue series presented in Section 2? The theoretical series that experienced the permanent shock has a persistence of one, and the theoretical series that experienced the transitory shock has a persistence of zero.[39] The results in Table A.1 indicate that the persistence of the general grant is below, and possibly close to, one. The results are less informative for the oil and gas revenue, due to the imprecision of the GMM estimates. Nonetheless, the downward-biased within-groups estimates indicate that the persistence of the oil and gas revenue is significantly greater than zero. The difference in the actual persistence of the two grants is not quite as stark as what was presented in the theoretical model. It would therefore be unsurprising if the difference in the responses to the two grants were slightly less stark than the predictions of the model.

The difference in persistence of the two grants is large in this model as well, with or without bias corrections for the small number of time periods. (These results are available upon request.)

[39]To see this, consider the model $Y_t = \alpha + \beta Y_{t-1} + U_t$ with $U_t = 0$ deterministically. Calculate $\beta = \text{Cov}(Y_t, Y_{t-1})/\text{V}(Y_{t-1})$ for two series, $Y_t' = (\ldots, 0, 0, 0, 1, 1, 1, \ldots)$ and $Y_t'' = (\ldots, 0, 0, 1, 0, 0 \ldots)$. It is straightforward to show that $\beta = 1$ for the first series and $\beta = 0$ for the second series.

A.5 Tables

Table A.1: Persistence of Grant Revenue over Time

Panel A: General Grant p.c.	OLS Levels		Within Groups		System GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
Lag 1	0.995***	0.864***	0.569***	0.512***	0.934***	0.365**
	(0.013)	(0.071)	(0.036)	(0.058)	(0.085)	(0.147)
Lag 2		0.101		0.013		0.577***
		(0.071)		(0.058)		(0.139)
Lag 3		0.051		0.011		0.017
		(0.083)		(0.061)		(0.077)
Persistence	0.995	1.016	0.569	0.536	0.934	0.959
	(0.013)	(0.013)	(0.036)	(0.056)	(0.085)	(0.027)
AR(2) test p-value					0.832	0.423
Observations	4,885	4,635	4,885	4,635	4,885	4,635
District clusters	372	372	372	372	372	372
Prov. × year clusters	384	384	384	384	384	384
p-value, H_0: unit root	0.000					
Within coef. of var.	0.318					

Panel B: Oil & Gas Revenue p.c.	OLS Levels		Within Groups		System GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
Lag 1	0.883***	0.591***	0.238***	0.224***	0.176	−0.047
	(0.040)	(0.094)	(0.079)	(0.066)	(0.627)	(0.491)
Lag 2		0.203**		−0.027		0.201
		(0.097)		(0.105)		(0.293)
Lag 3		0.144		−0.128		−0.188
		(0.099)		(0.087)		(0.360)
Persistence	0.883	0.938	0.238	0.069	0.176	−0.033
	(0.040)	(0.061)	(0.079)	(0.181)	(0.627)	(0.843)
AR(2) test p-value					0.995	0.984
Observations	4,885	4,635	4,885	4,635	4,885	4,635
District clusters	372	372	372	372	372	372
Prov. × year clusters	384	384	384	384	384	384
p-value, H_0: unit root	0.000					
Within coef. of var.	1.468					

Notes. This table shows results from regressing each grant variable on its lags. Panel A presents results for the general grant, and Panel B presents results for oil and gas revenue. Each regression includes a full set of island × year dummies. Columns 1 and 2 present pooled OLS estimates which do not account for district fixed effects. Columns 3 and 4 present "within groups" (or "fixed-effects") estimates which account for district fixed effects. Columns 5 and 6 present system GMM estimates which account for district fixed effects and dynamic panel bias. "Persistence" is defined as the sum of the lag coefficients. The AR(2) test p-value corresponds to the null hypothesis of zero serial correlation in the error term. Each panel reports the result of the Harris and Tzavalis (1999) unit-root test, as well as the "within" coefficient of variation, defined as the within-district sample standard deviation divided by the sample mean. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Expenditure Responses by Economic Classification (OLS)

	Cumulative Response: Expenditure per Capita				
	(1) Total	(2) Capital	(3) Goods & Services	(4) Personnel	(5) Other
General Grant p.c.					
0 Years later	0.89***	0.37***	0.11**	0.31***	0.04
	(0.12)	(0.10)	(0.05)	(0.06)	(0.03)
1 Year later	0.85***	0.35***	0.18***	0.39***	−0.09
	(0.17)	(0.10)	(0.04)	(0.07)	(0.07)
2 Years later	1.19***	0.65***	0.11	0.39***	−0.05
	(0.24)	(0.12)	(0.08)	(0.07)	(0.04)
3 Years later	0.93***	0.40***	0.11	0.46***	−0.05
	(0.21)	(0.11)	(0.07)	(0.09)	(0.05)
Oil & Gas Revenue p.c.					
0 Years later	0.48**	0.20***	0.10	0.08	0.10*
	(0.22)	(0.05)	(0.09)	(0.07)	(0.05)
1 Year later	0.92***	0.24***	0.24***	0.22***	0.16
	(0.27)	(0.05)	(0.08)	(0.08)	(0.10)
2 Years later	1.45***	0.40***	0.31***	0.31***	0.28*
	(0.29)	(0.06)	(0.11)	(0.09)	(0.15)
3 Years later	1.61***	0.41***	0.40***	0.43***	0.31**
	(0.38)	(0.07)	(0.15)	(0.08)	(0.15)
Test: Equal responses, 0 years	0.162	0.050	0.910	0.018	0.404
Test: Equal responses, 1 year	0.856	0.285	0.528	0.200	0.045
Test: Equal responses, 2 years	0.543	0.027	0.181	0.522	0.048
Test: Equal responses, 3 years	0.208	0.930	0.117	0.796	0.043
Test: Equal responses, all years	0.000	0.000	0.000	0.004	0.168
Observations	3,590	3,630	3,630	3,640	3,596
District clusters	372	372	372	372	372
Prov. × year clusters	306	306	306	306	306

Notes. This table reports OLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: Expenditure Responses by Function (OLS)

	Cumulative Response: Expenditure per Capita				
	(1) Education	(2) Administration	(3) Infrastructure	(4) Health	(5) Agriculture
General Grant p.c.					
0 Years later	0.17***	0.16	0.36***	0.06***	0.04***
	(0.05)	(0.12)	(0.12)	(0.02)	(0.01)
1 Year later	0.26***	0.25**	0.52***	0.11***	0.08***
	(0.05)	(0.12)	(0.13)	(0.02)	(0.01)
2 Years later	0.27***	0.28**	0.55***	0.08***	0.08***
	(0.04)	(0.13)	(0.12)	(0.03)	(0.02)
3 Years later	0.29***	0.21*	0.48***	0.09***	0.07***
	(0.06)	(0.12)	(0.13)	(0.03)	(0.02)
Oil & Gas Revenue p.c.					
0 Years later	0.08**	0.27*	0.21**	0.03	0.02*
	(0.04)	(0.15)	(0.10)	(0.03)	(0.01)
1 Year later	0.15**	0.34	0.45***	0.06	0.05***
	(0.07)	(0.26)	(0.13)	(0.05)	(0.01)
2 Years later	0.28***	0.46	0.65***	0.09	0.06**
	(0.07)	(0.34)	(0.11)	(0.07)	(0.03)
3 Years later	0.39***	0.81*	0.94***	0.13	0.09***
	(0.09)	(0.45)	(0.15)	(0.09)	(0.03)
Test: Equal responses, 0 years	0.149	0.470	0.026	0.459	0.256
Test: Equal responses, 1 year	0.318	0.771	0.372	0.464	0.098
Test: Equal responses, 2 years	0.870	0.661	0.455	0.894	0.432
Test: Equal responses, 3 years	0.452	0.255	0.000	0.690	0.663
Test: Equal responses, all years	0.000	0.000	0.000	0.001	0.002
Observations	2,893	2,948	2,893	2,892	2,879
District clusters	372	372	372	372	372
Prov. × year clusters	249	249	249	249	249

Notes. This table reports OLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: Expenditure Share Responses by Economic Classification (OLS)

	Cumulative Response: Expenditure Share (%)			
	(1) Capital	(2) Goods & Services	(3) Personnel	(4) Other
General Grant p.c.				
0 Years later	0.01	−0.77*	0.25	0.02
	(0.82)	(0.42)	(0.73)	(0.42)
1 Year later	−0.15	0.11	0.31	−0.90*
	(1.01)	(0.46)	(0.90)	(0.48)
2 Years later	1.18	−1.28**	0.28	−1.34**
	(1.14)	(0.57)	(1.06)	(0.52)
3 Years later	−0.28	−0.24	0.96	−0.35
	(1.30)	(0.59)	(1.02)	(0.62)
Oil & Gas Revenue p.c.				
0 Years later	0.64	−0.56	0.05	0.07
	(0.57)	(0.35)	(0.48)	(0.18)
1 Year later	−1.55**	0.05	1.00	0.09
	(0.67)	(0.29)	(0.64)	(0.34)
2 Years later	−2.09**	−0.05	0.92	0.73
	(1.02)	(0.38)	(1.01)	(0.56)
3 Years later	−2.68**	0.50	1.18	1.10**
	(1.10)	(0.45)	(1.32)	(0.50)
Test: Equal responses, 0 years	0.519	0.701	0.812	0.912
Test: Equal responses, 1 year	0.216	0.916	0.516	0.099
Test: Equal responses, 2 years	0.016	0.060	0.611	0.005
Test: Equal responses, 3 years	0.106	0.207	0.877	0.019
Test: Equal responses, all years	0.029	0.107	0.880	0.077
Observations	3,577	3,576	3,586	3,542
District clusters	372	372	372	372
Prov. × year clusters	306	306	306	306

Notes. This table reports OLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Expenditure Share Responses by Function (OLS)

	Cumulative Response: Expenditure Share (%)				
	(1) Education	(2) Administration	(3) Infrastructure	(4) Health	(5) Agriculture
General Grant p.c.					
0 Years later	−0.01	−2.62**	1.72*	−0.52**	−0.05
	(0.63)	(1.27)	(0.92)	(0.25)	(0.18)
1 Year later	1.45*	−2.58*	2.02*	0.02	0.05
	(0.84)	(1.57)	(1.03)	(0.29)	(0.22)
2 Years later	1.04	−1.08	1.44	−0.03	0.03
	(0.89)	(1.61)	(1.32)	(0.36)	(0.22)
3 Years later	0.20	−0.06	2.01	−0.17	0.06
	(0.80)	(1.63)	(1.36)	(0.35)	(0.19)
Oil & Gas Revenue p.c.					
0 Years later	0.12	−0.10	−0.28	−0.25**	−0.04
	(0.41)	(0.55)	(0.84)	(0.11)	(0.07)
1 Year later	0.91	−0.08	−0.27	−0.18	−0.02
	(0.92)	(0.87)	(1.13)	(0.25)	(0.10)
2 Years later	1.42	−1.20	0.38	−0.40	−0.07
	(1.12)	(1.78)	(1.95)	(0.39)	(0.20)
3 Years later	1.59	−0.05	1.83	−0.43	−0.00
	(1.71)	(1.93)	(2.02)	(0.44)	(0.22)
Test: Equal responses, 0 years	0.831	0.088	0.092	0.309	0.962
Test: Equal responses, 1 year	0.608	0.156	0.171	0.600	0.750
Test: Equal responses, 2 years	0.768	0.966	0.702	0.488	0.649
Test: Equal responses, 3 years	0.422	0.995	0.950	0.598	0.794
Test: Equal responses, all years	0.640	0.194	0.045	0.346	0.982
Observations	2,680	2,735	2,680	2,679	2,666
District clusters	372	372	372	372	372
Prov. × year clusters	249	249	249	249	249

Notes. This table reports OLS estimates of the cumulative spending responses after S years, derived from (2), to the general grant ($\sum_{k=0}^{S} \beta_k$) and oil and gas revenue ($\sum_{k=0}^{S} \delta_k$). Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Flypaper Effect

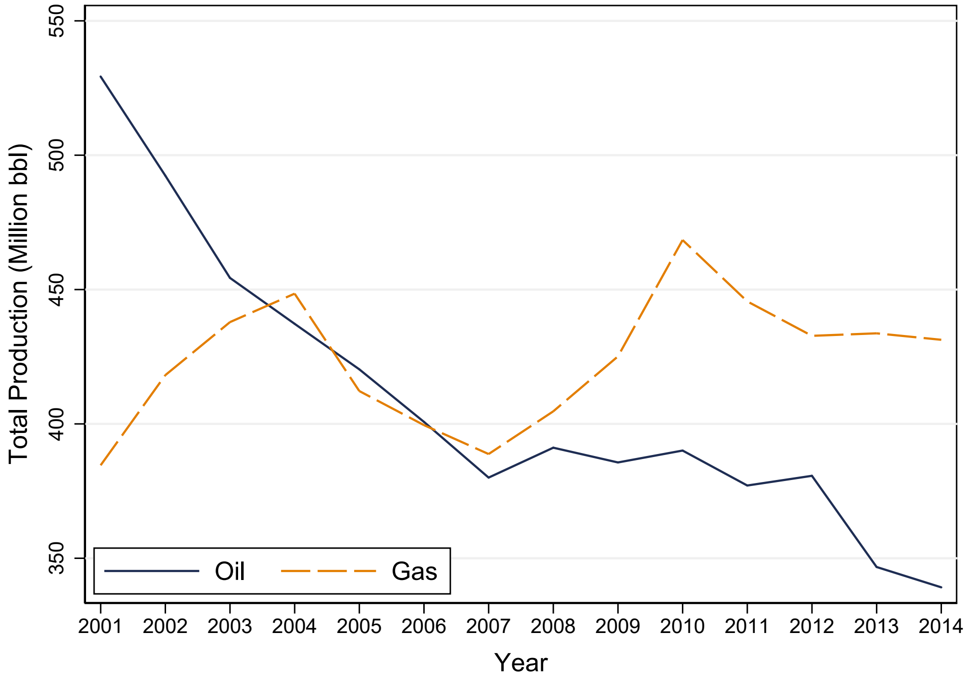
	Total Expenditure per Capita	
	(1) OLS	(2) 2SLS
General Grant p.c.	0.808***	0.397
	(0.193)	(2.451)
Lag 1	0.271	0.847
	(0.184)	(2.106)
Lag 2	0.179	0.569
	(0.268)	(0.713)
Lag 3	−0.214	−0.432
	(0.242)	(0.350)
Oil & Gas Revenue p.c.	0.640***	0.359**
	(0.207)	(0.167)
Lag 1	0.578***	0.571
	(0.179)	(0.665)
Lag 2	0.538***	0.344
	(0.206)	(0.501)
Lag 3	0.379***	0.149
	(0.119)	(0.180)
Non-Oil/Gas GDP p.c.	0.005	0.012
	(0.006)	(0.021)
Lag 1	0.002	−0.006
	(0.006)	(0.023)
Lag 2	0.000	−0.004
	(0.006)	(0.018)
Lag 3	0.001	0.006
	(0.008)	(0.013)
Oil/Gas GDP p.c.	0.010**	0.007*
	(0.004)	(0.004)
Lag 1	−0.018***	−0.017**
	(0.005)	(0.008)
Lag 2	0.001	0.004
	(0.002)	(0.003)
Lag 3	−0.001	0.000
	(0.004)	(0.006)
Coef. sum: General Grant p.c.	1.044	1.381
	(0.196)	(0.898)
Coef. sum: Oil & Gas Revenue p.c.	2.135	1.423
	(0.526)	(0.663)
Coef. sum: Non-Oil/Gas GDP p.c.	0.009	0.008
	(0.008)	(0.009)
Coef. sum: Oil/Gas GDP p.c.	−0.008	−0.006
	(0.005)	(0.009)
Test: equal sums, Gen. Grant & Non-Oil/Gas GDP	0.000	0.127
Test: equal sums, Gen. Grant & Oil/Gas GDP	0.000	0.128
Test: equal sums, Oil & Gas Rev. & Non-Oil/Gas GDP	0.000	0.032
Test: equal sums, Oil & Gas Rev. & Oil/Gas GDP	0.000	0.031
Observations	3,214	3,214
District clusters	372	372
Prov. × year clusters	278	278

Notes. Each regression includes a full set of district and island × year dummies. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province × year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

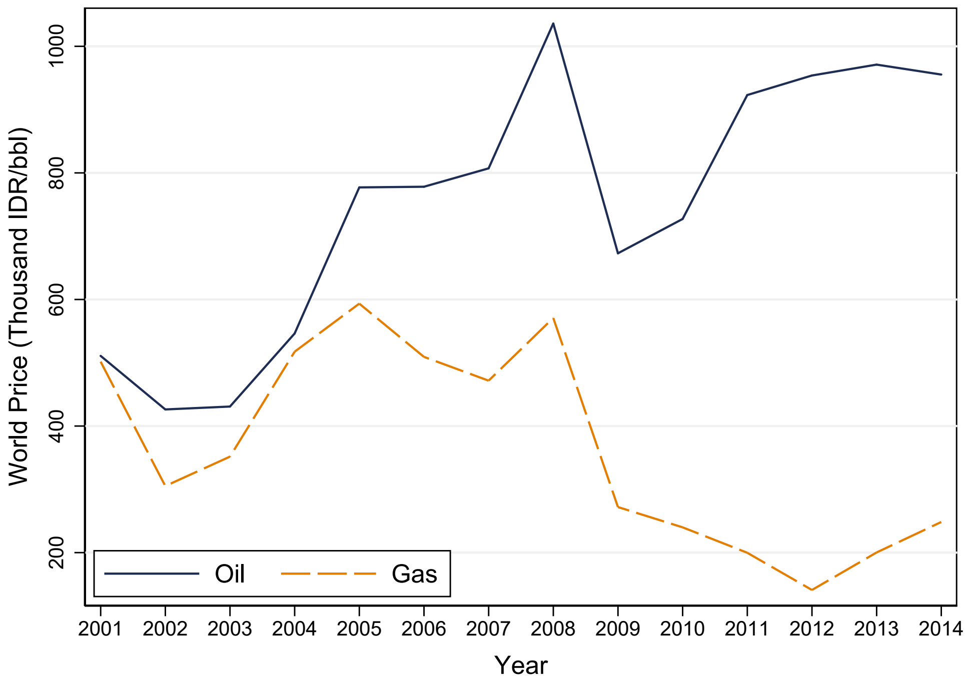
A.6 Figures

Figure A.1: Oil and Gas Production and Prices

(a) Total Oil and Gas Production



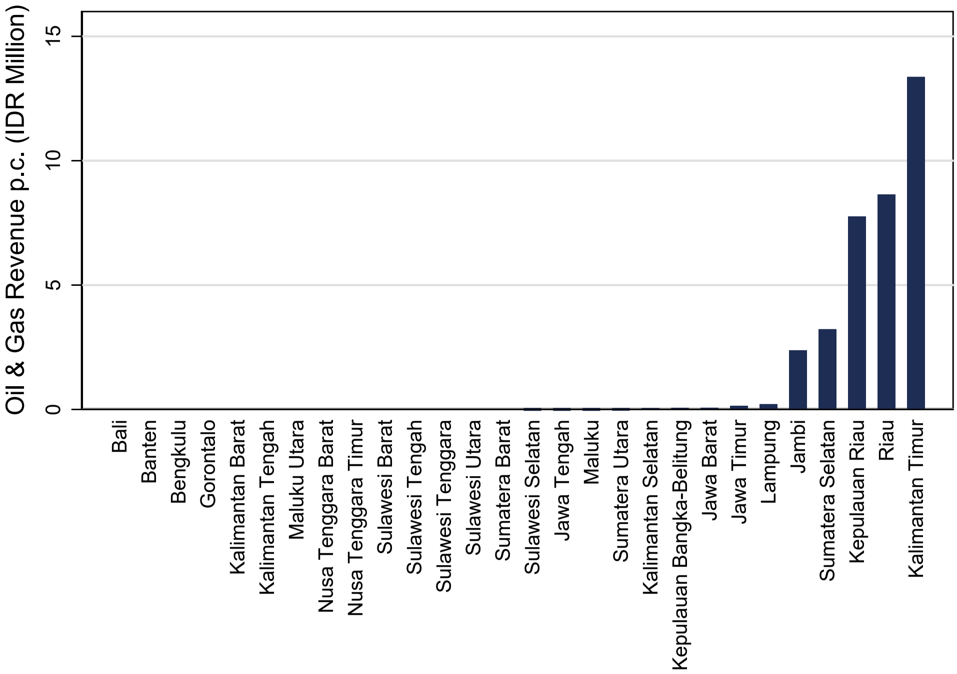
(b) World Oil and Gas Prices



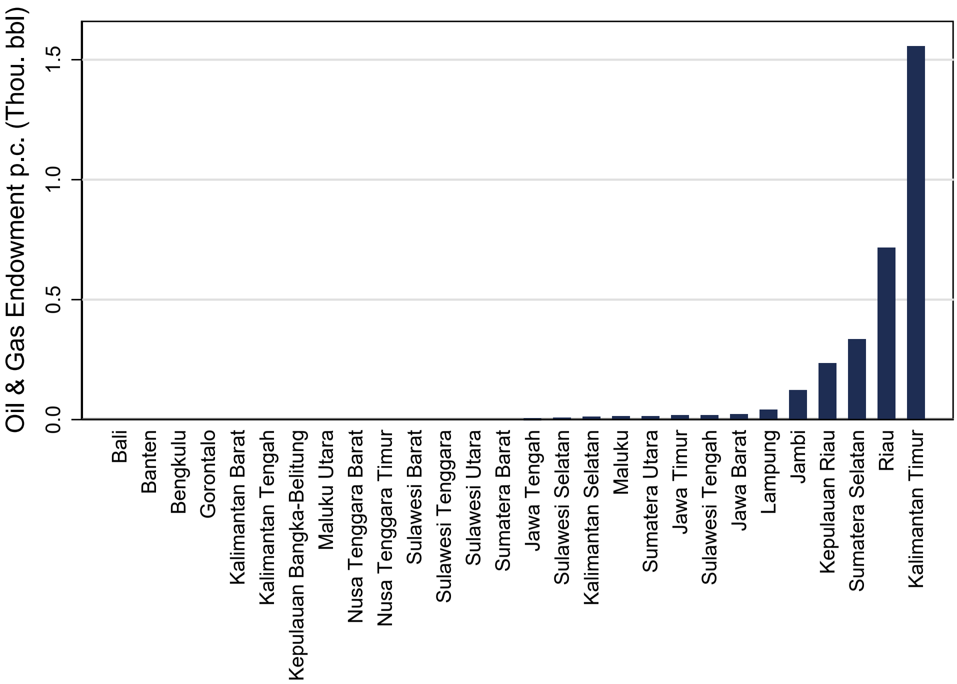
Notes. Panel (a) plots total production of oil (solid line) and gas (dashed line) in barrels of oil equivalent (millions). Panel (b) plots the Brent oil price (solid line) and the Nymex gas price (dashed line) in constant 2010 IDR (thousands) per barrel of oil equivalent.

Figure A.2: Shared Oil and Gas Revenue and Endowment per Capita by Province, 2014 Borders

(a) Shared Oil and Gas Revenue per Capita by Province, 2014



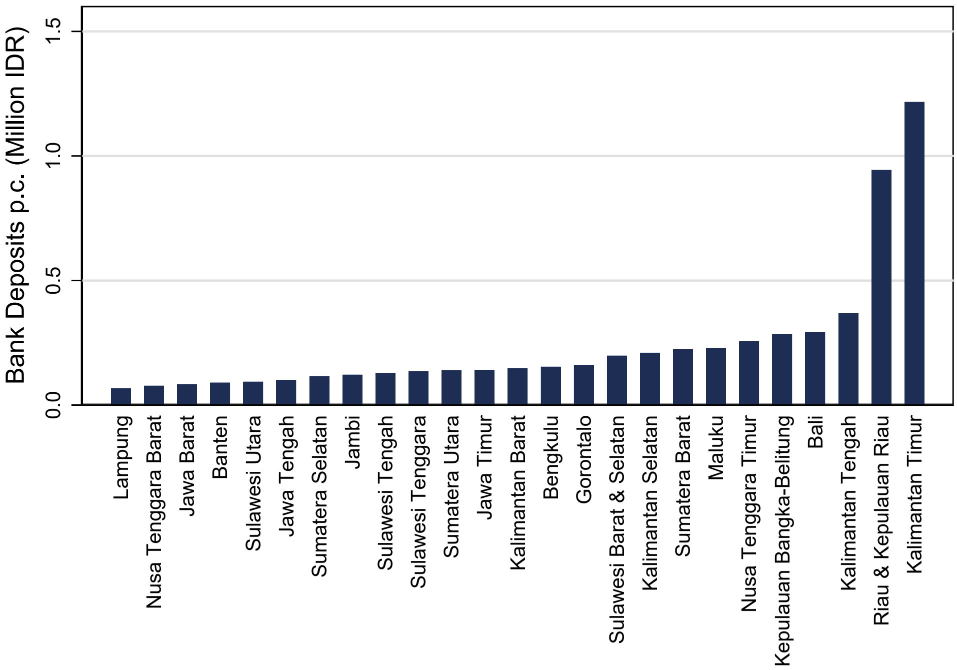
(b) Oil and Gas Endowment per Capita by Province



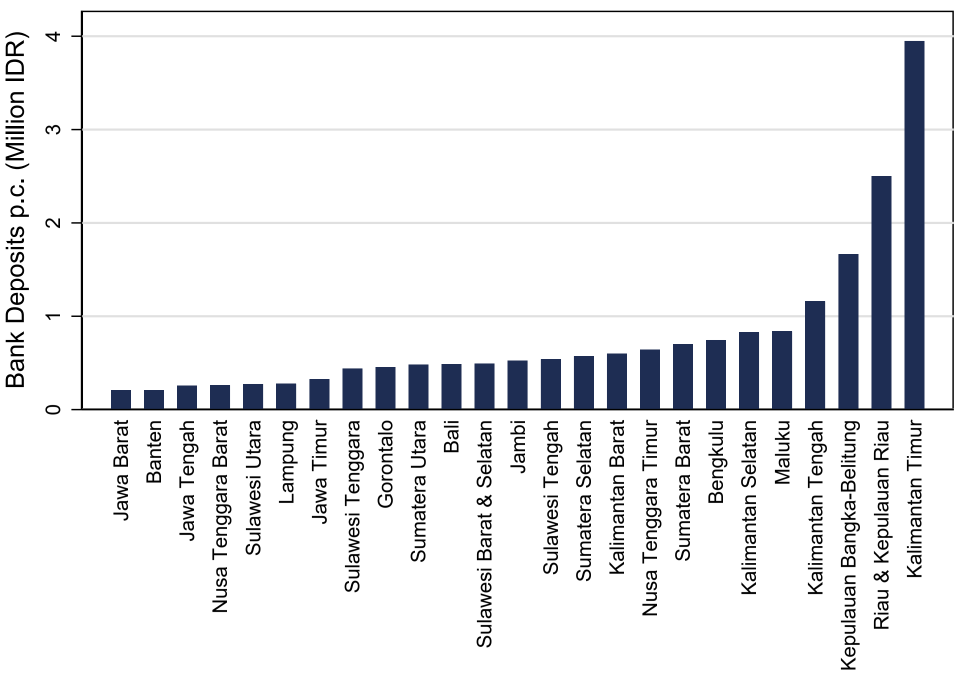
Notes. Panel (a) shows the total shared oil and gas revenue per capita by province in 2014. Revenue is expressed in constant 2010 IDR (millions). Panel (b) shows the oil and gas endowment per capita for each province known as of the year 2000 based on 2014 borders and population. Oil and gas endowment per capita is expressed in thousands of barrels of oil equivalent per capita. In both panels Kalimantan Utara is combined with its parent province, Kalimantan Timur, consistent with the national government's revenue-sharing policy through 2014.

Figure A.3: Outstanding Commercial Bank Deposits Owned by District Government

(a) 2002



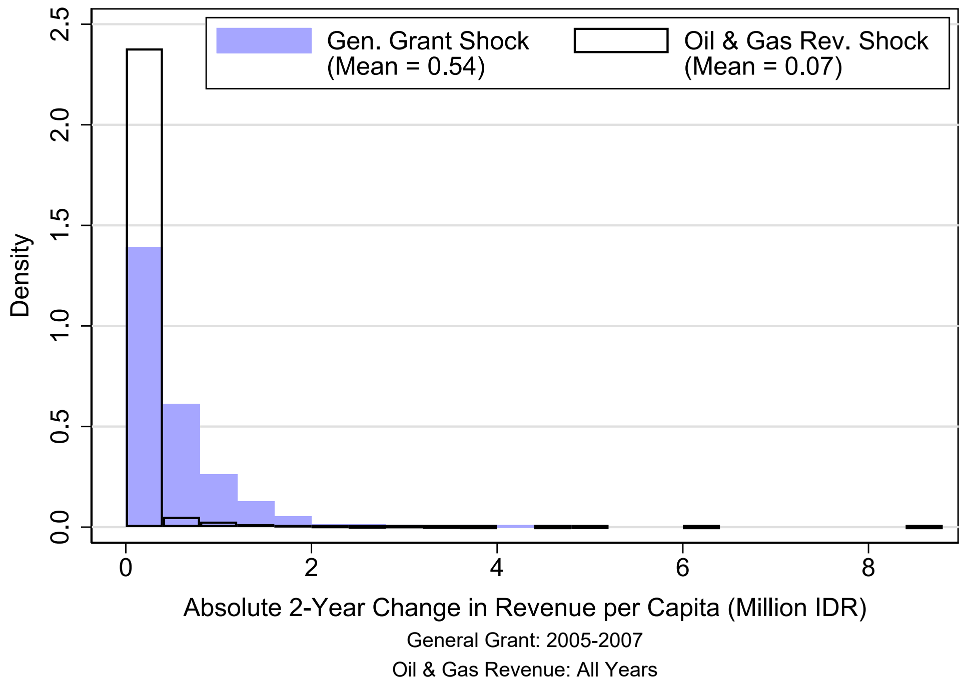
(b) 2006



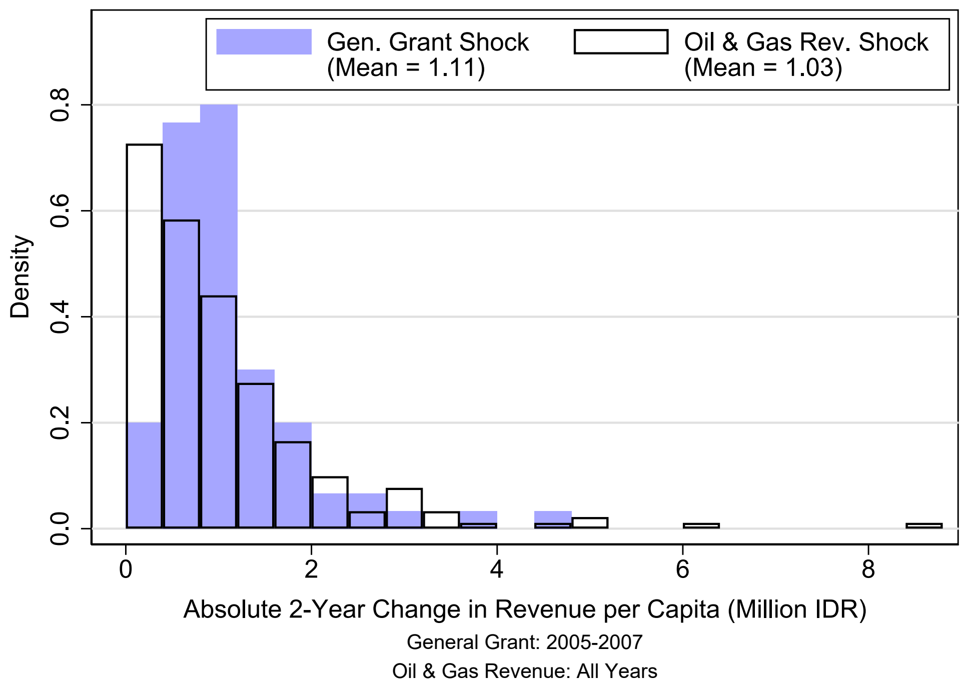
Notes. This figure shows the outstanding commercial bank deposits per capita owned by district governments, expressed in constant 2010 IDR (millions) and aggregated by province. Panel (a) shows deposits in 2002, and Panel (b) shows deposits in 2006.

Figure A.4: Distribution of Grant-Revenue Shocks

(a) All Districts

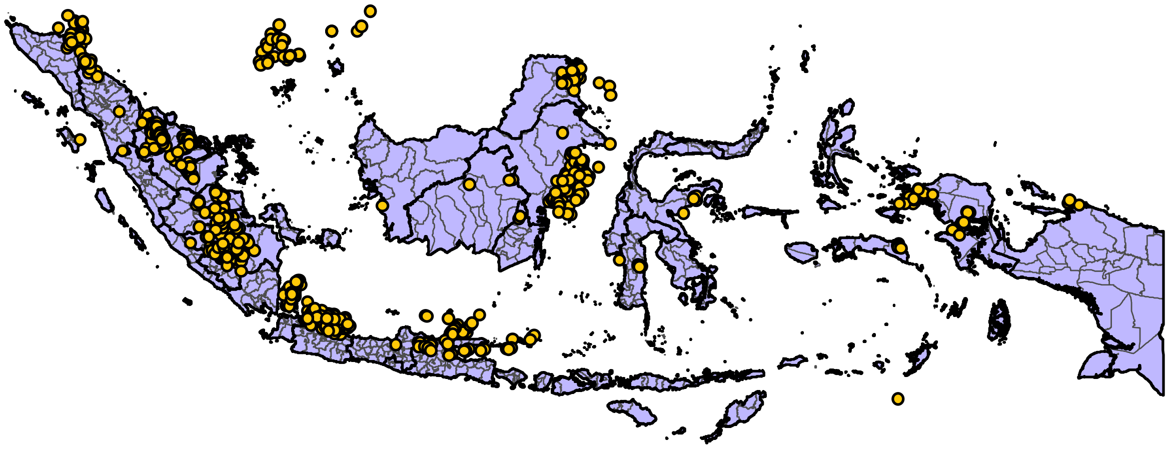


(b) Districts with High Exposure to Grant Shocks



Notes. Each panel displays two histograms of the absolute two-year change in grant revenue: one for the general grant over the period 2005–2007, and another for the oil and gas revenue over all years. Panel (a) uses the entire sample of districts, and Panel (b) uses the subsample of districts that were highly exposed to the grant shocks. The general grant histogram in Panel (b) is for districts exceeding the 75th percentile of land area per capita in 2006 and not located in oil-and-gas-rich provinces. The oil and gas revenue histogram in Panel (b) is for districts exceeding the 95th percentile in oil and gas endowment. Revenue is expressed in constant 2010 IDR per capita (millions).

Figure A.5: Oil and Gas Fields of Indonesia



Notes. Thin gray lines indicate district borders, thick black lines indicate province borders, and yellow dots indicate oil and gas fields. Data on oil and gas fields come from Rystad Energy.