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Abstract

I exploit unusual policy variation in Indonesia to examine how local responses to intergovernmental grants depend on their persistence. A national reform produced permanent increases in the general grant that were larger for less densely populated districts. Hydrocarbon-rich districts experienced transitory shocks to shared resource revenue. Public service delivery strongly responded to the permanent shock, but not to the transitory shocks, consistent with districts providing lumpy public services as a function of lifetime fiscal resources. I provide supporting evidence for this mechanism and rule out other potential mechanisms. I discuss implications for decentralization policy and research on taxation and accountability.

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1 Introduction

> *Citizens perceive the granting of intergovernmental fiscal transfers as the magical art of passing money from one government to another and seeing it vanish into thin air. These perceptions are well grounded in reality in developing countries . . .* (Shah, 2006, p. 17)

Intergovernmental transfers play an outsized role in local public finance in developing countries, yet many policymakers and academics are skeptical that increasing transfers to local governments will improve public service delivery. Supporting this skepticism are well-documented cases of local officials misappropriating funds from the center (e.g., Reinikka and Svensson, 2004; Olken, 2007; Ferraz and Finan, 2008, 2011) and studies showing that transfers reduce the quality of governance and fail to stimulate greater public good provision in Latin America.[1] The debate is far from over, however. Measurement issues make it difficult to prove that funds have not been put to good use,[2] and some studies have found positive impacts on public service delivery (Litschig and Morrison, 2013; Olsson and Valsecchi, 2015).

This paper identifies and addresses a novel empirical challenge: when local governments are forward-looking, the responses of public services to transitory changes in fiscal transfers do not reflect the true contribution of these funds to public service delivery. Governments that optimize intertemporally recognize that transitory changes in volatile transfers, such as shared natural resource revenue, have a relatively small impact on the intertemporal budget constraint. Increases in this type of transfer thus may not stimulate investment in new structures or hiring of frontline workers. Researchers may then mistakenly conclude that the funds are wasted or stolen, even when local officials are scrupulous. On the other hand, responses to permanent changes in transfers are highly informative for the marginal contribution of these funds to public service delivery.

I exploit unusual policy variation in Indonesia to study local government responses to two intergovernmental transfers of varying persistence. District governments are responsible for providing public goods and services in the areas of education, health, and local infrastructure, which are primarily financed by fiscal transfers. The country's largest intergovernmental transfer, the general grant, is highly persistent. A change in the allocation formula in 2006 resulted in permanent increases in this grant that were larger for less densely populated districts. I exploit the sharp increase in the revenue gradient in land area per capita to estimate the causal effects of a *permanent* increase in fiscal transfers. The second-largest transfer is the oil and gas grant, which is tied to local hydrocarbon extraction and exhibits

[1] See Caselli and Michaels (2013), Brollo et al. (2013), Monteiro and Ferraz (2014), and Gadenne (2017) on Brazil, and see Martínez (2020) on Colombia.

[2] Local governments can spend funds on a variety of projects and can invest in quality improvements that are not captured in available datasets. Some researchers have confronted these challenges by using detailed data on a wide array of public goods and services, and by examining outcomes, such as education or income, that should respond to quality improvements (e.g., Caselli and Michaels, 2013; Litschig and Morrison, 2013).

significant transitory variation in hydrocarbon-rich areas. I exploit the central government's royalty-sharing rule, spatial variation in initial hydrocarbon endowments, and time-series variation in aggregate revenue from this grant to estimate the causal effects of *transitory* shocks to fiscal transfers.

The permanent increase in the general grant stimulated greater provision of public schools, health facilities and personnel, and local roads. Increasing the grant by IDR 1 million (approximately USD 100) per capita improved overall public service delivery by half a standard deviation, relative to pre-reform levels. By contrast, transitory shocks to the oil and gas grant had small and statistically insignificant effects, and the estimates are precise enough to rule out moderate increases in public service delivery. For most outcomes we can statistically reject equal responses to the two grants, even after adjusting for multiple hypothesis testing.

The results are consistent with a model in which local governments provide lumpy public goods and services as a function of lifetime fiscal resources. The mean-reverting nature of the oil and gas grant implies that current-year changes have a small impact on lifetime resources. Even if the government has a high discount rate, it will be hesitant to increase spending on structures such as schools, which require a large upfront investment and a future stream of maintenance expenditure, or on employees that enjoy significant job security, when oil and gas revenue increases. Holding fixed the size of the initial shock, more persistent increases in revenue are more likely to stimulate greater investment and hiring of frontline workers.

Supporting this mechanism, the expenditure response to the general grant is hump-shaped over time and overshoots at its peak, increasing by about 1.60 rupiah for every rupiah of revenue, indicating large upfront investments. Hydrocarbon-rich districts do not perfectly smooth their spending, but the expenditure response to the oil and gas grant is around one third of the response to the general grant. Furthermore, the gap in the responses is smaller for more discretionary and less lumpy categories of spending, and larger for capital and personnel expenditure.

I consider other potential mechanisms. One possibility is that the magnitude of the grant shocks differ, and responses are nonlinear in the size of the current-year shock. Another possibility is that districts respond asymmetrically to increases and decreases in transfers. I test for these two mechanisms and find little evidence that they drive the results. I also show that the results are not driven by changes in political competition or differential pretrends.

Alternatively, the oil and gas grant may be more susceptible to waste or embezzlement, even though the grants are formally subject to the same rules and oversight by the central government. If this were true, then permanent increases in the oil and gas grant should stimulate public service delivery much less than permanent increases in the general grant. I test this hypothesis by exploiting the increase in permanent oil and gas grant revenue induced by Indonesia's decentralization in 2001. Using this source of variation, I find economically and statistically significant increases in public service delivery that are in the same ballpark as the increases induced by the general grant. Although waste and corruption are common in district governance, they cannot explain a significant portion of the *difference* in the responses to the two grants over the post-decentralization period.

Besides unique policy variation, the Indonesian setting offers additional advantages. First, there are a large number of district governments—over 300—with broad spending authority in the areas of education, health, and infrastructure. Second, districts had no control over income taxes and little control over property taxes during the study period. This virtually eliminates an important margin of response to revenue shocks—tax cuts—and enables the analysis to isolate the decision of how much to spend rather than save, and when to spend. Third, rich data on district fiscal outcomes and public service delivery over 1996–2014 make it possible to examine dynamic responses to fiscal transfers along many margins.

The results are informative for decentralization policy around the world. International organizations have pushed for greater fiscal decentralization in the developing world (World Bank, 1999; United Nations, 2009), but central governments have generally been hesitant to devolve tax responsibilities to local governments. Consequently, intergovernmental grants finance around 60 percent of subnational expenditure in developing countries but only around a third of subnational expenditure in OECD countries (Shah, 2006). An important question is whether central governments in developing countries should cede more tax authority to subnational governments to strengthen tax-benefit linkages (Gadenne and Singhal, 2014). Knowing how effective fiscal transfers are at achieving their objectives, and what type of variation in transfers can yield this information, is crucial in this debate.

This paper contributes to multiple literatures in development and public finance. First, it contributes to the literature that examines whether intergovernmental transfers actually improve public service delivery. As already mentioned, the evidence in this literature is mixed.[3] Motivated by the disappointing performance of some fiscal transfer programs, Gadenne (2017) and Martínez (2020) examine whether increases in local tax revenue lead to better outcomes than increases in transfers in Brazil and Colombia, respectively. Both studies conclude that tax revenue stimulates improvements in public service delivery, but transfers do not, arguing that citizens hold politicians accountable for how they spend tax revenue.[4] These studies do not report the persistence of the revenue shocks used for causal identification, which cannot be summarized by simple measures like the within-unit coefficient of variation. Consequently, it is difficult to know whether taxes and transfers have different effects due to differences in accountability or persistence.

Second, this paper is related to research on the so-called flypaper effect, the empirical

[3] Caselli and Michaels (2013) and Monteiro and Ferraz (2014) find that shared oil and gas revenue caused declines in public service delivery in Brazilian municipalities. However, Litschig and Morrison (2013) show that in an earlier period in Brazil, a formula-based, general-purpose transfer improved education outcomes. Olsson and Valsecchi (2015) provide earlier evidence that Indonesia's oil and gas grant improved public service delivery using a shorter panel and a different empirical strategy.

[4] See also Borge et al. (2015).

regularity that local governments have a greater propensity to spend out of non-matching grants than out of local private income.[5] This research seeks to determine how much grant revenue is spent, and how much is passed on to citizens in the form of lower taxes. By contrast, I focus on how the expenditure response depends on the persistence of the grant, in a setting where local governments have little control over tax rates. Recent work typically exploits a single exogenous shock to local revenue that is either transitory (e.g., Leduc and Wilson, 2017; Solé-Ollé and Viladecans-Marsal, 2019) or permanent (e.g., Helm and Stuhler, 2021). To the best of my knowledge, the only other paper that compares fiscal responses to two grants with differing persistence is Besfamille et al. (2021), who find qualitatively similar results using data on Argentinian provinces.

Finally, this research contributes to the literature on the resource curse (van der Ploeg, 2011). One concern in this literature is that the volatility and sheer size of resource-related fiscal transfers will lead to wasteful and volatile local spending (Cust and Viale, 2016; Natural Resource Governance Institute, 2016). If this concern is well founded, then central governments should consider smoothing revenue on behalf of local governments and distributing the funds from resource extraction more evenly across regions. I contribute to this debate by showing that in the context of Indonesia, natural resource revenue and less volatile general-purpose grants promote public service delivery to a similar degree, after properly accounting for the persistence of revenue shocks. Local governments thus seem capable of managing the volatility of natural resource revenue.

The rest of the paper proceeds as follows. Section 2 provides background information on institutions and local public finance in Indonesia following the transition to democracy. Section 3 presents a theoretical model of public expenditure on nondurable and lumpy durable goods in order to highlight how responses can depend on grant persistence and to generate testable predictions. Section 4 discusses the fiscal responses of districts to the two grants, and Section 5 discusses the impacts on public service delivery. Section 6 provides concluding remarks.

2 Decentralization in Indonesia

2.1 Institutional Background

The economic fallout from the 1997 Asian financial crisis led to widespread political protests in Indonesia and ultimately resulted in the resignation of Suharto as president in May of 1998. Suharto's ouster marked the end of three decades of highly centralized, authoritarian rule and gave way to democratic reforms and fiscal decentralization. In 1999 democratic elections

[5] See Hines and Thaler (1995) and Inman (2008) for summaries of the literature. Recent contributions include Knight (2002), Gordon (2004), Baicker (2005), Dahlberg et al. (2008), Lutz (2010), Cascio et al. (2013), Gennari and Messina (2014), Vegh and Vuletin (2015), Lundqvist (2015), Dahlby and Ferede (2016), Liu and Ma (2016), Leduc and Wilson (2017), and Helm and Stuhler (2021).

were held at the national and subnational levels, and the central government passed a law that would devolve significant autonomy and fiscal resources to subnational governments starting in 2001 (Law 22/1999).

There are four levels of subnational public administration in Indonesia: province, district, subdistrict, and village. Districts are responsible for the bulk of subnational policymaking; provinces mostly play a coordinating role, and subdistricts (*kecamatan*) carry out district policies. Districts are categorized as either rural districts (*kabupaten*) or urban districts (*kota*), but both types operate under the same political and fiscal institutions. The central government empowered districts, rather than provinces, in part because it feared that some provinces would attempt to secede if given autonomy. Indeed, Timor-Leste achieved independence in 1999, and secessionist sentiment was strong in other peripheral regions of the country. Empowering the smaller districts made coordination more difficult for would-be secessionists. As, Shah et al. (2006) note, "Strengthening local governments would facilitate strengthening political and economic union while addressing long-felt local grievances (p. 235)."

Starting in 1999, district parliaments were directly 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 the local parliament appointed the mayor. Starting in 2005, voters selected the mayor by direct election. Incumbent mayors were allowed to finish their terms before direct elections could be held, resulting in a staggered rollout of direct elections across districts from 2005 to 2008. Mayors can serve at most two five-year terms.

The "Big Bang" decentralization reforms of 2001 devolved significant expenditure authority to districts, so that Indonesia now ranks as one of the most decentralized countries in the developing world (Shah et al., 2012). Panel A of Appendix Table A.1 summarizes district revenue and expenditure. Districts provide public goods and services in the areas of education, health, and local infrastructure. However, own-source revenue accounts for only seven percent of total district revenue, so public expenditure is primarily financed by intergovernmental grants.[6] Most local funding comes from an unconditional, non-matching transfer known as the general grant (*Dana Alokasi Umum*), which accounts for over half of district revenue on average. A minority of districts receive significant revenue from local natural resource extraction. I discuss these two revenue sources in detail ahead. A small portion of expenditure is financed by conditional, matching transfers known as special allocation grants (*Dana Alokasi Khusus*) provided by the central government on a discretionary basis.

Districts are prohibited from introducing income taxes—individual or corporate—which are solely within the purview of the central government. However, districts receive a portion of the tax revenue collected within the district. Shared tax revenue accounts for around seven percent of the district budget. From 2001 to 2010, the central government also exercised sole authority over the property tax. Between 2011 and 2014, the property tax was gradually

[6] Own-source revenue mostly consists of business license fees, hotel and restaurant taxes, and utility fees.

decentralized to the districts, with most districts receiving this authority in 2014. This reform may not have had much impact in practice, at least over the study period: case studies suggest that districts were reluctant to deviate from pre-decentralization tax rates (von Haldenwang, 2017). Overall, local tax rates are not an important margin of adjustment to revenue shocks at the district level over the study period.

Following decentralization, subnational borrowing has been minimal, for three reasons. First, the central government banned foreign borrowing by districts and must pre-approve domestic borrowing (Blöndal et al., 2009). Second, many districts 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, pp. 127–128). Current revenue and reserves typically suffice to finance capital projects and smooth current expenditure.

The number of districts has grown from 341 in 2001 to 514 in 2014, due to district splitting.[7] The central government imposed two moratoria on splitting during the analysis period, the first from 2004 to 2006 and the second from 2009 to 2012. As a consequence, no splits occurred in 2006, the year that the general grant and the oil and gas grant experienced their largest shocks, as discussed ahead. Due to the structure of the general grant, transfers typically increase in per-capita terms in both the original ("parent") district and the new ("child") district(s) after a split. The baseline regressions flexibly control for district splits, though none of the results are sensitive to controlling for splits.[8] Section 4.3 below provides details.

Indonesia ushered in a second era of decentralization with the 2015 Village Law, which increased the authority of village governments to provide public services and increased fiscal transfers to villages. I focus on the period 2001–2014 to hold the federal structure constant.

2.2 General Grant

As already mentioned, the largest source of financing for most district governments is the General Allocation Fund (*Dana Alokasi Umum*), or "general grant" for short. The general grant is intended to equalize district capacity to provide local public services.[9] Each year the central government sets the total budget for the grant and allocates funds according to a formula. Half of the grant pool funds the "basic allocation," which covers the civil service wage bill. The basic allocation increases one-for-one with wage costs, but central regulations on recruitment and staffing prevent exorbitant spending on public employees that would otherwise occur due to the structure of the grant (Shah et al., 2012). The remaining half of the general grant pool is allocated according to the "fiscal gap," which is the difference between expenditure needs and fiscal capacity. Expenditure needs are calculated as a weighted sum

[7] See Fitrani et al. (2005), Burgess et al. (2012), and Bazzi and Gudgeon (2021) for details.

[8] An alternative approach would be to aggregate district outcomes to level of 2001 borders. I do not do this because the proper unit of analysis for my research question is a government, not an section of land.

[9] 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).

of indices related to population, land area, poverty, and construction costs. Fiscal capacity is defined as a weighted sum of imputed own-source revenue, shared tax revenue, and shared natural resource revenue. Appendix Section A.2 provides details on the formulae. After paying civil servant wages, districts have complete discretion over how to spend the grant.

In 2006 the central government dramatically increased the budget for the general grant. The grant budget depends on forecasts of the national government's long-term budget health, and a key parameter in these forecasts is the assumed future oil price. For years, the central government had deliberately underestimated the oil price to reduce its transfer obligations (Lewis and Oosterman, 2009). A rapidly falling debt-to-GDP ratio since 1999 created space for expanding transfers (World Bank, 2007, p. 10). In 2006 the general grant budget increased by 44 percent after the central government increased the oil price assumption from USD 30 per barrel to USD 60 per barrel (Agustina et al., 2012). That same year the central government changed the allocation formula, reducing the weight assigned to population and increasing the weight assigned to land area. The change in general grant revenue per capita dictated by the formula adjustment and budget increase was roughly linear in land area per capita. (See Appendix Section A.2.) Districts rich in oil and gas resources should have experienced a decline in general grant funds at this time, due to a rise in oil and gas revenue. However, a hold-harmless provision froze the general grant allocation in place for these resource-abundant districts (World Bank, 2007, p. 121). Both the increase in the budget and the change in the allocation formula were announced in October of 2004 (Law No. 33/2004).

Changes to the grant budget and formula in years other than 2006 were relatively minor, so the reform-driven variation in general grant revenue per capita can be approximated as

$$G_{d,t} \approx \theta_d + \pi A_d \cdot N_d \cdot 1(t \geq 2006),$$

where $\pi > 0$, A_d is land area per capita in district d in 2006, N_d is an indicator for being located in a non-hydrocarbon-rich province, and $1(t \geq 2006)$ is an indicator for years 2006 and later.[10] The above expression shows that in provinces without significant hydrocarbon endowments, general grant revenue per capita permanently increased in 2006, and the magnitude of the increase was proportional to district land area per capita. Data on district land area and population come from the World Bank's Indonesia Database for Policy and Economic Research (INDO-DAPOER), and data on intergovernmental grants come from the Ministry of Finance (*Kementerian Keuangan*). (See Appendix Section A.4 for details.)

Panel (a) of Figure 1 shows that while less densely populated districts initially received more general grant revenue per capita than more densely populated districts, the gap permanently widened starting in 2006 in non-hydrocarbon-rich provinces. By contrast, in hydrocarbon-rich provinces the gap was roughly constant over time, and there was no per-

[10]The hydrocarbon-rich provinces are Riau, Kepulauan Riau, Jambi, Sumatera Selatan, and Kalimantan Timur. (See Appendix Figure A.1.)

manent increase in the general grant. The policy reform of 2006 therefore created significant cross-district variation in the size of a permanent shock to the general grant within provinces that lack significant oil and gas resources.

The 2006 reform was intended to increase fiscal equalization across regions. There is little indication that political considerations determined the nature of the reform. Conceivably, members of the national legislature representing less densely populated districts could have used the reform 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. Alternatively, members of the national legislature may have wanted to improve the reelection 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 these districts in 2006. In reality, among resource-poor provinces, the average land area per capita of districts with mayoral elections in 2006 is statistically indistinguishable from the average land area per capita of districts with mayoral elections in 2005, 2007, or 2008.[11] This is unsurprising, as the timing of direct mayoral elections was largely determined by idiosyncratic historical factors (Martínez-Bravo et al., 2017). Overall, there is little reason to believe that the timing or size of the general grant reform were motivated by political considerations.

2.3 Oil and Gas Grant

Districts containing natural resources receive Shared Natural Resource Revenue (*Dana Bagi Hasil Sumber Daya Alam*), which depends on the revenue (royalties and taxes) collected by the central government from resource extraction within the district and province. Oil and natural gas are by far the largest sources of natural resource revenue in Indonesia. 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. Districts have complete discretion over how to spend the oil and gas grant.[12]

[11] Results available upon request.

[12] In 2009 the central government slightly increased the amount of oil and gas revenue shared with subnational governments, earmarking this additional revenue for education. 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.

Using the proprietary Rystad UCube database (Rystad Energy, 2016), I calculate the total economically recoverable oil and gas resources in each district as of 2000 (and known in 2000)—prior to fiscal decentralization. I then convert physical endowments into monetary values using the average prices of oil and gas over 2001–2014, insert these variables into the revenue-sharing formula in place of actual oil and gas revenue, and divide by district population. The resulting variable, denoted by $E_{d,t}$, represents the predetermined oil and gas endowment to which district d has a claim for revenue-sharing purposes, in constant 2010 IDR (billions) per capita. Appendix Section A.3 provides more details on the sharing rule and the endowment variable.

Panel (b) of Figure 1 shows that in districts in the top 5 percent in terms of hydrocarbon endowment, the oil and gas grant was large and experienced sharp year-to-year changes, especially over the period 2005–2009. The oil and gas grant was significantly smaller for districts between the 90th and 95th percentiles of endowment, and virtually nonexistent for districts in the bottom 90 percent. The figure also graphs total oil and gas grant revenue 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. The weighted value of production should be roughly proportional to the central government's transfer obligations dictated by the sharing rule. However, the two time series do not track each other—not even with a lag—indicating that the central government varied the timing of grant disbursements on a discretionary basis.[13] The variation in the oil and gas grant driven by endowments and central government policies is captured by $E_{d,t} \cdot \tilde{R}_{(-d),t}$, where $\tilde{R}_{(-d),t}$ is aggregate oil and gas grants excluding own-district grant revenue.

2.4 Geographic Variation in Exposure to Grant Shocks

The maps in Figure 2 show the spatial variation in district exposure to shocks to the two grants. Every island group except for Java contains districts with high exposure to the general grant reform—that is, low population density. Furthermore, there is rich within-island variation in land area per capita in all island groups except for Java. Oil and gas endowments are fairly geographically concentrated, with five provinces containing the bulk of the deposits and around one third of districts having an endowment of zero. Still, there is significant cross-district variation in endowments within most island groups and within hydrocarbon-rich provinces.

2.5 Magnitude and Persistence of Grant Shocks

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

[13] Cash flow problems at Pertamina, the state-owned oil and gas company, may have also delayed the transfers (World Bank, 2007).

variation. I divide this variation into two components: (1) the initial magnitude of shocks, and (2) the persistence of shocks. To examine the initial magnitude of shocks, Appendix Figure A.2 plots the distribution of the absolute two-year change in the general grant during 2005–2007 and the distribution of all absolute two-year changes in the oil and gas grant. In the subsample of districts with high exposure to one of the two grants, these distributions are reasonably similar, and nearly equal in mean. (See Appendix Section A.5 for details.)

Appendix Table A.2 presents estimates of persistence based on a dynamic panel model. The GMM estimates of the autoregressive coefficients for the general grant nearly sum to one, implying almost "perfect" persistence. The estimates for the oil and gas grant are less precise, but the totality of the evidence suggests the oil and gas grant is significantly less persistent than the general grant. (See Appendix Section A.6 for details.) The within-district coefficient of variation of the oil and gas grant (1.54) is 5 times that of the general grant (0.32), confirming that the oil and gas grant is more "volatile" than the general grant. However, this measure does not capture the persistence of shocks.[14]

3 Theoretical Model

This section develops a simple model of public expenditure, building on Obstfeld and Rogoff (1996, pp. 96–98). The goal is to understand how public good provision responds to revenue shocks of differing persistence, and how lumpy investment affects these responses. 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 durable-good investment in period t, and $\delta \in (0,1)$ is the depreciation rate. Let p_t denote the (exogenous) price of durable-good investment in units of the nondurable good in period t. Total government spending in period t is $G_t \equiv C_t + p_t I_t$. The local government has access to a risk-free bond with exogenous rate of return r. Fiscal transfers from the central government, F_t, are the local government's only source of revenue. Net assets, A_t, evolve according to the equation of motion $A_{t+1} = (1+r)A_t + F_t - C_t - p_t I_t$. The local government's intertemporal budget constraint is

$$\sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t (C_t + p_t I_t) = (1+r)A_0 + \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t F_t.$$

The government discounts citizen utility over time with factor $\beta \in (0,1)$. The government may be impatient, in that its discount rate may be greater than the interest rate ($\beta < 1/(1+r)$). Initially assume that investment is frictionless (non-lumpy). The government has perfect

[14]To see this, consider an example with two grants and four time periods. For any constant μ, the first grant equals $\mu - 1$ in the first two periods and $\mu + 1$ in the last two periods for all districts. The second grant alternates between $\mu - 1$ and $\mu + 1$ in each period for all districts. The within-unit coefficient of variation is the same for both grants, whereas the first grant exhibits greater persistence.

foresight and chooses a sequence $\{C_t, D_t\}_{t=0}^{\infty}$ to maximize

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

subject to the intertemporal budget constraint and the equation of motion for durables.[15] Let $\gamma \in (0,1)$ so that the citizen wants to consume both goods.

The optimal path of public good provision is characterized by the equations

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

The first is the usual Euler equation for consumption of nondurables, and the second states that the marginal rate of substitution between nondurables consumption and durables consumption equals the user cost of durables. Define the stock of lifetime resources,

$$R = (1+r)A_0 + (1-\delta)p_0 D_{-1} + \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t F_t.$$

Combining the optimality conditions with the intertemporal budget constraint yields the optimal levels of public good provision in each period,

$$C_t = \beta^t (1+r)^t \gamma (1-\beta) R, \qquad D_t = \frac{1}{\iota_t} \beta^t (1+r)^t (1-\gamma)(1-\beta) R.$$

Next consider how public good provision responds to revenue shocks. Suppose transfers evolve deterministically according to the difference equation

$$F_t = \rho F_{t-1} + \psi_t,$$

where $\rho \in [0,1]$ measures the persistence of the transfer. The effect of shock ψ_t on transfers j periods later is $\partial F_{t+j} / \partial \psi_t = \rho^j$. In particular, a one-unit increase in ψ_0 causes transfers to increase by one in all periods if $\rho = 1$ (permanent increase), but it causes only period-0 transfers to increase by one if $\rho = 0$ (transitory increase). The effect of a period-0 revenue shock on lifetime resources is $\partial R / \partial \psi_0 = (1+r)/(1+r-\rho)$, so the response of public good provision in period t is

$$\frac{\partial C_t}{\partial \psi_0} = \beta^t (1+r)^t \gamma (1-\beta) \frac{1+r}{1+r-\rho}, \qquad \frac{\partial D_t}{\partial \psi_0} = \frac{1}{\iota_t} \beta^t (1+r)^t (1-\gamma)(1-\beta) \frac{1+r}{1+r-\rho}. \tag{2}$$

The above expressions immediately imply the following result.

[15] 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.

Proposition 3.1 *The public goods response to a revenue shock is increasing in the persistence of the shock:*

$$\frac{\partial^2 C_t}{\partial\rho\partial\psi_0} > 0, \qquad \frac{\partial^2 D_t}{\partial\rho\partial\psi_0} > 0 \qquad \textit{for all } t.$$

Proposition 3.1 holds because more persistent shocks have a larger impact on lifetime resources.

Because D_{t-1} is predetermined in period t, the initial investment response equals the initial durables response, while the investment response in subsequent periods reflects the change in durables net of depreciation,

$$\frac{\partial I_0}{\partial\psi_0} = \frac{\partial D_0}{\partial\psi_0}, \qquad \frac{\partial I_t}{\partial\psi_0} = \frac{\partial D_t}{\partial\psi_0} - (1-\delta)\frac{\partial D_{t-1}}{\partial\psi_0} \qquad \text{for } t \geq 1. \tag{3}$$

Absent a steep downward trend in the user cost of durables over time, investment responds more in the current period than in subsequent periods, as does total government expenditure—even when the government's discount rate equals the interest rate.[16] Together, the expressions in (2) and (3) imply the following result.

Proposition 3.2 *For any discount factor $\beta \leq (1+r)^{-1}$, total expenditure "overshoots,"*

$$\frac{\partial G_0}{\partial\psi_0} > \frac{r}{1+r-\rho},$$

initially increasing by more than the increase in permanent income ($rR/(1+r)$) due to the shock.[17] *In particular, if transfers are perfectly persistent ($\rho = 1$), then spending initially increases more than one-for-one with current transfers ($\partial G_0/\partial\psi_0 > 1$). In addition, the spending response is always smaller in subsequent periods,*

$$\frac{\partial G_t}{\partial\psi_0} < \frac{\partial G_0}{\partial\psi_0} \qquad \textit{for } t \geq 1,$$

as long as a weak condition holds for the path of investment costs.[18]

[16] For $t \geq 1$,

$$\frac{\partial I_0}{\partial\psi_0} - \frac{\partial I_t}{\partial\psi_0} = \frac{(1-\gamma)(1-\beta)(1+r)}{1+r-\rho}\left(\frac{1}{\iota_0} - \beta^{t-1}(1+r)^{t-1}\left[\frac{\beta(1+r)}{\iota_t} - \frac{1-\delta}{\iota_{t-1}}\right]\right)$$

[17] To see this, note that

$$\frac{\partial G_0}{\partial\psi_0} = \frac{(1-\beta)(1+r)}{1+r-\rho}\left(\gamma + (1-\gamma)\frac{p_0}{\iota_0}\right),$$

and $p_0 > \iota_0$ as long as the price of investment is always strictly positive.

[18] Because

$$\frac{\partial G_t}{\partial\psi_0} = \beta^t(1+r)^t\frac{(1-\beta)(1+r)}{1+r-\rho}\left(\gamma + (1-\gamma)\left[\frac{p_t}{\iota_t} - \frac{1-\delta}{\beta(1+r)}\frac{p_t}{\iota_{t-1}}\right]\right),$$

To summarize, when investment is non-lumpy, the expenditure response to a shock to fiscal transfers (1) is larger the more persistent are transfers and (2) initially overshoots under mild assumptions, due to upfront investment in durables.

Now suppose that investment is lumpy due to non-convex adjustment costs. The local government incurs a fixed cost $\xi > 0$ every time it makes a "large" adjustment to the stock of durables. Following Khan and Thomas (2008), the government does not pay this fixed cost if adjustment is sufficiently small relative to the stock of durables—formally, if $I_t \in [aD_{t-1}, bD_{t-1}]$, where $a \leq 0 \leq b$. An example of such an investment is routine maintenance.

To simplify the dynamics of the model, assume that the price of investment is constant, $\iota_t = \iota$ for all t. Further assume that the government's discount rate equals the interest rate ($\beta(1+r) = 1$). Under these two assumptions the desired provision of the two public goods is constant over time and equal to

$$C_t = C = \gamma \frac{r}{1+r} R, \qquad D_t = D = \frac{1-\gamma}{\iota} \frac{r}{1+r} R \qquad \text{for all } t.$$

Finally, assume that $b = \delta$ so that the government can maintain a constant stock of durables without incurring the fixed cost. Regardless of whether these three assumptions are imposed, the investment response to a revenue shock will be concentrated in the initial period. The simplifying assumptions make it easier to analyze how non-convex adjustment costs affect this investment response.

For a period-0 shock of size $\mathrm{d}\psi_0$, let $\mathrm{d}R = \mathrm{d}\psi_0(1+r)/(1+r-\rho)$ denote the change in lifetime resources. If the government does not incur the fixed cost, public good provision is

$$C = \gamma \frac{r}{1+r} R + \frac{r}{1+r} \mathrm{d}R, \qquad D = \frac{1-\gamma}{\iota} \frac{r}{1+r} R.$$

The shock leaves the stock of durables unchanged, and all additional resources are devoted to the nondurable good. If the government does incur the fixed cost, the public goods increase proportionally with the increase in lifetime resources, net of the fixed cost:

$$C = \gamma \frac{r}{1+r} (R + \mathrm{d}R - \xi), \qquad D = \frac{1-\gamma}{\iota} \frac{r}{1+r} (R + \mathrm{d}R - \xi).$$

Let $\widetilde{\mathrm{d}R}$ denote the change in lifetime resources for which the government is indifferent between incurring the fixed cost and not incurring the fixed cost. Then $\widetilde{\mathrm{d}R}$ satisfies

$$\begin{aligned} &\gamma \log\left(\gamma \frac{r}{1+r} R + \frac{r}{1+r} \widetilde{\mathrm{d}R}\right) + (1-\gamma) \log\left(\frac{1-\gamma}{\iota} \frac{r}{1+r} R\right) = \\ &\gamma \log\left(\frac{1-\gamma}{\iota} \frac{r}{1+r} (R + \widetilde{\mathrm{d}R} - \xi)\right) + (1-\gamma) \log\left(\frac{1-\gamma}{\iota} \frac{r}{1+r} (R + \widetilde{\mathrm{d}R} - \xi)\right), \end{aligned} \tag{4}$$

where clearly $\widetilde{\mathrm{d}R} > \xi$.

a sufficient (but not necessary) condition for the inequality to hold is $p_0/\iota_0 > p_t/\iota_t - (1-\delta)p_t/\iota_{t-1}$.

Proposition 3.3 *Durable good provision increases only in response to large increases in lifetime resources:*

$$\mathrm{d}D = \begin{cases} \frac{1-\gamma}{\iota}\frac{r}{1+r}(\mathrm{d}R - \xi) & \textit{if } \mathrm{d}R > \widetilde{\mathrm{d}R} \\ 0 & \textit{if } \mathrm{d}R < \widetilde{\mathrm{d}R}, \end{cases}$$

where $\widetilde{\mathrm{d}R}$ *is defined by Equation* (4).

To summarize, when there are no fixed costs of adjusting the durable good, the response of the durable good to a revenue shock ($\mathrm{d}\psi_0$) is increasing in the persistence (ρ) of the shock. When there are fixed costs of adjustment, the durable good may not respond *at all* if the shock is sufficiently small or its persistence sufficiently low. Thus both the size of the initial shock and its persistence matter for the composition of the spending response. As discussed in the previous section, among Indonesian districts that are highly exposed to shocks to either the general grant or the oil and gas grant, the size of the initial shock is similar for both grants. Therefore, shocks to the two grants have different impacts on behavior primarily because of differences in persistence.

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. District governments in Indonesia sometimes receive transfers late in the year, face delays in the process of getting budgets approved by the province, and have difficulty procuring goods and services in a timely manner. Fiscal responses thus may occur with a lag. The empirical tests discussed ahead allow for lagged responses.

Another important consideration is corruption. Local officials may appropriate a portion of the fiscal transfers for private consumption, driving a wedge between reported spending and actual public good provision. In the presence of corruption, the qualitative predictions of the model still hold, as long as the share of resources appropriated by government officials does not vary markedly with the persistence of transfers.[19]

A final consideration is asymmetric responses. Public good provision may respond differently to increases and decreases in transfers, possibly because reducing the stock of durables is more costly than increasing the stock. This could matter empirically, because the oil and gas grant experienced both increases and decreases, whereas the general grant only experienced an increase. I test for asymmetric responses ahead.

[19] For example, if the local government's felicity function is $\lambda(\gamma \log C_t + (1-\gamma)\log D_t) + (1-\lambda)\log S_t$, where S_t is rents, then public good provision is a share λ of the provision under no corruption, and similar comparative statics obtain.

4 Fiscal Responses to Grants

4.1 Data

I begin the empirical analysis by estimating the dynamic fiscal responses to the general grant and the oil and gas grant, with the goal of testing the predictions of the theoretical model. Data on district revenue and expenditure come from the Ministry of Finance and INDO-DAPOER. All fiscal variables are expressed in constant 2010 IDR 1 million (approximately USD 100) per capita. To ensure that all districts in the sample operate under the same institutional environment, I omit provinces that have a special administrative or fiscal arrangement with the central government. The final sample contains 348 districts from 29 provinces. (See Appendix Section A.4 for details.)

4.2 Identifying Assumptions

Both grants could be endogenous in the sense that they are correlated with unobserved determinants of spending and public service delivery. The general grant is likely endogenous because it is a function of the civil service wage bill and fiscal need. An adverse shock that increases fiscal need would lead to an increase in the general grant while also potentially affecting local demand for public services or local capacity to provide those services. The oil and gas grant could also be endogenous if it responds to the local business environment, local economic shocks, conflict, or other factors that affect district expenditure and public services. Furthermore, grant amounts could, in theory, deviate from the allocations prescribed by law due to political manipulation. Such deviations could reflect the relative bargaining power of the district, introducing another source of endogeneity. In light of these potential sources of bias, I exploit the sources of exogenous variation in grants described in Sections 2.2 and 2.3.

I capture exogenous variation in the general grant with the instrumental variable $A_d \cdot N_d \cdot 1(t \geq 2006)$, where A_d is land area per capita in district d in 2006, N_d is an indicator for being located in a non-hydrocarbon-rich province, and $1(t \geq 2006)$ is an indicator for years 2006 and later. As already mentioned, this instrument is relevant because in non-hydrocarbon-rich provinces the permanent increase in the general grant dictated by the 2006 reform was proportional to land area per capita. Intuitively, the empirical strategy compares the change in the general grant revenue gradient in land area per capita to the change in the corresponding spending gradient for districts in non-hydrocarbon-rich provinces. The key identifying assumption is that the spending gradient would not have changed in the absence of the 2006 reform. This assumption allows the level of spending to be correlated with land area per capita, but it rules out any correlation between land area per capita and *changes* in spending due to factors other than the 2006 reform. Put another way, the assumption basically states that outcomes in districts with different population densities would have followed parallel paths over time in the absence of the general grant reform. While this identifying assumption is not testable, it would be more plausible if the spending gradient in land area per capita were constant over time prior to the reform, and if there were no confounding policy changes that were systematically related to the 2006 reform. I test for a constant pre-reform gradient and examine confounding policies ahead.

I capture exogenous variation in the oil and gas grant with the instrumental variable $E_{d,t} \cdot \tilde{R}_{(-d),t}$, where $E_{d,t}$ is the predetermined oil and gas endowment to which district d has a claim for revenue-sharing purposes, and $\tilde{R}_{(-d),t}$ is aggregate oil and gas grants excluding own-district revenue. The validity of this instrument hinges on the assumption that outcomes in districts with different endowment levels would have followed parallel trends in the absence of shocks to the oil and gas grant. This rules out omitted factors that vary over time and differentially affect districts with different endowment levels. One concern is that districts with better political institutions and leadership may attract more oil and gas exploration, increasing known endowment (Cust and Harding, 2019; Cassidy, 2019; Arezki et al., 2019). The instrument avoids contamination along these lines by measuring endowment known as of 2000, prior to fiscal decentralization. Before 2001, the central government was the sole actor negotiating with oil and gas companies, so incentives to explore were roughly uniform across the country.[20] It is therefore plausible that 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, as already discussed, aggregate oil and gas grant revenue does not covary with aggregate oil and gas production—or its lags—apparently because the central government varies the timing of grant disbursements on a discretionary basis (Figure 1). Indeed, the largest shock to oil and gas grants occurred in 2006, the same year the central government increased the general grant budget in response to an upwardly revised oil price forecast. This policy change was exogenous from the standpoint of district governments and unrelated to trends in oil and gas production.

The identifying assumptions do *not* imply that we should expect districts to exhibit constant spending gradients in endowment over *any* period after decentralization. The reason is that shocks to the oil and gas grant occurred in every year starting in 2001; there is no "pre-shock" period under decentralization. Section 5.6 considers the impact of the permanent increase in oil and gas revenue induced by decentralization. In that section I estimate the public services gradient in the years prior to decentralization, when hydrocarbon-rich districts did not receive significant revenue from oil and gas production.

[20] Separatist violence in Aceh and Papua has disrupted resource extraction in the past, but these regions are excluded from the sample due to their special fiscal arrangements with the central government.

4.3 Reduced-Form Effects over Time

I first present graphical evidence by plotting the reduced-form impacts of exposure to grant shocks over time. To do so, I estimate the regression

$$Y_{d,t} = \sum_{j \neq 2005} \theta_j A_d \cdot N_d \cdot D_t^j + \sum_{j \neq 2005} \gamma_j E_d \cdot D_t^j + \boldsymbol{\pi}' \boldsymbol{X}_{d,t} + \alpha_d + \lambda_{i(d),t} + u_{d,t}, \tag{5}$$

where $Y_{d,t}$ is total expenditure in district d and year t, A_d is land area per capita in 2006, N_d is an indicator for being located in a non-hydrocarbon-rich province, E_d is average hydrocarbon endowment per capita over 2001–2014, and D_t^j is an indicator that equals one if $t = j$. The covariates $\boldsymbol{X}_{d,t}$ are indicators for whether the district has split, interacted with indicators for whether the district is a parent or a child district, as well as two lags of these indicators.[21] The model also includes district fixed effects, α_d, and island-by-year effects, $\lambda_{i(d),t}$.[22] The coefficient θ_j captures the change in the spending gradient in exposure to the general grant reform between 2005 and year j. Similarly, γ_j captures the change in the spending gradient in exposure to the oil and gas grant between 2005 and year j. I also estimate Equation (5) with the grants as outcomes to visualize the time-varying effects of exposure on grant revenue.

Throughout the paper I report standard errors that are robust to heteroskedasticity and two-way clustering at the district and province-by-year levels to account for within-district serial correlation and cross-district correlation within provinces in a given year (Cameron et al., 2011). The within-district correlation is due to the persistence of fiscal variables and unobservables over time. The cross-district correlation could arise from the fact that, in any given year, non-producing districts located in the same province are entitled to the same amount of oil and gas grant revenue.

Figure 3 displays point estimates and 95-percent confidence intervals for the parameters in Equation (5). Panel (a) plots the estimates of $\{\theta_j\}$ separately for total expenditure (blue circles) and general grant revenue (red diamonds). The estimates confirm that districts with greater land area per capita experienced larger permanent increases in general grant revenue starting in 2006. These districts responded by sharply increasing expenditure in 2006. This expenditure response grew over the next three years before partially subsiding in 2010. The estimates for $j < 2005$ are close to zero and statistically insignificant, implying that the spending gradient in exposure to the general grant reform was constant prior to the reform. This suggests that the reform did not target districts based on preexisting fiscal trends, and that there were no anticipatory effects.

Panel (b) plots the estimates of $\{\gamma_j\}$ separately for total expenditure (blue circles) and oil and gas grant revenue (red diamonds). Hydrocarbon-rich districts experienced sharp,

[21]This specification is motivated by the patterns observed in the data: general grant revenue per capita steadily increases in the two years after a split (relative to non-splitting districts), with child districts seeing larger increases.

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

transitory changes in the oil and gas grant, especially over 2005–2009. The figure suggests that expenditure responds somewhat to these shocks, though the response appears to be less than one-for-one and is spread out over several years. Overall, expenditure in hydrocarbon-rich districts evolves more smoothly over time than the oil and gas grant.

4.4 Dynamic Expenditure Responses

Next I examine the dynamic expenditure responses to the two grants by estimating the direct projections (Jordà, 2005)

$$\begin{aligned} Y_{d,t+h} - Y_{d,t-k} = \beta^h (G_{d,t} - G_{d,t-k}) + \delta^h (R_{d,t} - R_{d,t-k}) \\ + \phi^{h\prime} (\boldsymbol{X}_{d,t} - \boldsymbol{X}_{d,t-k}) + \lambda^h_{i(d),t} + \varepsilon^h_{d,t}, \end{aligned} \tag{6}$$

where Y is total expenditure, G is general grant revenue, and R is oil and gas grant revenue. The model controls for covariates $\boldsymbol{X}$ described in the previous section, island-by-year effects, and district fixed effects (via differencing). The index $k \in \{1, 2\}$ represents the duration of the revenue shock considered, and h represents the time horizon of the expenditure response. The horizon-specific coefficients β^h and δ^h represent the per-dollar effect of a k-year change in the general grant and the oil and gas grant, respectively, on expenditure h years later.

Instrumental-variables (IV) estimates of the coefficients in Equation (6) are based on the excluded instruments $\boldsymbol{Z}_{d,t} - \boldsymbol{Z}_{d,t-k}$. In levels, the 2×1 instrument vector is

$$\boldsymbol{Z}_{d,t} \equiv \left(A_d \cdot N_d \cdot 1(t \geq 2006), \quad E_{d,t} \cdot \tilde{R}_{(-d),t} \right),$$

where A_d is land area per capita in 2006, N_d is an indicator for being located in a non-hydrocarbon-rich province, $E_{d,t}$ is district hydrocarbon endowment, and $\tilde{R}_{(-d),t}$ is aggregate oil and gas grants excluding own-district grants.

Table 1 presents the first-stage results. To improve readability, land area per capita is measured in tens of square kilometers per capita, and aggregate oil and gas grants are measured in 2010 IDR trillions. Panel A presents estimates based on one-year changes ($k = 1$). The first instrument, $A_d \cdot N_d \cdot 1(t \geq 2006)$, has a positive and highly significant effect on general grant revenue per capita, with a point estimate of 0.81 and a standard error of 0.08. The magnitude and statistical significance of this estimate are similar when the second instrument, $E_{d,t} \cdot \tilde{R}_{(-d),t}$, is included. The second instrument has a positive and highly significant effect on oil and gas grant revenue per capita, with a point estimate of 0.83 and a standard error of 0.04. Similarly, this first-stage effect is insensitive to the inclusion of the first instrument. Using two-year changes produces similar estimates (Panel B).

Table 2 reports the IV estimates of β^h and δ^h from Equation (6) for different horizons h.[23]

[23] The estimates that do not control for $\boldsymbol{X}$ are similar and are reported in Appendix Table A.3. Appendix Table A.4 reports the ordinary least squares estimates for the sake of comparison.

I focus the discussion on the results for one-year changes in grants (Panel A), as the results are qualitatively similar for two-year changes (Panel B). The point estimate of 0.72 (S.E. = 0.11) in the first row and first column indicates that an increase in the general grant by 1 rupiah per capita immediately raises total expenditure by 0.72 rupiah per capita. Columns 2–6 show that the expenditure response to the general grant steadily grows for three years, peaking at 1.63 (S.E. = 0.23), before declining to 0.71 (S.E. = 0.18) five years after the shock. Total expenditure is less responsive to the oil and gas grant, initially increasing by 0.22 (S.E. = 0.07) and peaking at 0.50 (S.E. = 0.16) two years later. The Sanderson and Windmeijer (2016) F statistic, which tests for weak identification of individual coefficients on the endogenous variables, ranges from 77 to 109 for the general grant, and 163 to 386 for the oil and gas grant, indicating that the structural parameters are strongly identified.

Each column in Table 2 reports p-values from testing two hypotheses. The first hypothesis, $H_0\colon \beta^h = \delta^h$, is motivated by Proposition 3.1, which states that the spending response to a revenue shock is increasing in the persistence of the shock ($\beta^h > \delta^h$). The second hypothesis, $H_0 : \beta^h \leq 1$, is motivated by Proposition 3.2, which states that persistent revenue shocks will increase upfront investment in durable goods, producing a greater than one-for-one spending response ($\beta^h > 1$) if the shock is sufficiently persistent. Because $h \in \{0, 1, \ldots, 5\}$, each hypothesis is actually a family of six hypotheses. The more hypotheses one tests, the greater the probability of rejecting at least one true null hypothesis in the family, known as the family-wise error rate (FWER). To address this concern, the table reports adjusted p-values based on the Holm step-down method (Holm, 1979), which fixes the FWER rather than merely fixing the significance level of each individual hypothesis test. The Holm method is conservative and allows for arbitrary dependence between hypothesis tests.[24] For comparison, the table also reports conventional (unadjusted) p-values.

There is strong evidence against $H_0\colon \beta^h = \delta^h$, which is rejected at the one-percent level for all horizons, testing methods, and shock durations. The general grant clearly induced a larger expenditure response than the oil and gas grant. In the specification with one-year changes in grants (Panel A), $H_0\colon \beta^h \leq 1$ is rejected for $h = 3$ at the one-percent level using unadjusted p-values ($p = 0.003$) and at the five-percent level using the Holm method ($p = 0.020$), providing evidence of an overshooting expenditure response to the general grant. The evidence is weaker in the specification with two-year changes in grants (Panel B): the hypothesis is rejected for $h = 2$ using unadjusted p-values ($p = 0.052$) but is never rejected using Holm p-values. Overall, the fiscal results are consistent with Propositions 3.1 and 3.2.

The first row of Appendix Figure A.3 plots the expenditure responses broken down by economic classification and ordered by the budget share: total, personnel, capital, goods and services, and "other."[25] All types of expenditure respond more to the general grant than

[24] For a family of k hypotheses with unadjusted p-values $\{p_i\}_{i=1}^k$, the Holm p-values are $p_i^H = \min\{1, n_i p_i\}$, where n_i is the number of p-values that are greater than or equal to p_i.

[25] The "other" category includes unplanned spending, interest payments, and discretionary financial assistance and donations (Sjahrir et al., 2013).

to the oil and gas grant, but the difference is most pronounced for capital expenditure. The next largest difference is found in personnel spending, which could involve significant long-term commitments due to the difficulty of firing public employees.[26] The difference in the responses is smallest for goods and services and "other" expenditure, which likely contain less lumpy and more discretionary items. The results suggest that lumpy investment and committed expenditure drive the difference in the total expenditure responses to the grants.

The second row of Appendix Figure A.3 summarizes the responses for the five largest functional categories of expenditure in order of budget share: administration, education, infrastructure, health, and agriculture. (Note that these categories are non-exhaustive.) All categories appear to respond more to the general grant. Infrastructure spending exhibits the biggest difference, which again points to the importance of lumpy investment.

4.5 Threats to Validity

As already mentioned, the key identifying assumption is that the relationship between expenditure and exposure to the grant shocks, as determined by land area per capita and hydrocarbon endowments, would have been constant over time in the absence of shocks to the grants. While the assumption is not testable, one implication is that districts with varying exposure to the grant shocks would have experienced similar spending trends over periods when no grant shocks occurred. This implication is not testable for the oil and gas grant, which experienced shocks in every period. However, it is testable for the general grant, which maintained a roughly time-invariant relationship with land area per capita over 2001–2005. As already discussed, the spending gradient in land area per capita was constant over time prior to 2006 (Figure 3), which is consistent with the identifying assumption.

The identifying assumption could also be violated if other policy or economic shocks coincided with the grant shocks and differed in their intensity according to district exposure to the grant shocks. For example, the estimated response to the oil and gas grant would be biased if changes in oil and gas production both correlated with changes in the grant and influenced expenditure. However, as already discussed, this is unlikely to be an important source of bias, as there is no clear relationship between changes in hydrocarbon production and changes in the oil and gas grant, even allowing for lagged effects (Figure 1).

Alternatively, the estimates could be biased if grant shocks were correlated with changes in other sources of revenue. To conserve space, Appendix Table A.5 presents estimates of the mean responses of alternative revenue sources over horizons 0 through 5. An additional 1 rupiah per capita of general grant revenue is associated with an additional 0.07 rupiah per capita (S.E. = 0.03) of the special grant in the specification with one-year shocks. This effect is half as large, and statistically insignificant, in the specification with two-year shocks.

[26]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).

The responses of own-source revenue and shared tax revenue are small in magnitude and statistically indistinguishable for the general grant and the oil and gas grant. Because the special grant is an earmarked, discretionary transfer, one may be concerned that this grant targeted districts that benefited the most from the general grant reform. Any bias due to this grant is necessarily small, given the small magnitude of the point estimate. Nevertheless, I re-estimate the model controlling for the special grant, noting that the endogeneity of this grant could introduce a new source of bias. The estimates reported in Appendix Table A.6 are slightly smaller than the baseline estimates, but the general pattern is very similar. Overall, there is little indication that other sources of revenue cause significant bias.

Finally, the estimates could be biased if the functional form of Equation (6) is incorrect. In particular, the assumption that spending responds symmetrically to increases and decreases in revenue might not hold, due to downward rigidities in expenditure. Asymmetric spending responses could lead to a mistaken conclusion that spending responds more to the general grant, because the effect of the general grant is identified from a single increase whereas the effect of the oil and gas grant is identified from several increases and decreases. To examine whether this is an important source of bias, I estimate the model

$$Y_{d,t+h} - Y_{d,t-k} = \beta^h (G_{d,t} - G_{d,t-k}) + \delta^{h,+} (R_{d,t} - R_{d,t-k})^+ \\ + \delta^{h,-} (R_{d,t} - R_{d,t-k})^- + \phi^{h\prime} (\boldsymbol{X}_{d,t} - \boldsymbol{X}_{d,t-k}) + \lambda^h_{i(d),t} + \varepsilon^h_{d,t}, \quad (7)$$

which allows for asymmetric responses to increases and decreases in the oil and gas grant, denoted by $(R_{d,t} - R_{d,t-k})^+ \equiv \max\{0, R_{d,t} - R_{d,t-k}\}$ and $(R_{d,t} - R_{d,t-k})^- \equiv \min\{0, R_{d,t} - R_{d,t-k}\}$. (The instrument $E_{d,t} \cdot \tilde{R}_{(-d),t}$ is likewise partitioned into increases and decreases.)

Appendix Table A.7 presents the results. Focusing on one-year changes in grants (Panel A), expenditure increases significantly in response to increases in the oil and gas grant, while the response to decreases in the oil and gas grant is weaker and potentially negative. The null hypothesis of symmetry ($\delta^{h,+} = \delta^{h,-}$) is rejected at the 10-percent level for several time horizons using unadjusted p-values, but not when using the Holm correction. This provides suggestive evidence of asymmetric responses. However, the null hypothesis that *increases* in the two grants induce the same response ($\beta^h = \delta^{h,+}$) is rejected for all testing methods and time horizons except for $h = 5$. The baseline results therefore are not driven by asymmetric responses to the oil and gas grant.

5 Impacts on Public Service Delivery

5.1 Data

Having established that the fiscal responses to the two grants are consistent with the theory, I next examine the impacts on public service delivery. Data on public goods and services come from the Village Potential Statistics (*Pendataan Potensi Desa*, or PODES), a triennial census that is intended to cover every village in Indonesia. Each survey is filled out by the village head and includes information on public goods and services related to education, health, and infrastructure. I merge villages across six survey waves from 1999 to 2014, producing a balanced panel of around 44,000 villages located in districts in the analysis sample. I then aggregate outcomes to the district level. (See Appendix Section A.4 for details.)

The outcomes of interest are public schools, health facilities, health personnel, and road quality. I focus on these outcomes due to data availability and the fact that district governments are responsible for either provision (education and health) or financing (local roads) of these services.[27] Panel B of Appendix Table A.1 provides summary statistics. All of the measures of public service delivery involve either lumpy investment (schools, health clinics, road quality) or committed expenditure (health personnel). The theory predicts that the general grant will have a larger impact on these outcomes than the oil and gas grant, and that the outcomes may not even respond to the oil and gas grant.

5.2 Identifying Assumptions

As previously discussed, the key identifying assumption is that districts with different exposure to the grant shocks would have experienced similar trends in public service delivery in the absence of shocks to the grants. Apart from the concerns discussed in the context of fiscal responses, one potential problem is that less developed areas could be experiencing catch-up growth in public services over this period. If public service delivery trends differed for districts with different population densities for reasons other than the general grant reform, the estimates would be biased. Catch-up growth in public services would likely produce differential trends prior to the reform, however. I test for differential pretrends ahead.

5.3 Reduced-Form Effects

I begin by estimating the reduced-form impacts of exposure to the two grants on public service delivery using the regression

$$Y_{d,t} = \sum_{\ell \in \mathscr{L}} \theta_\ell A_d \cdot N_d \cdot D_t^\ell + \sum_{\ell \in \mathscr{L}} \gamma_\ell E_d \cdot D_t^\ell + \boldsymbol{\pi}' \boldsymbol{X}_{d,t} + \alpha_d + \lambda_{i(d),t} + u_{d,t}, \tag{8}$$

where $Y_{d,t}$ is a public service outcome in district d in survey year t, and D_t^ℓ is an indicator that equals one if $t = \ell$. The set $\mathscr{L}$ includes all available survey years except for the reference year, 2005. Thus θ_ℓ and γ_ℓ measure the change in the gradients of Y in exposure to the general grant reform and exposure to the oil and gas grant, respectively, between 2005 and year ℓ.

[27] 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 village governments usually initiate and implement the projects (World Bank, 2010).

Figure 4 displays point estimates and 95-percent confidence intervals for the parameters in Equation (8). Panel (a) plots the estimates of $\{\theta_\ell\}$. This gradient is roughly constant over time prior to 2006, which means that pretrends were similar for districts with different exposure to the general grant reform.[28] For almost all outcomes, the gradient increases after 2006, suggesting that the permanent increase in the general grant increased public service delivery. The only exception is public primary schools per capita, for which the gradient decreases after 2006. This decrease is smaller than the increase in the gradient of public secondary schools per capita. As shown in Appendix Figure A.4, the gradient of school access, measured as the share of villages with at least one school, did not change for public primary schools, whereas it increased for public kindergartens and secondary schools. This suggests that the decrease in the gradient of public primary schools is due to a reduction in schools in villages that already had multiple schools. Overall, the general grant reform appears to have increased access to public schools, in addition to paved roads and health services.

Panel (b) of Figure 4 displays the estimates of $\{\gamma_\ell\}$. Despite the large increase in the oil and gas grant in 2006, only the gradient of doctors per capita sharply increases from 2005 to 2008. The gradients of public secondary schools per capita and access to paved roads steadily grow over the entire sample period, but changes in these gradients do not coincide with the sharp changes in the oil and gas grant. The reduced-form evidence is inconsistent with investment responding to transitory shocks to revenue, however it is consistent with public services responding to the permanent increase in oil and gas revenue starting in 2001, as discussed below.

5.4 Mean Responses of Public Service Delivery

Next I examine how public service delivery responds to the grants on a per-dollar basis. Because outcomes are observed only every three years, I aggregate grant revenue over time by taking three-year averages. For year t in which public service delivery is observed, let $\overline{G}_{d,t}$ denote average general grant revenue in district d across years t, $t-1$, and $t-2$, and likewise let $\overline{R}_{d,t}$ denote the three-year average of the oil and gas grant.[29] I apply the same transformation to the instruments and estimate the direct projections

$$Y_{d,t+h} - Y_{d,t-3} = \beta^h(\overline{G}_{d,t} - \overline{G}_{d,t-3}) + \delta^h(\overline{R}_{d,t} - \overline{R}_{d,t-3}) + \phi^{h\prime}(\boldsymbol{X}_{d,t} - \boldsymbol{X}_{d,t-3}) + \lambda^h_{i(d),t} + \varepsilon^h_{d,t}, \tag{9}$$

for $h \in \{0,3,6\}$. Differencing removes district fixed effects, and island-by-year effects control for arbitrary regional differences in the evolution of public services over time. Equation (9) allows grants to have lagged effects, due to lagged expenditure responses or time to build.

[28] There is a slight upward pretrend in the gradient of public secondary schools, but this pretrend is small relative to the change in the gradient following the general grant reform.

[29] In 2002 $\overline{G}_{d,t}$ and $\overline{R}_{d,t}$ are measured as two-year averages because the grants did not exist in 2000.

Table 3 reports IV estimates of the mean responses to the two grants, $\sum_{h\in\{0,3,6\}} \beta^h/3$ and $\sum_{h\in\{0,3,6\}} \delta^h/3$, to conserve space. (Appendix Figure A.5 plots the entire dynamic responses.) These estimates represent the average change in public service delivery over the short and medium term due to an increase in grant revenue by IDR 1 million (≈ USD 100) per capita. For context, total revenue per capita averages around 2 million IDR per capita over the sample period. Columns 1–3 report the estimates for public schools. The mean response of public kindergartens to the general grant is 0.338 (S.E. = 0.136), which means that increasing the general grant by IDR 1 million per capita raises the number of kindergartens per 10,000 people by over 0.3. This is a large increase relative to the baseline mean of around 0.2. Surprisingly, the provision of public primary schools falls in response to the general grant, with a mean response of −0.656 (S.E. = 0.217). However, this effect is small relative to the baseline mean of around 8. The mean response of public secondary schools is 1.081 (S.E. 0.160), which represents a near-doubling relative to the baseline mean of 1.2. Overall, the general grant significantly increases the provision of public schools, as the increase in public kindergartens and secondary schools is over twice a large as the reduction in primary schools. By contrast, the mean response to the oil and gas grant is close to zero and statistically insignificant for public kindergartens and secondary schools. The effect of the oil and gas grant on public primary schools (−0.176) is negative and statistically significant, but small in magnitude.[30]

Columns 4–6 report the estimates for health personnel and facilities. The mean response to the general grant is 0.463 (S.E. = 0.203) for doctors, 1.249 (S.E. = 0.488) for midwives, and 0.777 (S.E. = 0.426) for health care centers. These effects range from 0.2 to 0.3 of the baseline mean of the respective outcomes. Once again, the mean responses to the oil and gas grant are small and statistically insignificant. The outcome in column 7 is the share of villages where the main road is paved. At baseline, the average share is 0.64. Increasing the general grant by IDR 1 million per capita raises this share by 0.048 (S.E. = 0.019). The effect of the oil and gas grant is virtually zero.

For six out of seven outcomes considered, the general grant has a positive, statistically significant, and economically large effect. For five of these six outcomes, we can statistically reject equal responses to the two grants at the five-percent level using conventional p-values. (For one outcome the hypothesis is rejected at the 10-percent level.) Furthermore, in all six cases the hypothesis is rejected at the 10-percent level using p-values that are adjusted for multiple hypothesis testing. Thus most public services, considered individually, respond more to the general grant than to the oil and gas grant, consistent with Proposition 3.3.

To assess overall responses, I construct a public services index, defined as the average of the seven public good outcomes after standardizing each outcome by its baseline mean and standard deviation. As shown in column 8, the mean response of the index to the general grant is 0.543 (S.E. = 0.118), implying that public service delivery increases by over half a standard deviation. The mean response to the oil and gas grant is −0.039 (S.E. = 0.109), and

[30]The effects of the two grants on total public schools differ at the five-percent level. (Result not reported.)

the hypothesis of equal responses to the two grants is easily rejected ($p < 0.001$). Again, the general grant appears to stimulate economically and statistically significant improvements in public service delivery, while the oil and gas grant does not. In fact, the estimates for the oil and gas grant are precise enough to rule out modest effects.

5.5 Threats to Validity

The potential sources of bias in estimating β^h and δ^h in Equation (9) are similar to those discussed for the fiscal responses. The fact that the gradient of public service delivery in exposure to the general grant reform is roughly constant over time prior to 2006 suggests that the estimated impacts of the general grant are not driven by prior trends in services (Figure 4). The estimates are very similar when no controls are used or when special grant revenue is added to the set of controls (Appendix Tables A.8 and A.9). When I allow for asymmetric responses to increases and decreases in the oil and gas grant, I consistently find that public service delivery responds more to the general grant than to increases in the oil and gas grant (Appendix Table A.10). The OLS estimates also suggest that public service delivery responds more to the general grant, but the point estimates for the general grant are considerably smaller than the IV estimates (Appendix Table A.11). This is consistent with the general grant endogenously increasing in response to negative shocks at the district level.

It is possible that the grants have different effects on local politics, which could impact how revenue is translated into services. This would not necessarily induce bias in the baseline estimates, but it would change the interpretation of those estimates. Appendix Table A.12 reports IV estimates of the effects of the two grants on different measures of political competition. For the first outcome (number of candidates), higher values indicate greater competition. For the remaining outcomes (Herfindahl Index of vote shares, size of winning coalition, reelection of incumbent, and margin of victory), higher values indicate less competition. I estimate two versions of the model: the first assuming that grants in the election year affect the outcomes, and the second assuming that grants in the year before the election affect the outcomes. The reason is that the appropriate timing is unclear, as elections happen any time from January to December and grants are disbursed in installments throughout the year. The estimates indicate that neither grant has a strong effect on political competition, and in nine out of 10 regressions we fail to reject the hypothesis that the grants have equal effects.

5.6 Response to Permanent Oil and Gas Grant Revenue

The fact that the general grant stimulates greater public service delivery, while the oil and gas grant does not, is consistent with district governments adjusting lumpy public good provision only when there is a large change in lifetime fiscal resources. An alternative mechanism could be that the oil and gas grant is more susceptible to waste or embezzlement by public officials. This seems unlikely, as the grants are subject to the same rules and oversight by the central government. Luckily, this mechanism has testable implication: a *permanent* increase in the oil and gas grant should have a much smaller impact on public service delivery than the permanent increase in the general grant.

Decentralization induced a large permanent increase in the oil and gas revenue received by district governments. Prior to 2001, districts received virtually no revenue from local natural resource extraction. The increase in permanent revenue induced by decentralization therefore approximately equals the average value of the oil and gas grant from 2001 to 2014, denoted by $\overline{R}_d$. To examine the impact of permanent oil and gas revenue on public service delivery, I estimate the long-difference regression

$$Y_{d,2014} - Y_{d,1999} = \delta \overline{R}_d + \phi' \boldsymbol{X}_d + \lambda_{i(d)} + \varepsilon_d, \tag{10}$$

where $Y_{d,2014} - Y_{d,1999}$ is the change in the outcome from 1999 to 2014.[31] The model controls for island fixed effects, $\lambda_{i(d)}$, and covariate vector $\boldsymbol{X}_d$, which contains land area per capita multiplied by a dummy for being located in a non-hydrocarbon-rich province, as well as separate splitting dummies for parent and child districts. I estimate the regression using hydrocarbon endowment as an instrument for $\overline{R}_d$. The key identifying assumption is that the change in public service delivery from 1999 to 2014 would have been the same on average for hydrocarbon-rich districts and non-hydrocarbon-rich rich in the absence of the oil and gas revenue sharing policy.

Table 4 presents the estimates of δ. The full-sample results presented in Panel A indicate that permanent oil and gas revenue stimulates greater provision of public kindergartens and secondary schools and lesser provision of public primary schools. These results are qualitatively similar to the estimates for the general grant, albeit smaller in absolute value. Permanent oil and gas revenue has no effect on the number of doctors, and it increases the number of midwives and health centers, though the latter effect is statistically insignificant. Compared to the general grant, the oil and gas grant has a larger effect on midwives and a smaller effect on health care centers, though in both cases the 95-percent confidence interval includes the point estimate for the general grant. Interestingly, the oil and gas grant increases the prevalence of paved roads by twice as much as the general grant, and the 95-percent confidence interval excludes the point estimate for the general grant. The final column indicates that overall public service delivery increases by 0.403 standard deviations (S.E. = 0.110). The corresponding estimate for the general grant is larger at 0.543 but still falls within the 95-percent confidence interval for the effect of permanent oil and gas revenue.

In Panels B and C of Table 4, the sample is restricted to districts in hydrocarbon-rich provinces and geographically similar "control" districts. The "controls" in Panel B are districts whose centroid is within 100 km of a hydrocarbon-rich province, and the "controls" in Panel C are districts that border a hydrocarbon-rich province. The estimates based on these

[31] The baseline year is defined as 2002 for doctors and midwives, which are missing data in 1999.

subsamples are very similar to the full-sample estimates, implying a slightly larger increase in overall public service delivery.

The long-difference estimates suggest that permanent increases in the two grants stimulate public service delivery to a similar degree. Thus the baseline results for public service delivery likely reflect the differing persistence of the two grants in the post-decentralization period, rather than a greater propensity for the oil and gas grant to be wasted or stolen.

The estimates in Table 4 would be biased if hydrocarbon-rich and non-hydrocarbon-rich districts would have experienced different trends in public service delivery over the decentralized period in the absence of the oil and gas revenue sharing policy. While the validity of the endowment instrument is not directly testable, it is possible to test whether trends in public service delivery prior to decentralization differed according to hydrocarbon endowment. To do this, I add a second year of pre-decentralization public service delivery using the 1996 village census. The resulting sample of villages is slightly smaller than the baseline sample of villages, which may increase noise in the estimates somewhat. (See Appendix Section A.4 for details.) I then estimate Equation (8), using 1999 as the reference year. The coefficient γ_{1996} equals the difference in the public services gradient in endowment in 1996 compared to 1999. Finding $\gamma_{1996} \neq 0$ would mean that pre-decentralization trends in public service delivery differed by endowment, casting doubt on the identifying assumption.

Figure 5 displays the results. (Unfortunately, it is not possible to estimate pretrends for the number of doctors and midwives, as data on these outcomes are missing in 1999.) The estimates suggest that trends in public service delivery were not systematically different in hydrocarbon-rich and non-hydrocarbon-rich districts prior to decentralization. In particular, the public services index has very similar (and statistically indistinguishable) gradients in 1996 and 1999. Furthermore, the gradient increases in 2005 and continues to increase in the following years, suggesting that the permanent increase in oil and gas revenue significantly increased public service delivery, albeit with a lag.

6 Conclusion

Indonesian districts experienced large shocks to unconditional grants in the period following decentralization. Districts with greater land area per capita and few natural resources saw a larger permanent increase in the general grant starting in 2006. Districts richly endowed with hydrocarbons experienced large swings in the oil and gas grant. Public service delivery strongly responded to the general grant, but not to the oil and gas grant, suggesting that local governments consider the persistence of revenue shocks when adjusting lumpy public goods and services. The pattern of fiscal responses, and the responses to a permanent increase in oil and gas revenue, support this interpretation. Revenue persistence is an important, yet neglected, determinant of how public service delivery responds to revenue shocks.

A long line of research argues that non-tax revenue hinders government performance, but scholars have only recently started comparing policy responses to tax and non-tax revenue. This work has done an admirable job in identifying exogenous increases in local tax revenue using the rollout of tax-capacity investments (Gadenne, 2017) and upward revisions to assessed property values (Martínez, 2020). In both papers the tax-revenue increases appear to be permanent. In Gadenne (2017) fiscal transfers increase when municipal population crosses a cutoff over time. The amount of time that crossing municipalities spend just above the cutoff is similar to the amount of time that municipalities are observed in a tax-capacity program in her sample, so the revenue shocks could have similar persistence. Martínez (2020) exploits shocks to shared oil and gas revenue, which are clearly transitory. To quantify the accountability effects of local taxation, future research should first establish that tax and non-tax revenue shocks used for identification purposes exhibit similar persistence.

The results are potentially relevant to how central governments use intergovernmental grants to conduct national fiscal policy. The general grant stimulated larger and more immediate fiscal responses than the oil and gas grant. This suggests that increasing transfers to local governments during economic downturns could be more effective at stimulating the economy when the increase is perceived to be permanent.

If local responses to revenue shocks depend on the shock's impact on lifetime fiscal resources, then both the initial size and the persistence of the shock should matter. This paper studies a context in which revenue shocks were similar in size but differed in persistence. An interesting question for future work is whether responses differ according to the initial size of the shock, holding persistence fixed. Future research should also examine how local governments respond to different types of revenue shocks in contexts with significant local taxation, where governments have an additional margin of response—tax cuts.

References

AGUSTINA, C. D., E. AHMAD, D. NUGROHO, AND H. SIAGIAN (2012): "Political Economy of Natural Resource Revenue Sharing in Indonesia," Working Paper 55, Asia Research Centre.

ALBOUY, D. (2012): "Evaluating the Efficiency and Equity of Federal Fiscal Equalization," *Journal of Public Economics*, 96, 824–839.

ARELLANO, M. AND S. BOND (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, 58, 277–297.

ARELLANO, M. AND O. BOVER (1995): "Another Look at the Instrumental Variable Estimation of Error-Components Models," *Journal of Econometrics*, 68, 29–51.

AREZKI, R., F. VAN DER PLOEG, AND F. TOSCANI (2019): "The Shifting Natural Wealth of Nations: The Role of Market Orientation," *Journal of Development Economics*, 138, 228–245.

BAICKER, K. (2005): "Extensive or Intensive Generosity? The Price and Income Effects of Federal Grants," *Review of Economics and Statistics*, 87, 371–384.

BAZZI, S. AND M. A. CLEMENS (2013): "Blunt Instruments: Avoiding Common Pitfalls in

Identifying the Causes of Economic Growth," *American Economic Journal: Macroeconomics*, 5, 152–186.

BAZZI, S. AND M. GUDGEON (2021): "The Political Boundaries of Ethnic Divisions," *American Economic Journal: Applied Economics*, 13, 235–66.

BESFAMILLE, M., D. JORRAT, O. MANZANO, AND P. SANGUINETTI (2021): "How Do Subnational Governments React to Shocks to Different Revenue Sources? Evidence from Hydrocarbon- Producing Provinces in Argentina," Working Paper 9251, CESifo.

BLÖNDAL, J. R., I. HAWKESWORTH, AND H.-D. CHOI (2009): "Budgeting in Indonesia," *OECD Journal on Budgeting*, 9, 49–79.

BLUNDELL, R. AND S. BOND (1998): "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics*, 87, 115–143.

BOND, S. (2002): "Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice," Working Paper CWP09/02, Cemmap, Institute for Fiscal Studies.

BORGE, L.-E., P. PARMER, AND R. TORVIK (2015): "Local Natural Resource Curse?" *Journal of Public Economics*, 131, 101–114.

BROLLO, F., T. NANNICINI, R. PEROTTI, AND G. TABELLINI (2013): "The Political Resource Curse," *American Economic Review*, 103, 1759–1796.

BURGESS, R., M. HANSEN, B. A. OLKEN, P. POTAPOV, AND S. SIEBER (2012): "The Political Economy of Deforestation in the Tropics," *Quarterly Journal of Economics*, 127, 1707–1754.

CAMERON, A. C., J. B. GELBACH, AND D. L. MILLER (2011): "Robust Inference With Multiway Clustering," *Journal of Business and Economic Statistics*, 29, 238–249.

CASCIO, E. U., N. GORDON, AND S. REBER (2013): "Local Responses to Federal Grants: Evidence from the Introduction of Title I in the South," *American Economic Journal: Economic Policy*, 5, 126–159.

CASELLI, F. AND G. MICHAELS (2013): "Do Oil Windfalls Improve Living Standards? Evidence from Brazil," *American Economic Journal: Applied Economics*, 5, 208–238.

CASSIDY, T. (2019): "The Long-Run Effects of Oil Wealth on Development: Evidence from Petroleum Geology," *Economic Journal*, 129, 2745–2778.

CHRISTELIS, D., D. GEORGARAKOS, T. JAPPELLI, L. PISTAFERRI, AND M. VAN ROOIJ (2020): "Asymmetric Consumption Effects of Transitory Income Shocks," *Economic Journal*, 129, 2322–2341.

CUST, J. AND T. HARDING (2019): "Institutions and the Location of Oil Exploration," *Journal of the European Economic Association*, 18, 1321–1350.

CUST, J. AND C. VIALE (2016): "Is There Evidence for a Subnational Resource Curse?" Policy paper, Natural Resource Governance Institute.

DAHLBERG, M., E. MÖRK, J. RATTSØ, AND H. ÅGREN (2008): "Using a Discontinuous Grant Rule to Identify the Effect of Grants on Local Taxes and Spending," *Journal of Public Economics*, 92, 2320–2335.

DAHLBY, B. AND E. FEREDE (2016): "The Stimulative Effects of Intergovernmental Grants and the Marginal Cost of Public Funds," *International Tax and Public Finance*, 23, 114–139.

FERRAZ, C. AND F. FINAN (2008): "Exposing Corrupt Politicians: The Effects of Brazil's Publicly Released Audits on Local Elections," *Quarterly Journal of Economics*, 123, 703–745.

——— (2011): "Electoral Accountability and Corruption: Evidence from the Audits of Local Governments," *American Economic Review*, 101, 1274–1311.

FITRANI, F., B. HOFMAN, AND K. KAISER (2005): "Unity in Diversity? The Creation of New Local Governments in a Decentralising Indonesia," *Bulletin of Indonesian Economic Studies*, 41, 57–79.

GADENNE, L. (2017): "Tax Me, But Spend Wisely? Sources of Public Finance and Government Accountability," *American Economic Journal: Applied Economics*, 9, 274–314.

GADENNE, L. AND M. SINGHAL (2014): "Decentralization in Developing Economies," *Annual Review of Economics*, 6, 581–604.

GENNARI, E. AND G. MESSINA (2014): "How Sticky are Local Expenditures in Italy? Assessing the Relevance of the Flypaper Effect through Municipal Data," *International Tax and Public Finance*, 21, 324–344.

GORDON, N. (2004): "Do Federal Grants Boost School Spending? Evidence from Title I," *Journal of Public Economics*, 88, 1771–1792.

HARRIS, R. D. F. AND E. TZAVALIS (1999): "Inference for Unit Roots in Dynamic Panels where the Time Dimension is Fixed," *Journal of Econometrics*, 91, 201–226.

HELM, I. AND J. STUHLER (2021): "The Dynamic Response of Municipal Budgets to Revenue Shocks," Working paper, Universidad Carlos III de Madrid.

HINES, J. R. AND R. H. THALER (1995): "The Flypaper Effect," *Journal of Economic Perspectives*, 9, 217–226.

HOLM, S. (1979): "A Simple Sequentially Rejective Multiple Test Procedure," *Scandinavian Journal of Statistics*, 6, 65–70.

HOLTZ-EAKIN, D., W. NEWEY, AND H. S. ROSEN (1988): "Estimating Vector Autoregressions with Panel Data," *Econometrica*, 56, 1371–1395.

INMAN, R. P. (2008): "The Flypaper Effect," Working Paper 14579, NBER.

JORDÀ, S. (2005): "Estimation and Inference of Impulse Responses by Local Projections," *American Economic Review*, 95, 161–182.

KHAN, A. AND J. K. THOMAS (2008): "Idiosyncratic Shocks and the Role of Nonconvexities in Plant and Aggregate Investment Dynamics," *Econometrica*, 76, 395–436.

KLEIBERGEN, F. AND R. PAAP (2006): "Generalized Reduced Rank Tests Using the Singular Value Decomposition," *Journal of Econometrics*, 133, 97–126.

KNIGHT, B. (2002): "Endogenous Federal Grants and Crowd-Out of State Government Spending: Theory and Evidence from the Federal Highway Aid Program," *American Economic Review*, 92, 71–92.

LEDUC, S. AND D. WILSON (2017): "Are State Governments Roadblocks to Federal Stimulus? Evidence on the Flypaper Effect of Highway Grants in the 2009 Recovery Act," *American Economic Journal: Economic Policy*, 9, 253–292.

LELAND, H. E. (1968): "Saving and Uncertainty: The Precautionary Demand for Saving," *Quarterly Journal of Economics*, 82, 465–473.

LEWIS, B. D. AND A. OOSTERMAN (2009): "The Impact of Decentralization on Subnational Government Fiscal Slack in Indonesia," *Public Budgeting and Finance*, 29, 27–47.

LITSCHIG, S. AND K. M. MORRISON (2013): "The Impact of Intergovernmental Transfers on Education Outcomes and Poverty Reduction," *American Economic Journal: Applied Economics*, 5, 206–240.

LIU, C. AND G. MA (2016): "Taxation without Representation: Local Fiscal Response to Intergovernmental Transfers in China," *International Tax and Public Finance*, 23, 854–874.

LUNDQVIST, H. (2015): "Granting Public or Private Consumption? Effects of Grants on Local Public Spending and Income Taxes," *International Tax and Public Finance*, 22, 41–72.

LUTZ, B. (2010): "Taxation with Representation: Intergovernmental Grants in a Plebiscite Democracy," *Review of Economics and Statistics*, 92, 316–332.

MARTÍNEZ, L. R. (2020): "Sources of Revenue and Government Performance: Evidence from Colombia," Working paper, University of Chicago.

MARTÍNEZ-BRAVO, M., P. MUKHERJEE, AND A. STEGMANN (2017): "The Non-Democratic Roots of Elite Capture: Evidence from Soeharto Mayors in Indonesia," *Econometrica*, 85, 1991–2010.

MONTEIRO, J. AND C. FERRAZ (2014): "Learning to Punish: Resource Windfalls and Political Accountability in Brazil," Working paper, PUC-Rio.

NATURAL RESOURCE GOVERNANCE INSTITUTE (2016): "Natural Resource Revenue Sharing," Technical report, Natural Resource Governance Institute.

NICKELL, S. (1981): "Biases in Dynamic Models with Fixed Effects," *Econometrica*, 49, 1417–1426.

OBSTFELD, M. AND K. ROGOFF (1996): *Foundations of International Macroeconomics*, Cambridge, MA: MIT Press, first ed.

OLKEN, B. (2007): "Monitoring Corruption: Evidence from a Field Experiment in Indonesia," *Journal of Political Economy*, 115, 200–249.

OLSSON, O. AND M. VALSECCHI (2015): "Resource Windfalls and Local Government Behavior: Evidence from a Policy Reform in Indonesia," Working Paper 635, SWOPEC.

REINIKKA, R. AND J. SVENSSON (2004): "Local Capture: Evidence from a Central Government Transfer Program in Uganda," *Quarterly Journal of Economics*, 119, 679–705.

ROODMAN, D. (2009): "A Note on the Theme of Too Many Instruments," *Oxford Bulletin of Economics and Statistics*, 71, 135–158.

RYSTAD ENERGY (2016): "UCube Database," https://www.rystadenergy.com/Products/EnP-Solutions/UCube, accessed September 18, 2016.

SANDERSON, E. AND F. WINDMEIJER (2016): "A Weak Instrument F-test in Linear IV Models with Multiple Endogenous Variables," *Journal of Econometrics*, 190, 212–221.

SHAH, A. (2006): "A Practitioner's Guide to Intergovernmental Fiscal Transfers," Policy Research Working Paper 4039, World Bank.

SHAH, A., R. QIBTHIYYAH, AND A. DITA (2012): "General Purpose Central-Provincial-Local Transfers (DAU) in Indonesia: From Gap Filling to Ensuring Fair Access to Essential Public Services for All," Working paper, World Bank.

SHAH, A., S. SHAH, C. HEYMANS, J. STEFFENSEN, B. QIAQO, O. ALOK, S. ECKARDT, M. MAKHMUTOVA, P. SWIANIEWICZ, M. ASENSIO, J. R. AFONSO, E. ARAUJO, AND L. LETELIER (2006): *Local Governance In Developing Countries*, World Bank.

SJAHRIR, B. S., K. KIS-KATOS, AND G. G. SHULZE (2013): "Political Budget Cycles in Indonesia at the District Level," *Economic Letters*, 120, 342–345.

SOLÉ-OLLÉ, A. AND E. VILADECANS-MARSAL (2019): "Housing Booms and Local Spending," *Journal of Urban Economics*, 113, 103185.

UNFPA INDONESIA (2014): "Midwifery Consultancy Report," Technical report, United Nations Population Fund.

UNITED NATIONS (2009): *International Guidelines on Decentralization and Access to Basic Services for All*, Nairobi: UN-HABITAT.

VAN DER PLOEG, F. (2011): "Natural Resources: Curse or Blessing?" *Journal of Economic Literature*, 49, 366–420.

VAN DER PLOEG, F. AND A. J. VENABLES (2013): "Absorbing a Windfall of Foreign Exchange: Dutch Disease Dynamics," *Journal of Development Economics*, 103, 229–243.

VEGH, C. A. AND G. VULETIN (2015): "Unsticking the Flypaper Effect in an Uncertain World," *Journal of Public Economics*, 131, 142–155.

VON HALDENWANG, C. (2017): "The Political Cost of Local Revenue Mobilisation: Decentralisation of the Property Tax in Indonesia," *Public Finance and Management*, 17, 124–151.

WASI, N. AND A. FLAAEN (2015): "Record linkage using Stata: Preprocessing, linking, and reviewing utilities," *Stata Journal*, 15, 672–697.

WORLD BANK (1999): *World Development Report 1999/2000: Entering the 21st Century - The Changing Development Landscape*, World Bank.

——— (2007): "Spending for Development: Making the Most of Indonesia's Opportunities," Technical report, World Bank, Jakarta.

——— (2010): "Village Capacity in Maintaining Infrastructure: Evidence from Rural Indonesia," Technical report, World Bank, Jakarta.

ZELDES, S. P. (1989): "Consumption and Liquidity Constraints: An Empirical Investigation," *Journal of Political Economy*, 97, 305–346.

7 Tables

Table 1: First Stage Estimates

	General Grant p.c.		Oil & Gas Grant p.c.	
	(1)	(2)	(3)	(4)
	Panel A: One-Year Changes ($k = 1$)			
Area p.c. 2006 × Non-Oil/Gas × Year ≥ 2006	0.81***	0.78***		−0.01
	(0.08)	(0.09)		(0.02)
Endowment p.c. × Agg. Oil & Gas Grant		−0.03	0.83***	0.82***
		(0.03)	(0.04)	(0.04)
Observations	4,286	4,286	4,286	4,286
District clusters	348	348	348	348
Prov. × year clusters	358	358	358	358
	Panel B: Two-Year Changes ($k = 2$)			
Area p.c. 2006 × Non-Oil/Gas × Year ≥ 2006	0.84***	0.89***		−0.03
	(0.14)	(0.13)		(0.03)
Endowment p.c. × Agg. Oil & Gas Grant		0.07	0.80***	0.79***
		(0.05)	(0.06)	(0.06)
Observations	3,953	3,953	3,953	3,953
District clusters	348	348	348	348
Prov. × year clusters	332	332	332	332

Notes: Panel A presents first-stage estimates based on one-year differences of the variables, and Panel B presents estimates based on two-year differences. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Dynamic Responses of Total Expenditure to Grants

	Response of Total Expenditure per Capita after h Years					
	$h = 0$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 5$
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: One-Year Changes in Grants ($k = 1$)					
General Grant p.c.	0.72^{***}	1.06^{***}	1.45^{***}	1.63^{***}	0.72^{***}	0.71^{***}
	(0.11)	(0.19)	(0.37)	(0.23)	(0.16)	(0.18)
Oil & Gas Grant p.c.	0.22^{***}	0.32^{***}	0.50^{***}	0.45^{***}	0.10^{***}	0.12
	(0.07)	(0.09)	(0.16)	(0.06)	(0.03)	(0.12)
H_0: Gen. = Oil & Gas						
Unadjusted p-value	0.000	0.000	0.005	0.000	0.000	0.000
Adjusted p-value	*0.000*	*0.000*	*0.005*	*0.000*	*0.000*	*0.000*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.995	0.388	0.108	0.003	0.956	0.941
Adjusted p-value	*0.995*	*1.000*	*0.538*	*0.020*	*1.000*	*1.000*
SW F-stat.: Gen. Grant	77.0	87.4	96.8	103.2	92.5	109.4
SW F-stat.: Oil & Gas	188.3	162.8	191.8	200.2	386.3	256.7
Observations	4,286	3,953	3,608	3,268	2,921	2,576
District clusters	348	348	348	348	348	348
Prov. × year clusters	358	330	302	274	246	218
	Panel B: Two-Year Changes in Grants ($k = 2$)					
General Grant p.c.	0.78^{***}	1.04^{***}	1.41^{***}	0.95^{***}	0.56^{***}	0.63^{***}
	(0.15)	(0.28)	(0.25)	(0.21)	(0.13)	(0.17)
Oil & Gas Grant p.c.	0.10	0.25^{*}	0.24^{***}	0.06	−0.07	0.09
	(0.07)	(0.13)	(0.09)	(0.08)	(0.10)	(0.13)
H_0: Gen. = Oil & Gas						
Unadjusted p-value	0.000	0.010	0.000	0.000	0.000	0.003
Adjusted p-value	*0.000*	*0.010*	*0.000*	*0.001*	*0.000*	*0.006*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.927	0.448	0.052	0.592	1.000	0.986
Adjusted p-value	*1.000*	*1.000*	*0.314*	*1.000*	*1.000*	*1.000*
SW F-stat.: Gen. Grant	47.1	49.3	50.0	49.9	51.6	50.6
SW F-stat.: Oil & Gas	817.8	740.4	618.2	724.0	484.4	512.0
Observations	3,953	3,608	3,268	2,920	2,576	2,234
District clusters	348	348	348	348	348	348
Prov. × year clusters	332	304	276	248	220	192

Notes: This table reports IV estimates of β^h and δ^h in Equation (6). Panel A presents estimates based on one-year changes in grants, and Panel B presents estimates based on two-year changes in grants. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Adjusted p-values use the Holm correction for multiple hypothesis testing. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Mean Responses of Public Service Delivery to Grants

	Public Schools per 10,000 People			Health Personnel & Facilities per 10,000 People			Share of Villages	Index
	(1) Kindergarten	(2) Primary	(3) Secondary	(4) Doctors	(5) Midwives	(6) Health Centers	(7) Paved Road	(8)
General Grant p.c.	0.338**	−0.656***	1.081***	0.463**	1.249**	0.777*	0.048**	0.543***
	(0.136)	(0.217)	(0.160)	(0.203)	(0.488)	(0.426)	(0.019)	(0.118)
Oil & Gas Grant p.c.	0.014	−0.176**	−0.006	−0.024	−0.089	0.016	0.002	−0.039
	(0.046)	(0.072)	(0.197)	(0.106)	(0.219)	(0.168)	(0.017)	(0.109)
Baseline mean outcome	0.192	8.015	1.221	1.665	5.691	2.598	0.641	-0.001
H_0: Gen. = Oil & Gas								
Unadjusted p-value	0.020	0.017	0.000	0.029	0.023	0.069	0.036	0.000
Adjusted p-value	*0.100*	*0.099*	*0.000*	*0.087*	*0.090*	*0.069*	*0.071*	
SW F-stat.: Gen. Grant	105.5	105.5	105.5	105.6	105.6	100.6	105.5	105.5
SW F-stat.: Oil & Gas	108.8	108.8	108.8	107.6	107.6	372.6	108.8	108.8
Observations	1,392	1,392	1,392	1,388	1,388	1,044	1,392	1,392
District clusters	348	348	348	347	347	348	348	348
Prov. × year clusters	111	111	111	111	111	83	111	111

Notes: This table reports IV estimates of the mean responses of public service delivery to the general grant, $\sum_{h\in\{0,3,6\}} \beta^h/3$, and to the oil and gas grant, $\sum_{h\in\{0,3,6\}} \delta^h/3$, obtained by replacing the outcome in Equation (9) with $\sum_{h\in\{0,3,6\}} Y_{d,t+h}/3 - Y_{d,t-3}$. Because the data on health care centers are missing in 2008, β^0 and δ^0 are not identifiable for this outcome, so the table reports $\sum_{h\in\{3,6\}} \beta^h/2$ and $\sum_{h\in\{3,6\}} \delta^h/2$. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. The baseline mean of the outcome variable is measured in 2002. Adjusted p-values use the Holm correction for multiple hypothesis testing. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Public Service Delivery Responses to Permanent Oil and Gas Grant Revenue

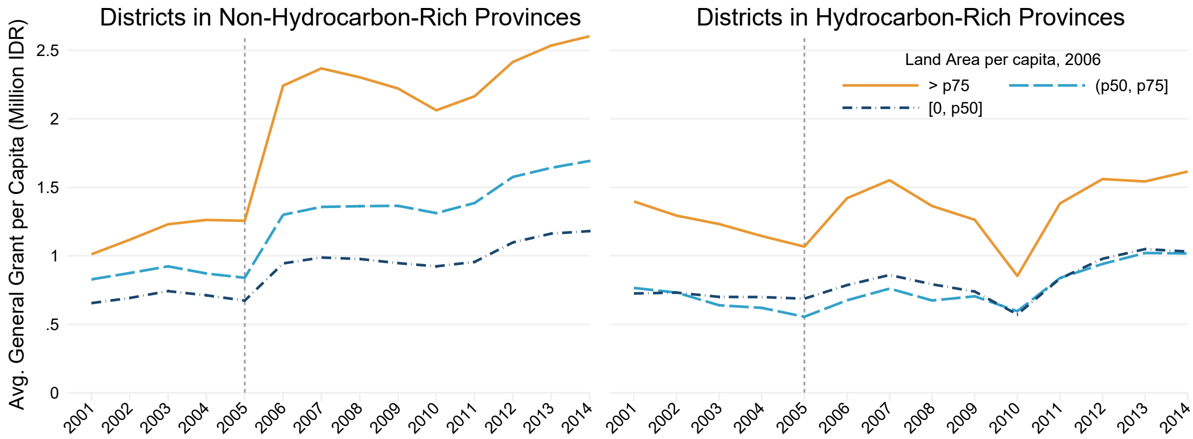
Long Difference of Outcome:	Public Schools per 10,000 People			Health Personnel & Facilities per 10,000 People			Share of Villages	Index
	(1) Kindergarten	(2) Primary	(3) Secondary	(4) Doctors	(5) Midwives	(6) Health Centers	(7) Paved Road	(8)
	Panel A: Full Sample of Districts							
Avg. Oil & Gas Grant p.c.	0.131**	−0.004	0.758***	0.208**	1.276**	0.396**	0.099***	0.403***
	(0.065)	(0.196)	(0.197)	(0.086)	(0.627)	(0.165)	(0.018)	(0.110)
KP first-stage F-stat.	87.9	87.9	87.9	87.8	87.8	87.9	87.9	87.9
Observations	348	348	348	347	347	348	348	348
	Panel B: Control Districts within 100 km of Hydrocarbon-Rich Province							
Avg. Oil & Gas Grant p.c.	0.135**	0.088	0.777***	0.219**	1.201*	0.403**	0.101***	0.416***
	(0.064)	(0.192)	(0.195)	(0.085)	(0.632)	(0.163)	(0.017)	(0.108)
KP first-stage F-stat.	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Observations	262	262	262	262	262	262	262	262
	Panel C: Control Districts Bordering Hydrocarbon-Rich Province							
Avg. Oil & Gas Grant p.c.	0.122	0.243	0.712***	0.177	0.855	0.471***	0.102***	0.408***
	(0.077)	(0.196)	(0.218)	(0.115)	(0.649)	(0.163)	(0.021)	(0.124)
KP first-stage F-stat.	73.7	73.7	73.7	73.7	73.7	73.7	73.7	73.7
Observations	110	110	110	110	110	110	110	110

Notes: This table reports IV estimates of δ in Equation (10). Outcomes are measured in long differences from 1999 to 2014, except for doctors and midwives, which are measured in long differences from 2002 to 2014. Each regression controls for island fixed effects and indicators for whether the district ever split, defined separately for parent and child districts. The Kleibergen and Paap (2006) first-stage Wald rk F-statistic is reported. Standard errors, reported in parentheses, are robust to heteroskedasticity. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

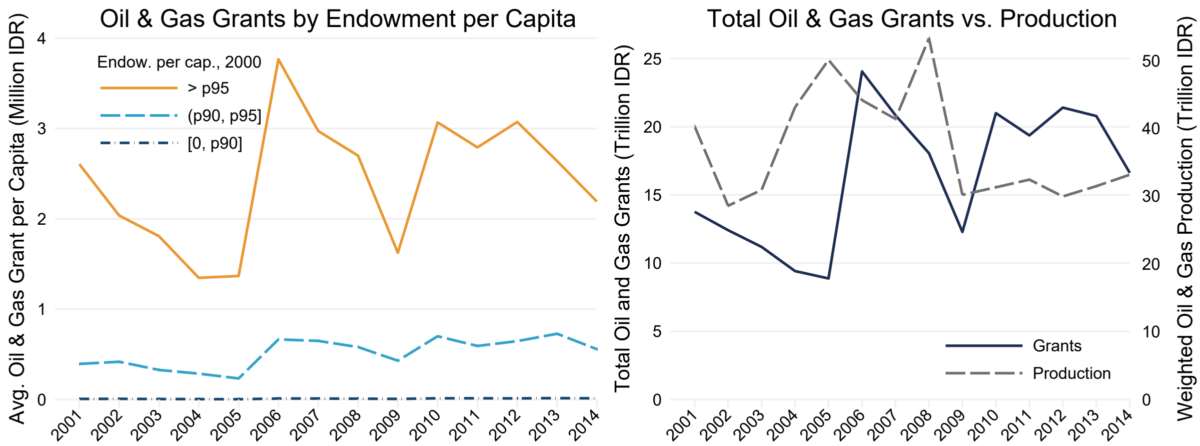
8 Figures

Figure 1: Permanent and Transitory Shocks to Grant Revenue

(a) District General Grant Revenue by Land Area per Capita



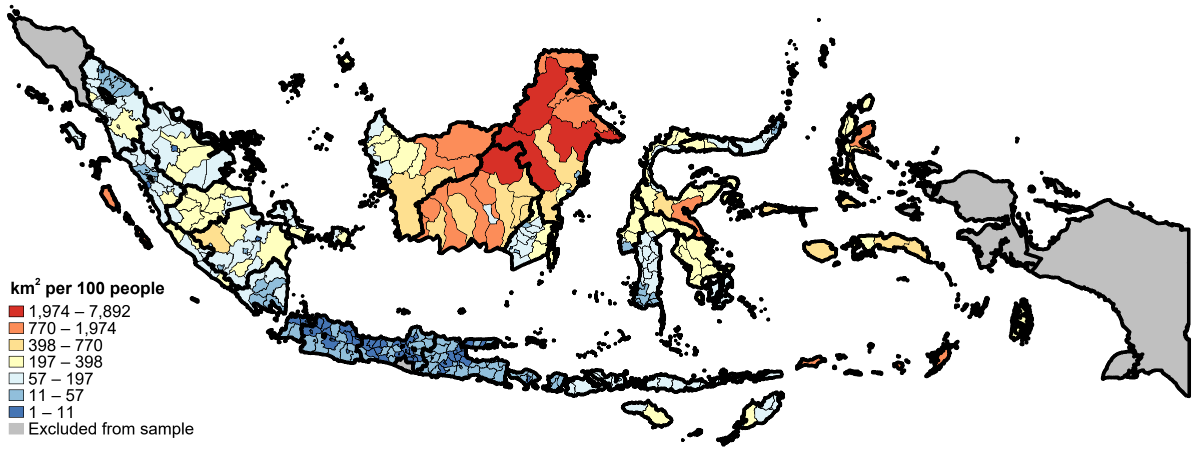
(b) District Oil and Gas Grant Revenue and Aggregate Production



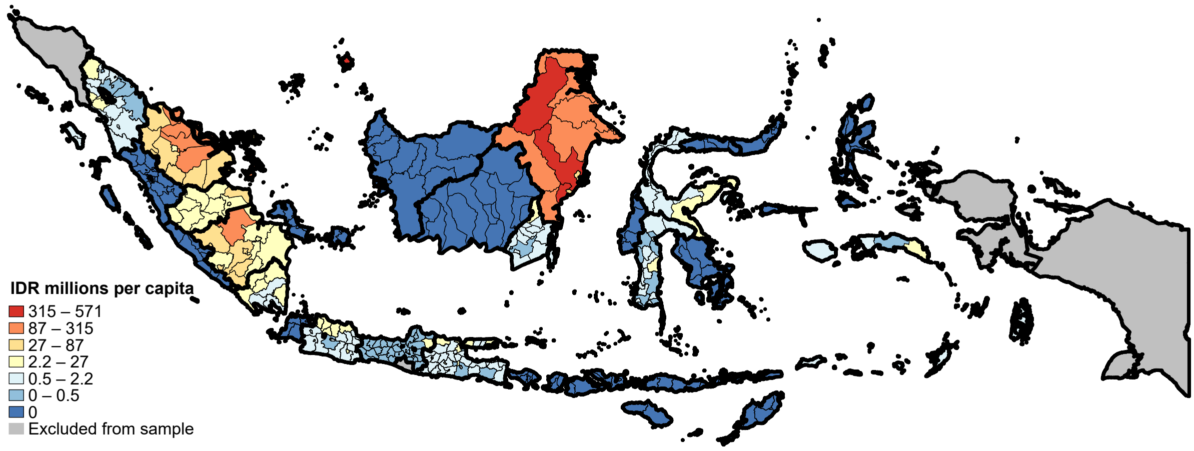
Notes: Panel (a) plots average general grant revenue per capita for districts located in non-hydrocarbon-rich provinces (left panel) and hydrocarbon-rich provinces (right panel) and divided according to land area per capita in 2006. Panel (b) plots average oil and gas grant revenue for districts divided according to hydrocarbon endowment per capita (left panel) and total oil and gas grants and production (right panel). Grants are expressed in constant 2010 IDR 1 million. Hydrocarbon-rich provinces are Riau, Kepulauan Riau, Jambi, Sumatera Selatan, and Kalimantan Timur. The vertical dashed line indicates the timing of the general grant reform.

Figure 2: District Exposure to Grant Revenue Shocks

(a) Land Area per Capita



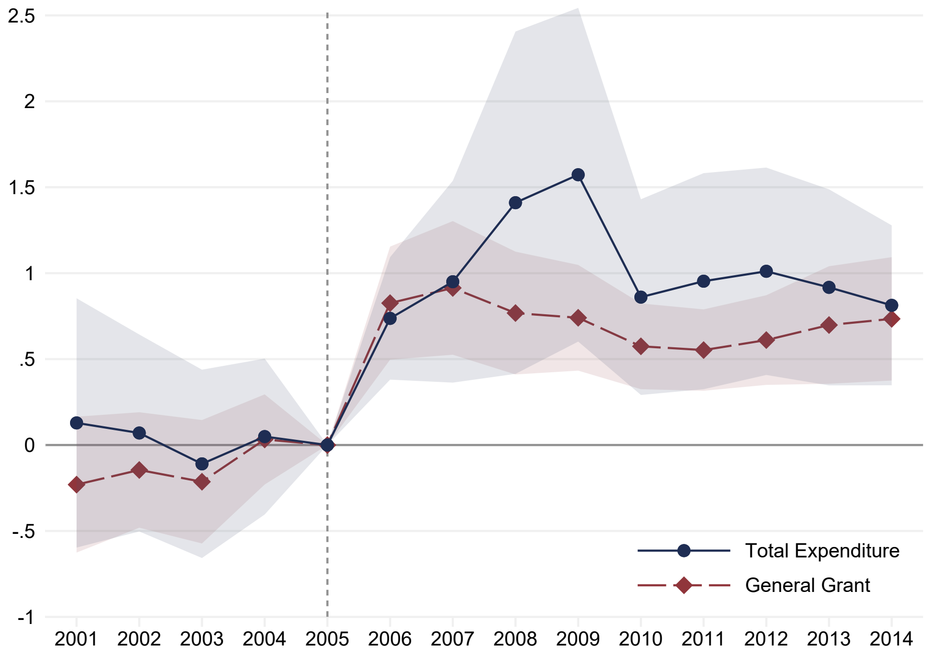
(b) Oil and Gas Endowment per Capita



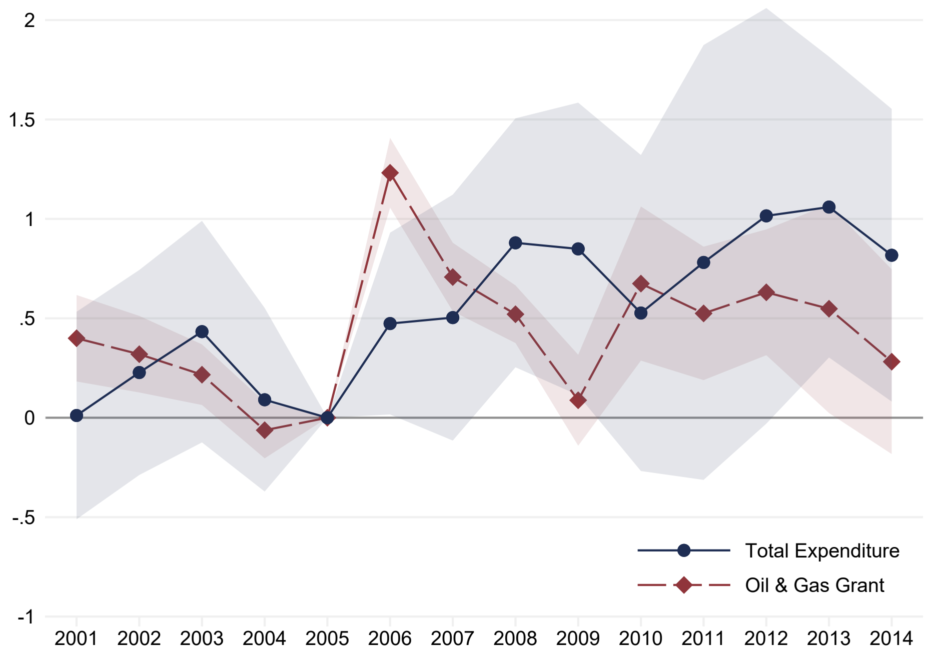
Notes: District borders (thin lines) and province borders (thick lines) are displayed as they existed in 2006. Oil and gas endowment per capita is calculated according to Equation (A.2) in the Appendix. Color bins are based on the 25th, 50th, 75th, 90th, 95th, and 99th percentiles.

Figure 3: Reduced-Form Effects of Grant Exposure on Fiscal Variables over Time

(a) Year-by-Year Gradient in *Area p.c. 2006* × *Non-Oil/Gas* Relative to 2005



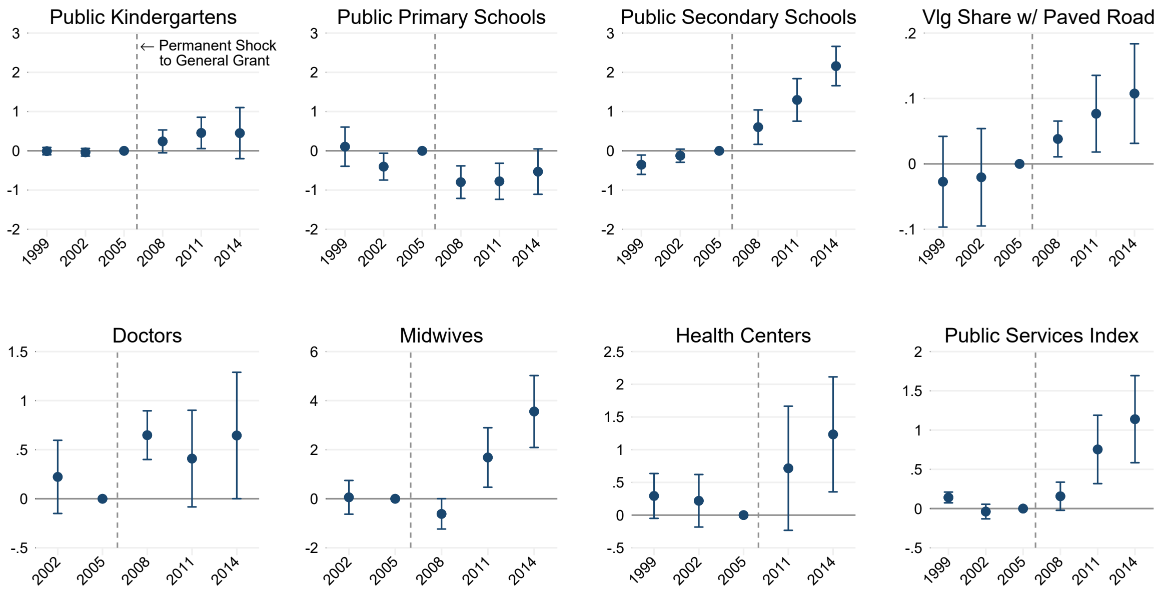
(b) Year-by-Year Gradient in *Endowment p.c.* Relative to 2005



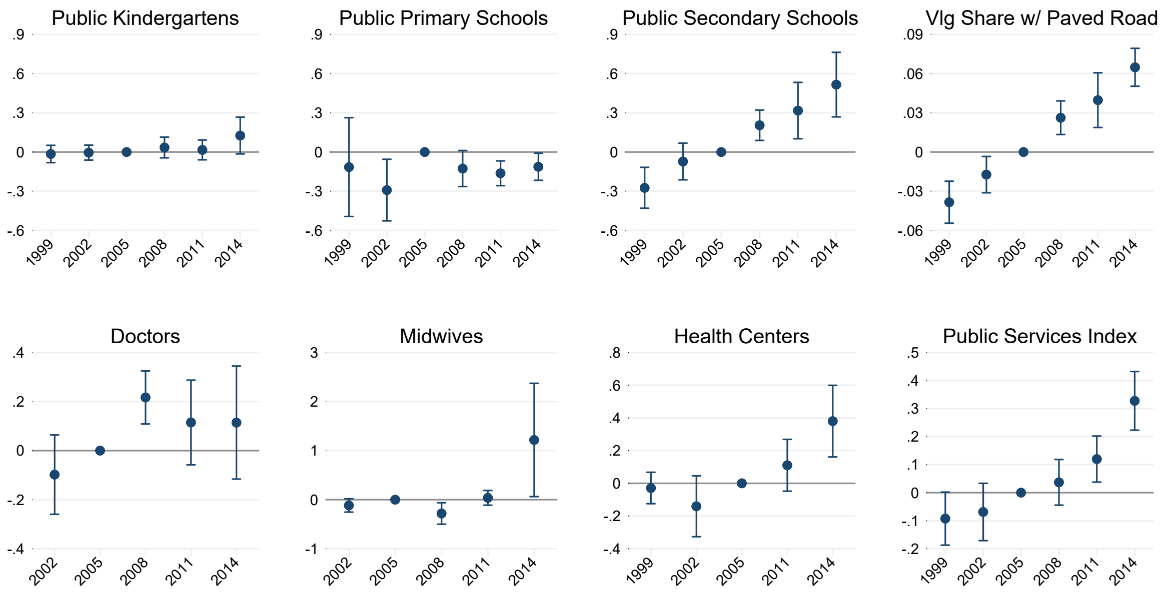
Notes: This figure displays point estimates and 95-percent confidence intervals for parameters from Equation (5). The blue circles are estimates of $\{\theta_j\}_{j\in\mathcal{J}}$ (Panel (a)) and $\{\gamma_j\}_{j\in\mathcal{J}}$ (Panel (b)) when the outcome is total expenditure per capita. The red diamonds in Panel (a) are estimates of $\{\theta_j\}_{j\in\mathcal{J}}$ when the outcome is general grant revenue per capita, and the red diamonds in Panel (b) are estimates of $\{\gamma_j\}_{j\in\mathcal{J}}$ when the outcome is oil and gas grant revenue per capita. Hydrocarbon endowment is measured in constant 2010 IDR 100 millions per capita to make the vertical axes of the two graphs similar. Confidence intervals are robust to heteroskedasticity and two-way clustering by district and province-by-year.

Figure 4: Reduced-Form Effects of Grant Exposure on Public Service Delivery over Time

(a) Year-by-Year Gradient in *Area p.c. 2006* × *Non-Oil/Gas* Relative to 2005



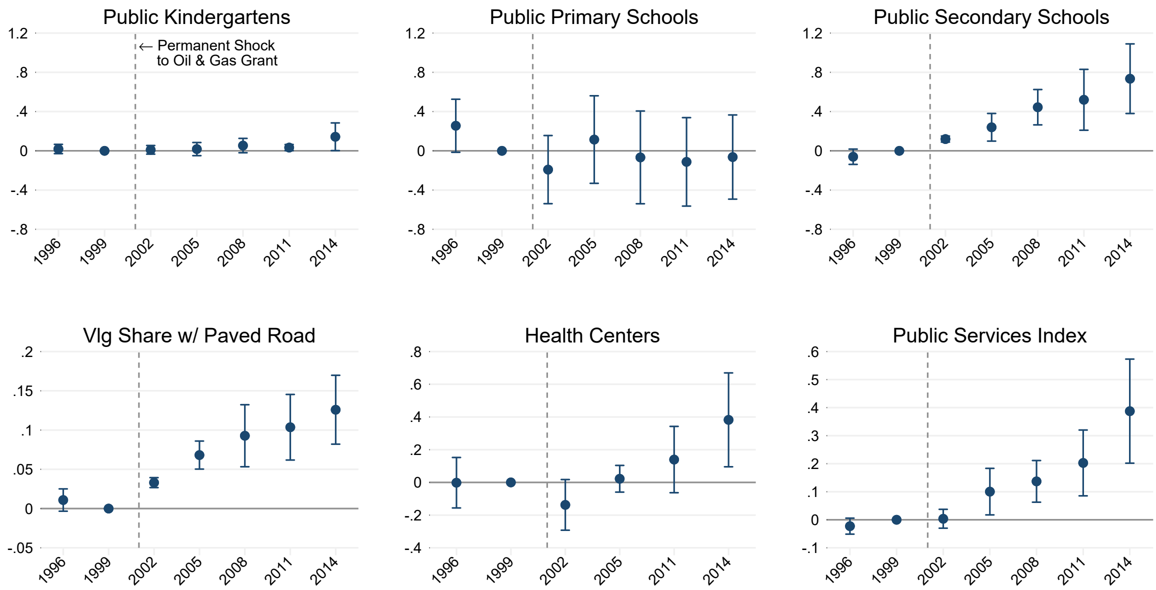
(b) Year-by-Year Gradient in *Endowment p.c.* Relative to 2005



Notes: This figure displays point estimates and 95-percent confidence intervals for $\{\theta_\ell\}_{\ell \in \mathscr{L}}$ (Panel (a)) and $\{\gamma_\ell\}_{\ell \in \mathscr{L}}$ (Panel (b)) in Equation (8). The reference year is 2005. Hydrocarbon endowment is measured in constant 2010 IDR 100 millions per capita to make the vertical axes in the two panels similar. Confidence intervals are robust to heteroskedasticity and two-way clustering by district and province-by-year.

Figure 5: Reduced-Form Effects of Oil and Gas Grant Exposure on Public Service Delivery

(a) Year-by-Year Gradient in *Endowment p.c.* Relative to 1999



Notes: This figure displays point estimates and 95-percent confidence intervals for $\{\gamma_\ell\}_{\ell\in\mathscr{L}}$ in Equation (8), where the reference year is 1999. Hydrocarbon endowment is measured in constant 2010 IDR 100 millions per capita. Confidence intervals are robust to heteroskedasticity and two-way clustering by district and province-by-year.

A Appendix (For Online Publication)

Contents

A.1 Extensions to Theoretical Model

This section briefly discusses 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 $p_t + \phi I_t/2$, so that the marginal cost of investment is increasing and linear in the level of investment. Then equation (1) is modified to become

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

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 to durables consumption in every period, (ii) increase the steady-state ratio of nondurables 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, adding a fixed cost of making large adjustments 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 could 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 et al., 2020). This asymmetric response implies that district governments should react more strongly to the oil and gas grant 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 grant, and hence were most exposed to the grant shocks (World Bank, 2007, p. 127). Figure A.6 shows that reserves per capita were much higher in the hydrocarbon-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).[32] 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."[33] The diversification effect is probably less relevant for Indonesia, where district governments have no control over income taxes and little control over property taxes. 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 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

The formula for the general grant is

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

Half of the general grant pool is devoted to the basic allocation. From 2001 to 2005, the basic allocation consisted of a small lump-sum portion and a portion that covered most of the civil service wage bill. Starting in 2006, the lump sum was eliminated and the basic allocation covered the entire civil service wage bill (World Bank, 2007, p. 193), meaning that the grant increases one-for-one with wage costs. Central regulations on recruitment and staffing prevent exorbitant spending on public employees that would otherwise occur due to the structure of the grant (Shah et al., 2012). The remaining half of the general grant pool is allocated according to the fiscal gap, defined as the difference between expenditure needs and fiscal capacity.

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

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

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

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

Imputed own-source revenue is calculated as the predicted values from a regression of actual own-source revenue on regional GDP (World Bank, 2007, p. 193). From 2002 to 2011, 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 (Shah et al., 2012).

From 2002 to 2005 the expenditure-needs formula was

$$\overline{Exp}_t \cdot (0.4 \cdot PopI_{d,t} + 0.1 \cdot PovGapI_{d,t} + 0.1 \cdot AreaI_{d,t} + 0.4 \cdot CostI_{d,t}),$$

where $\overline{Exp}_t$ is average expenditure of all district governments in year t, $PopI_{d,t}$ is the population index equal to the population of district d divided by average district population in year t, and the poverty gap, land area, and construction cost indices are defined analogously.

Starting in 2006, the expenditure-needs formula was

$$\overline{Exp}_t \cdot (0.3 \cdot PopI_{d,t} + 0.1 \cdot 1/HDI_{d,t} + 0.15 \cdot GDPI_{d,t} + 0.15 \cdot AreaI_{d,t} + 0.3 \cdot CostI_{d,t}),$$

where $HDI_{d,t}$ is the human development index and $GDPI_{d,t}$ is the GDP per capita index. The expenditure-needs formula changed in three ways. First, $\overline{Exp}_t$ 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 GDP per capita index.[34] 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 to 2011 (Shah et al., 2012).[35]

Holding fixed the Basic Allocation and Fiscal Capacity, the change in the per capita general

[34] The latter index is district GDP per capita divided by average district GDP per capita.

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

grant allocation to district d from 2005 to 2006 is given by

$$\begin{aligned}\frac{GenGrant_{d,06}}{Pop_{d,06}}-\frac{GenGrant_{d,05}}{Pop_{d,05}} = &\left(0.3\cdot\frac{\overline{Exp}_{06}}{\overline{Pop}_{06}}-0.4\cdot\frac{\overline{Exp}_{05}}{\overline{Pop}_{05}}\right)\\ &+\left(0.15\cdot\frac{\overline{Exp}_{06}}{\overline{Area}}\cdot\frac{Area_d}{Pop_{d,06}}-0.1\cdot\frac{\overline{Exp}_{05}}{\overline{Area}}\cdot\frac{Area_d}{Pop_{d,05}}\right)\\ &+\left(0.3\cdot\frac{\overline{Exp}_{06}}{Pop_{d,06}}\cdot\frac{Cost_{d,06}}{\overline{Cost}_{06}}-0.4\cdot\frac{\overline{Exp}_{05}}{Pop_{d,05}}\cdot\frac{Cost_{d,05}}{\overline{Cost}_{05}}\right)\\ &+\left(0.1\cdot\frac{\overline{Exp}_{06}}{Pop_{d,06}}\cdot\frac{1}{HDI_{d,06}}+0.15\cdot\frac{\overline{Exp}_{06}}{Pop_{d,06}}\cdot\frac{GDP_{d,06}}{\overline{GDP}_{06}}\right.\\ &\left.\quad-0.1\cdot\frac{\overline{Exp}_{05}}{Pop_{d,05}}\cdot\frac{PovGap_{d,05}}{\overline{PovGap}_{05}}\right).\end{aligned}$$

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.[36] 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:

$$\begin{aligned}\frac{GenGrant_{d,06}}{Pop_{d,06}}-\frac{GenGrant_{d,05}}{Pop_{d,05}} \approx &\frac{(0.3\cdot\overline{Exp}_{06}-0.4\cdot\overline{Exp}_{05})}{\overline{Pop}_{06}}\\ &+\frac{(0.15\cdot\overline{Exp}_{06}-0.1\cdot\overline{Exp}_{05})}{\overline{Area}}\cdot\frac{Area_d}{Pop_{d,06}}\\ &+\frac{(0.3\cdot\overline{Exp}_{06}-0.4\cdot\overline{Exp}_{05})}{Pop_{d,06}}\cdot\frac{Cost_{d,06}}{\overline{Cost}_{06}}\\ &+\left(0.1\cdot\frac{\overline{Exp}_{06}}{Pop_{d,06}}\cdot\frac{1}{HDI_{d,06}}+0.15\cdot\frac{\overline{Exp}_{06}}{Pop_{d,06}}\cdot\frac{GDP_{d,06}}{\overline{GDP}_{06}}\right.\\ &\left.\quad-0.1\cdot\frac{\overline{Exp}_{05}}{Pop_{d,06}}\cdot\frac{PovGap_{d,06}}{\overline{PovGap}_{06}}\right).\end{aligned}$$

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 $(0.15\cdot\overline{Exp}_{06}-0.1\cdot\overline{Exp}_{05})$ is large and positive due to the overall general grant budget increase and the increase in the weight assigned to land area. This term is scaled by relative area per capita, $Area_d/(\overline{Area}\cdot Pop_{d,06})$. The change in general grant revenue received by district d from 2005 to 2006 can be approximated as

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

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

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 Details on the Oil and Gas Grant

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.

Formally, let $R^O_{d,t}$ and $R^G_{d,t}$ denote oil and gas revenues (royalties and taxes) collected by the central government in district d in year t, and let $p(d)$ denote the province where district d is located. The oil and gas grant per capita is

$$R_{d,t} = \frac{1}{Pop_{d,t}}\left(0.062 \cdot R^O_{d,t} + 0.122 \cdot R^G_{d,t} + \frac{1}{N_{p(d),t}-1} \sum_{\substack{j \neq d \\ p(j)=p(d)}} \left(0.062 \cdot R^O_{j,t} + 0.122 \cdot R^G_{j,t}\right)\right),$$

where $Pop_{d,t}$ is the population of district d in year t, and $N_{p(d),t}$ is the number of districts in province $p(d)$ in year t. Using the Rystad UCube database (Rystad Energy, 2016), I calculate for each district the total economically recoverable oil and gas resources as of 2000 (and known in 2000)—prior to fiscal decentralization. I then convert physical endowments into monetary values using the average prices of oil and gas over 2001–2014, and I denote these measures by $E^O_{d,t}$ and $E^G_{d,t}$. Each variable is measured in constant 2010 IDR (billions). The only reason these endowment measures could vary over time is because district and province borders sometimes change.[37] Using the sharing rule, I define the variable

$$E_{d,t} = \frac{1}{Pop_{d,t}}\left(0.062 \cdot E^O_{d,t} + 0.122 \cdot E^G_{d,t} + \frac{1}{N_{p(d),t}-1} \sum_{\substack{j \neq d \\ p(j)=p(d)}} \left(0.062 \cdot E^O_{j,t} + 0.122 \cdot E^G_{j,t}\right)\right), \quad \text{(A.2)}$$

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

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

A.4 Data Appendix

Instrumental Variables

The data used for constructing the instrumental variables come from two sources. The World Bank's Indonesia Database for Policy and Economic Research (INDO-DAPOER) provides district land area and population by year.[38] Data on oil and gas reserves come from the proprietary UCube database maintained by Rystad Energy (2016), an international oil and gas consulting company.[39] I define oil and gas endowments as the value of reserves that were known to exist as of the year 2000. I assign hydrocarbon assets to districts using the geographic coordinates of the assets in combination with a shapefile of district borders provided by the Indonesian Statistical Bureau. 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). However, assigning hydrocarbon assets to districts according to this rule leads to severe underestimation of endowments—judging from the discrepancy between predicted and actual oil and gas grant revenue—in a few archipelagic districts. The error is likely due to the shapefile's omission of many small islands which extend the claims of these districts to hydrocarbon resources. For example, Kabupaten Natuna has 272 islands, but only a few dozen are present in the shapefile. To compensate, I instead assign offshore hydrocarbon assets to the nearest district provided that the assets are located within 80 nautical miles of the shoreline.

Revenue and Expenditure

Data on intergovernmental grants come from the Ministry of Finance (*Kementerian Keuangan*).[40] Each year district mayors report on the district's finances to the Ministry of Finance. Data on other revenue sources, as well as expenditure disaggregated by economic classification and function, come from the Ministry of Finance and INDO-DAPOER. 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. 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.

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

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

[40] The Ministry of Finance data are hosted at http://www.djpk.kemenkeu.go.id/.

Realized expenditure is missing in at least one year over 2002–2005 for a small number of districts. To minimize imbalance in the panel, I replace missing realized expenditure with budgeted expenditure for districts where budgeted and realized expenditure never differed by more than 15 percent over the period 2001–2004.

The final fiscal 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 expressed in constant 2010 IDR 1 million (approximately USD 100) per capita.

Public Goods and Services

Data on public service delivery come from the Village Potential Statistics (*Pendataan Potensi Desa*, or PODES) survey waves of 2000, 2003, 2005, 2008, 2011, and 2014. PODES 2000 was enumerated in September–October of 1999, and PODES 2003 was enumerated in August of 2002. Subsequent surveys were enumerated in April or May of the year in the title. I define the year of each observation as the enumeration year, resulting in triennial data over 1999–2014. The surveys are intended to cover every village in Indonesia. Due to a massive tsunami in 2004, PODES 2005 is missing all districts on Nias Island.[41] A special survey was conducted on Nias in 2005, but it lacks data on the number health personnel and health care centers. Villages on Nias Island and therefore excluded.

I merge villages across the survey waves of 2000 through 2014 using village identifiers, village names, and official crosswalks provided by the Central Bureau of Statistics (*Badan Pusat Statistik*). In many cases the crosswalk information is incomplete or does not perfectly align with the information in PODES. To minimize the chances of an incorrect merge, I first perform a fuzzy merge on the village identifier and the village name, imposing an exact match in the identifier and a very close match in the village name.[42] Unmerged villages are then merged via exact matches of unique village names within each subdistrict. Any remaining unmerged villages are then merged via exact matches of unique village names within each district. To maximize the success rate of this procedure, I heavily rely on manual inspection to correct cases of subdistrict identifier recodings that are missed by the crosswalks as well as subtle variation in the spelling of village names. The merge rate, defined as the percentage of villages in the 2014 wave that were successfully merged across all six waves, is very high in most districts, averaging 94.9 percent with a median of 99.6 percent. Only three percent of districts in the sample have a merge rate of less than 50 percent.

To test for changes in the gradient in hydrocarbon endowment prior to decentralization, I add the 1996 wave of PODES using the merge procedure described above. PODES 1996 was enumerated in 1996 (no month given). Around 98 percent of villages in PODES 2000 were

[41] These districts are Nias, Nias Utara, Nias Barat, Nias Selatan, and Gunung Sitoli.

[42] This is performed in Stata using the `reclink2` command (Wasi and Flaaen, 2015). I impose a minimum matching score of 0.97.

successfully merged to PODES 1996.

Around one quarter of villages split into multiple villages between 1999 and 2014. To maintain a consistent unit of observation, I aggregate village outcomes up to 1999 borders. Out of the 67,704 villages that existed in 1999, 64,743 (or 96 percent) were successfully merged across all PODES waves from 2000 to 2014. Of these villages, 48,576 are located in districts included in the analysis sample.

I exclude villages that were involved in an amalgamation during the sample period (around two percent of villages). I further exclude villages with data that appear to be unreliable. 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 annual population growth of more than 10 percent followed by a population decline of more than 10 percent in the next period, or vice versa. Finally, I drop villages with implausibly large changes in public goods from one survey year to the next. The data cleaning procedure reduces the sample of villages by 10 percent. The final dataset is a balanced panel of around 44,000 villages located in the districts included in the analysis sample (defined below).

I construct the following measures of public goods at the village level:

- **Public Kindergartens**: Number of public kindergartens in the village.
- **Public Primary Schools**: Number of public primary schools in the village.
- **Public Secondary Schools**: Number of public secondary schools in the village. It aggregates junior and senior secondary schools in the village.
- **Doctors**: Number of doctors in the village. This variable is missing in 1999.
- **Midwives**: Number of midwives in the village. This variable is missing in 1999.
- **Health Care Centers**: Number of primary health care centers in the village. It aggregates public health centers (*puskesmas*), supporting public health centers (*puskesmas pembantu*), and polyclinics (*poliklinik*). These facilities have trained doctors and nurses that provide basic medical care. This variable is missing in 2008.[43]
- **Paved Road**: Indicator variable equal to one if the main village road is made of asphalt, as opposed to gravel, dirt, or other materials.

I then aggregate these measures to the district level. Villages are assigned to districts based on 2014 district borders, so the composition of villages within a district does not change when a district splits into multiple districts. I express the first six measures as the number of public goods per 10,000 people by summing across all villages in the district, dividing by

[43] Polyclinics are relatively rare compared to public health centers and supporting public health centers. The results are very similar when polyclinics are excluded from the health care centers variable.

the aggregate population of these villages, and multiplying by 10,000.[44] I use *Paved Road* to calculate the share of villages in the district with a paved road.

Lastly, I construct an overall index of public service delivery. I standardize each outcome variable using its mean and standard deviation in the full sample in 2002. Then I take the average of the standardized outcome variables for each district-year observation.

District Elections

Data on the direct elections of district mayors (*Pemilihan kepala daerah*, or *Pilkada*) in years 2005–2008 were generously provided by Martínez-Bravo et al. (2017). I constructed the data for 2010–2013 and 2015 from various sources. The General Elections Commission (*Komisi Pemilihan Umum*, or KPU) shared data for 2010–2013 via email. These data were missing information on roughly half of the elections in 2013. With the help of a research assistant, I filled in the remaining information using district government websites, Indonesian Wikipedia, and local news articles. I scraped the 2015 data from a KPU website.[45] No mayoral elections were held in 2009 or 2014.

The election variables are:

- **Number of Candidates**: Number of candidates running in the first round of the election.
- **Herfindahl Index**: $\sum_i s_i^2$, where s_i is the vote share obtained by candidate i in the first round.
- **Number of Parties in Winning Coalition**: Number of parties in the coalition of the winning candidate.
- **Incumbent Reelected**: Indicator variable equal to one if the incumbent won the election. This variable is missing for elections in which the incumbent could not run due to the term limit.
- **Margin of Victory**: Difference in the vote shares of the first-place and second-place candidates in the first found, in percentage points.

Sample Selection

To ensure that all districts in the sample operate within the same institutional environment, I omit provinces that have a special administrative or fiscal arrangement with the central government. These provinces are DI Yogyakarta, which has special autonomy status; DKI

[44] I impute 2014 village population, which is missing in the PODES, based on village population in 2011 and an assumed annual growth rate equal to the median annual growth rate from 1999 to 2011 for villages in the sample.

[45] The website is http://infopilkada.kpu.go.id/sitap-2015/.

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.

I drop the handful of districts that are missing expenditure data in 2005, as this year is important for measuring baseline outcomes prior to the general grant reform. The five districts on Nias Island are excluded as they are missing data on public services in 2005, as already mentioned. The final sample contains 348 districts with non-missing data on revenue, expenditure, and public service delivery.

A.5 Magnitude of Grant Shocks

Figure A.2 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 grant shocks. The general grant shock is measured over the period 2005–2007, while the oil and gas grant shock is measured over all two-year periods, starting with 2001–2003. Panel (a) shows the results for the entire sample of districts. Both shocks are skewed to the right, and the skew is greater for the oil and gas grant. The mean of the general grant shock (0.49) greatly exceeds the mean of the oil and gas grant 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 hydrocarbon-rich provinces, as well as the oil and gas grant 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) nearly equals the mean of the oil and gas grant shock (1.16). (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.6 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 grant 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.[46] The working hypothesis is that the oil and gas grant is more volatile than the general grant. The within-district coefficient of variation of the oil and gas grant (1.54) is nearly five times that of the general grant (0.32), confirming that the oil and gas grant 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

$$Grant_{d,t} = \sum_{j=1}^{J} \alpha_j Grant_{d,t-j} + \eta_d + \psi_{i(d),t} + \nu_{d,t} \tag{A.3}$$

separately for each grant variable, where η_d is a district fixed effect and $\psi_{i(d),t}$ is an island-by-year effect. The sum of the autoregressive coefficients, $\sum_{j=1}^{J} \alpha_j$, captures the persistence of the process.

Table A.2 presents estimates of the coefficients in equation (A.3) 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 grant. For both grants we reject the presence of a unit root.[47] Columns 1 and 2 report "OLS levels" estimates that control for island-by-year effects but do not control for district fixed effects. OLS estimates of persistence are 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). The estimated persistence of the general grant ranges from 1.00 to 1.01, while estimated persistence of the oil and gas grant ranges from 0.90 to 0.94. The general grant therefore appears to be more persistent than the oil and gas revenue, however these estimates are likely to be biased.

Columns 3 and 4 report the "within-groups" estimates—commonly called "fixed-effects" estimates—which control for island-by-year effects and district fixed effects. Within-groups estimates of persistence are biased downwards due to the negative correlation between, e.g., the transformed $Grant_{d,t-1}$ and the transformed $\nu_{d,t}$ (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 $T = 14$. Furthermore, the bias is larger the more persistent is the series. Therefore, one may view the within-groups estimates as a lower bound on the true persistence (asymptotically), where the bound is relatively tighter for the oil and gas grant compared to the general grant. The

[46]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 $\sqrt{\tilde{S}_x}/\overline{\overline{x}}$.

[47]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.)

estimated persistence of the general grant ranges from 0.51 to 0.62, and these estimates are quite precise. The persistence of the oil and gas grant is lower, ranging from 0.06 to 0.33, where the former estimate is statistically indistinguishable from zero. The general grant appears to be much more persistent than the oil and gas grant, 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 do not suffer from Nickell bias and are consistent as the number of districts grows and the number of time periods is fixed.[48] According to these estimates, the persistence of the general grant ranges from 0.96 to 0.97. The estimated persistence of the oil and gas grant ranges from 0.20 to 0.83, though these estimates are imprecise. Overall, the three estimators point to the same conclusion: the general grant is more persistent than the oil and gas grant.[49]

[48] System GMM was developed by Holtz-Eakin et al. (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.

[49] 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. 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.)

A.7 Tables

Table A.1: Summary Statistics

	Mean	Std. Dev.	Min.	Max.	Obs.
Panel A: Fiscal Variables (Annual)					
General Grant Revenue per Capita	1.16	0.87	0.00	7.95	4,723
Oil & Gas Grant per Capita	0.15	0.66	0.00	10.17	4,723
Area p.c. 2006 × Non-Oil/Gas × Year ≥ 2006	0.08	0.22	0.00	2.72	4,723
Endowment p.c. × Agg. Oil & Gas Grant	0.22	0.90	0.00	13.29	4,723
Total Revenue per Capita	2.02	1.85	0.35	23.71	4,674
Special Grant Revenue per Capita	0.12	0.15	0.00	0.99	4,684
Own-Source Revenue per Capita	0.14	0.15	0.00	1.12	4,682
Shared Tax Revenue per Capita	0.14	0.17	0.00	1.18	4,530
Total Expenditure per Capita	2.00	1.82	0.28	22.52	4,670
Personnel Expenditure per Capita	0.89	0.56	0.03	6.69	4,494
Capital Expenditure per Capita	0.54	0.78	0.00	11.49	4,656
Goods & Services Expenditure per Capita	0.38	0.43	0.00	7.45	4,442
Other Expenditure per Capita	0.15	0.23	0.00	5.46	4,406
Administration Expenditure per Capita	0.58	0.70	0.01	11.18	3,734
Education Expenditure per Capita	0.52	0.32	0.00	3.10	3,735
Infrastructure Expenditure per Capita	0.32	0.57	0.00	10.76	3,731
Health Expenditure per Capita	0.16	0.14	0.00	1.80	3,735
Agriculture Expenditure per Capita	0.08	0.10	0.00	1.12	3,718
Population (Millions)	0.59	0.61	0.03	5.33	4,733
Panel B: Public Goods and Services (Triennial)					
Public Kindergartens per 10,000 People	0.30	0.50	0.00	9.95	1,740
Public Primary Schools per 10,000 People	7.33	3.13	1.60	23.75	1,740
Public Secondary Schools per 10,000 People	1.59	1.16	0.15	11.10	1,740
Doctors per 10,000 People	1.94	1.48	0.00	10.24	1,735
Midwives per 10,000 People	6.05	3.49	0.57	31.78	1,735
Health Care Centers per 10,000 People	2.59	1.72	0.61	17.34	1,392
Share of Villages with Paved Road	0.73	0.25	0.00	1.00	1,740

Notes: All fiscal variables are measured in constant 2010 IDR 1 million (≈ USD 100) per capita. Data on health care centers are unavailable in 2008.

Table A.2: 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	1.00***	0.88***	0.62***	0.51***	0.97***	0.48
	(0.01)	(0.08)	(0.04)	(0.08)	(0.07)	(0.94)
Lag 2		0.14		0.03		0.56
		(0.10)		(0.08)		(0.95)
Lag 3		−0.01		−0.03		−0.08
		(0.11)		(0.08)		(0.15)
Persistence	1.00***	1.01***	0.62***	0.51***	0.97***	0.96***
	(0.01)	(0.01)	(0.04)	(0.07)	(0.07)	(0.09)
Observations	4,374	3,678	4,374	3,678	4,374	3,678
District clusters	348	348	348	348	348	348
Prov. × year clusters	384	384	358	306	358	306
AR(2) test p-value					0.926	0.564
H_0: unit root p-value	0.000					
Within coef. of var.	0.320					

Panel B: Oil & Gas Grant p.c.

	OLS Levels		Within Groups		System GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
Lag 1	0.90***	0.66***	0.33***	0.30***	0.20	0.71
	(0.04)	(0.05)	(0.09)	(0.08)	(0.48)	(1.07)
Lag 2		0.08		−0.12		−0.01
		(0.06)		(0.09)		(0.60)
Lag 3		0.20*		−0.13		0.13
		(0.12)		(0.14)		(1.08)
Persistence	0.90***	0.94***	0.33***	0.06	0.20	0.83
	(0.04)	(0.06)	(0.09)	(0.25)	(0.48)	(2.66)
Observations	4,374	3,678	4,374	3,678	4,374	3,678
District clusters	348	348	348	348	348	348
Prov. × year clusters	384	384	358	306	358	306
AR(2) test p-value					0.765	0.483
H_0: unit root p-value	0.000					
Within coef. of var.	1.546					

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 grant. Each regression includes a full set of island-by-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.3: Dynamic Responses of Total Expenditure to Grants (No Controls)

	Response of Total Expenditure per Capita after h Years					
	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: One-Year Changes in Grants ($k=1$)					
General Grant p.c.	0.74***	1.10***	1.52***	1.68***	0.80***	0.75***
	(0.10)	(0.17)	(0.35)	(0.22)	(0.16)	(0.14)
Oil & Gas Grant p.c.	0.22***	0.31***	0.50***	0.44***	0.09**	0.11
	(0.07)	(0.09)	(0.16)	(0.06)	(0.04)	(0.12)
H_0: Gen. = Oil & Gas						
Unadjusted p-value	0.000	0.000	0.002	0.000	0.000	0.000
Adjusted p-value	*0.000*	*0.000*	*0.002*	*0.000*	*0.000*	*0.000*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.995	0.285	0.068	0.001	0.897	0.956
Adjusted p-value	*0.995*	*1.000*	*0.339*	*0.006*	*1.000*	*1.000*
SW F-stat.: Gen. Grant	76.9	83.2	82.1	85.5	79.0	87.6
SW F-stat.: Oil & Gas	176.5	148.9	171.4	176.4	341.0	225.6
Observations	4,286	3,953	3,608	3,268	2,921	2,576
District clusters	348	348	348	348	348	348
Prov. × year clusters	358	330	302	274	246	218
	Panel B: Two-Year Changes in Grants ($k=2$)					
General Grant p.c.	0.85***	1.15***	1.47***	1.06***	0.66***	0.71***
	(0.12)	(0.24)	(0.23)	(0.21)	(0.11)	(0.15)
Oil & Gas Grant p.c.	0.10	0.24*	0.24**	0.05	−0.08	0.08
	(0.07)	(0.13)	(0.10)	(0.08)	(0.10)	(0.14)
H_0: Gen. = Oil & Gas						
Unadjusted p-value	0.000	0.001	0.000	0.000	0.000	0.000
Adjusted p-value	*0.000*	*0.001*	*0.000*	*0.000*	*0.000*	*0.001*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.885	0.261	0.019	0.388	0.999	0.978
Adjusted p-value	*1.000*	*1.000*	*0.115*	*1.000*	*0.999*	*1.000*
SW F-stat.: Gen. Grant	46.5	48.6	47.0	46.7	48.1	47.2
SW F-stat.: Oil & Gas	535.6	486.3	419.6	477.1	338.7	380.5
Observations	3,953	3,608	3,268	2,920	2,576	2,234
District clusters	348	348	348	348	348	348
Prov. × year clusters	332	304	276	248	220	192

Notes: This table reports IV estimates of β^h and δ^h in Equation (6). Panel A presents estimates based on one-year changes in grants, and Panel B presents estimates based on two-year changes in grants. Each regression controls only for island-by-year effects. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Adjusted p-values use the Holm correction for multiple hypothesis testing. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table A.4: Dynamic Responses of Total Expenditure to Grants (OLS)

	Response of Total Expenditure per Capita after h Years					
	$h = 0$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 5$
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: One-Year Changes in Grants ($k = 1$)					
General Grant p.c.	0.73***	0.89***	1.48***	1.30***	0.78**	0.78**
	(0.10)	(0.20)	(0.26)	(0.32)	(0.33)	(0.34)
Oil & Gas Grant p.c.	0.21***	0.34***	0.55***	0.50***	0.16***	0.17
	(0.07)	(0.07)	(0.12)	(0.04)	(0.05)	(0.13)
p-value: Gen. = Oil & Gas	0.001	0.000	0.000	0.018	0.065	0.176
p-value: Gen. Grant ≤ 1	0.997	0.701	0.032	0.176	0.746	0.739
Observations	4,286	3,953	3,608	3,268	2,921	2,576
District clusters	348	348	348	348	348	348
Prov. × year clusters	358	330	302	274	246	218
	Panel B: Two-Year Changes in Grants ($k = 2$)					
General Grant p.c.	0.82***	1.00***	1.28***	0.93***	0.66**	0.63**
	(0.14)	(0.23)	(0.23)	(0.30)	(0.28)	(0.31)
Oil & Gas Grant p.c.	0.13	0.29***	0.33***	0.16	−0.00	0.16
	(0.09)	(0.09)	(0.07)	(0.10)	(0.15)	(0.19)
p-value: Gen. = Oil & Gas	0.001	0.000	0.000	0.035	0.093	0.330
p-value: Gen. Grant ≤ 1	0.902	0.498	0.111	0.591	0.888	0.883
Observations	3,953	3,608	3,268	2,920	2,576	2,234
District clusters	348	348	348	348	348	348
Prov. × year clusters	332	304	276	248	220	192

Notes: This table reports OLS estimates of β^h and δ^h in Equation (6). Panel A presents estimates based on one-year changes in grants, and Panel B presents estimates based on two-year changes in grants. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.5: Mean Responses of Alternative Revenue Sources to Grants

	Mean Responses: $\frac{1}{6}\sum_{h=0}^{5}\beta^h$ and $\frac{1}{6}\sum_{h=0}^{5}\delta^h$		
	Special Grant	Own-Source	Shared Taxes
	(1)	(2)	(3)
	Panel A: One-Year Changes in Grants ($k=1$)		
General Grant p.c.	0.07***	0.04	0.03
	(0.03)	(0.02)	(0.04)
Oil & Gas Grant p.c.	0.01	0.02***	−0.01
	(0.01)	(0.01)	(0.01)
p-value: Gen. = Oil & Gas	0.009	0.572	0.307
SW F-stat.: Gen. Grant	77.0	77.0	99.5
SW F-stat.: Oil & Gas	188.4	188.3	169.8
Observations	4,282	4,286	4,133
District clusters	348	348	348
Prov. × year clusters	358	358	358
	Panel B: Two-Year Changes in Grants ($k=2$)		
General Grant p.c.	0.03	0.02	0.01
	(0.04)	(0.02)	(0.03)
Oil & Gas Grant p.c.	0.00	0.03***	−0.02**
	(0.01)	(0.01)	(0.01)
p-value: Gen. = Oil & Gas	0.501	0.720	0.243
SW F-stat.: Gen. Grant	46.9	47.1	45.3
SW F-stat.: Oil & Gas	948.3	817.8	185.3
Observations	3,949	3,953	3,862
District clusters	348	348	348
Prov. × year clusters	332	332	332

Notes: This table reports IV estimates of the mean responses of alternative sources of revenue (per capita) to the general grant, $\sum_{h=0}^{5}\beta^h/6$, and to the oil and gas grant, $\sum_{h=0}^{5}\delta^h/6$, obtained by replacing the outcome in Equation (6) with $\sum_{h=0}^{5} Y_{d,t+h}/6 - Y_{d,t-k}$. Panel A presents estimates based on one-year changes in grants, and Panel B presents estimates based on two-year changes in grants. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: Dynamic Responses of Total Expenditure to Grants (Controlling for Special Grant)

	Response of Total Expenditure per Capita after h Years					
	$h = 0$ (1)	$h = 1$ (2)	$h = 2$ (3)	$h = 3$ (4)	$h = 4$ (5)	$h = 5$ (6)
	Panel A: One-Year Changes in Grants ($k = 1$)					
General Grant p.c.	0.63***	1.01***	1.25***	1.55***	0.60***	0.55**
	(0.13)	(0.20)	(0.39)	(0.26)	(0.18)	(0.22)
Oil & Gas Grant p.c.	0.20**	0.32***	0.48***	0.45***	0.10**	0.10
	(0.08)	(0.09)	(0.16)	(0.06)	(0.04)	(0.13)
H_0: Gen. = Oil & Gas						
Unadjusted p-value	0.000	0.000	0.028	0.000	0.001	0.009
Adjusted p-value	*0.000*	*0.000*	*0.028*	*0.000*	*0.004*	*0.018*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.998	0.488	0.254	0.018	0.984	0.978
Adjusted p-value	*0.998*	*1.000*	*1.000*	*0.106*	*1.000*	*1.000*
SW F-stat.: Gen. Grant	86.2	83.8	97.5	106.2	95.5	109.2
SW F-stat.: Oil & Gas	207.6	179.3	200.2	207.7	478.1	266.5
Observations	4,279	3,925	3,588	3,248	2,901	2,556
District clusters	348	348	348	348	348	348
Prov. × year clusters	358	330	302	274	246	218
	Panel B: Two-Year Changes in Grants ($k = 2$)					
General Grant p.c.	0.70***	0.95***	1.27***	0.83***	0.43***	0.45**
	(0.15)	(0.30)	(0.25)	(0.23)	(0.16)	(0.22)
Oil & Gas Grant p.c.	0.09	0.23*	0.24***	0.05	−0.06	0.07
	(0.07)	(0.12)	(0.09)	(0.07)	(0.10)	(0.14)
H_0: Gen. = Oil & Gas						
Unadjusted p-value	0.000	0.024	0.000	0.002	0.003	0.105
Adjusted p-value	*0.001*	*0.049*	*0.000*	*0.009*	*0.010*	*0.105*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.974	0.562	0.138	0.778	1.000	0.993
Adjusted p-value	*1.000*	*1.000*	*0.827*	*1.000*	*1.000*	*1.000*
SW F-stat.: Gen. Grant	57.0	58.7	61.5	60.4	65.2	63.0
SW F-stat.: Oil & Gas	682.5	608.4	536.7	625.7	427.2	469.6
Observations	3,946	3,583	3,251	2,903	2,559	2,217
District clusters	348	348	348	348	348	348
Prov. × year clusters	332	304	276	248	220	192

Notes: This table reports IV estimates of β^h and δ^h in Equation (6). Panel A presents estimates based on one-year changes in grants, and Panel B presents estimates based on two-year changes in grants. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. The regressions also control for one- or two-year changes in special grant revenue per capita. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Adjusted p-values use the Holm correction for multiple hypothesis testing. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.7: Dynamic Responses of Total Expenditure to Grants (Allowing for Asymmetric Responses)

	Response of Total Expenditure per Capita after h Years					
	$h=0$ (1)	$h=1$ (2)	$h=2$ (3)	$h=3$ (4)	$h=4$ (5)	$h=5$ (6)
	Panel A: One-Year Changes in Grants ($k=1$)					
General Grant p.c.	0.80***	1.16***	1.68***	1.92***	1.04***	1.17***
	(0.10)	(0.15)	(0.31)	(0.27)	(0.26)	(0.34)
Oil & Gas Grant p.c.$^+$	0.31***	0.43***	0.77***	0.79***	0.48*	0.67
	(0.09)	(0.09)	(0.14)	(0.22)	(0.25)	(0.45)
Oil & Gas Grant p.c.$^-$	−0.02	0.02	−0.24	−0.45	−1.12	−1.22*
	(0.12)	(0.30)	(0.59)	(0.55)	(0.73)	(0.73)
H_0: Symmetry						
Unadjusted p-value	0.031	0.187	0.101	0.086	0.092	0.088
Adjusted p-value	*0.189*	*0.187*	*0.201*	*0.429*	*0.276*	*0.353*
H_0: Gen. = Oil & Gas$^+$						
Unadjusted p-value	0.000	0.000	0.000	0.000	0.044	0.165
Adjusted p-value	*0.000*	*0.000*	*0.000*	*0.000*	*0.088*	*0.165*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.982	0.144	0.014	0.000	0.438	0.305
Adjusted p-value	*0.982*	*0.575*	*0.070*	*0.002*	*0.877*	*0.914*
SW F-stat.: Gen. Grant	80.4	81.8	90.4	114.0	115.9	123.2
SW F-stat.: Oil & Gas$^+$	234.1	189.2	215.3	231.5	888.3	449.0
SW F-stat.: Oil & Gas$^-$	252.5	188.1	222.7	174.8	215.2	262.1
	Panel B: Two-Year Changes in Grants ($k=2$)					
General Grant p.c.	0.95***	1.24***	1.72***	1.30***	0.99***	1.10***
	(0.11)	(0.24)	(0.25)	(0.27)	(0.25)	(0.29)
Oil & Gas Grant p.c.$^+$	0.36***	0.56***	0.74***	0.62**	0.62	0.86*
	(0.08)	(0.13)	(0.20)	(0.27)	(0.43)	(0.51)
Oil & Gas Grant p.c.$^-$	−0.33**	−0.34	−0.67	−1.00*	−1.39**	−1.35*
	(0.13)	(0.36)	(0.53)	(0.60)	(0.62)	(0.69)
H_0: Symmetry						
Unadjusted p-value	0.000	0.027	0.038	0.054	0.046	0.055
Adjusted p-value	*0.001*	*0.134*	*0.153*	*0.107*	*0.138*	*0.055*
H_0: Gen. = Oil & Gas$^+$						
Unadjusted p-value	0.000	0.005	0.000	0.027	0.255	0.529
Adjusted p-value	*0.000*	*0.019*	*0.001*	*0.082*	*0.511*	*0.529*
H_0: Gen. Grant ≤ 1						
Unadjusted p-value	0.687	0.157	0.002	0.133	0.515	0.363
Adjusted p-value	*0.687*	*0.629*	*0.011*	*0.667*	*1.000*	*1.000*
SW F-stat.: Gen. Grant	43.9	46.5	47.6	47.1	47.7	47.6
SW F-stat.: Oil & Gas$^+$	221.2	200.2	243.6	213.1	201.3	158.0
SW F-stat.: Oil & Gas$^-$	84.9	74.9	79.9	76.8	69.6	65.8

Notes: This table reports IV estimates of β^h, $\delta^{h,+}$, and $\delta^{h,-}$ in Equation (7). Panel A presents estimates based on one-year changes in grants, and Panel B presents estimates based on two-year changes in grants. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Adjusted p-values use the Holm correction for multiple hypothesis testing. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table A.8: Mean Responses of Public Service Delivery to Grants (No Controls)

	Public Schools per 10,000 People			Health Personnel & Facilities per 10,000 People			Share of Villages	Index
	(1) Kindergarten	(2) Primary	(3) Secondary	(4) Doctors	(5) Midwives	(6) Health Centers	(7) Paved Road	(8)
General Grant p.c.	0.333***	−0.615***	1.048***	0.495**	1.271***	0.742*	0.049**	0.542***
	(0.126)	(0.223)	(0.141)	(0.204)	(0.473)	(0.428)	(0.019)	(0.110)
Oil & Gas Grant p.c.	0.020	−0.192**	0.017	−0.020	−0.067	0.034	0.001	−0.029
	(0.044)	(0.085)	(0.195)	(0.103)	(0.221)	(0.165)	(0.016)	(0.107)
Baseline mean outcome	0.192	8.015	1.221	1.665	5.691	2.598	0.641	-0.001
H_0: Gen. = Oil & Gas								
Unadjusted p-value	0.015	0.041	0.000	0.022	0.018	0.089	0.030	0.000
Adjusted p-value	*0.092*	*0.082*	*0.000*	*0.089*	*0.090*	*0.089*	*0.089*	
SW F-stat.: Gen. Grant	103.6	103.6	103.6	103.5	103.5	99.4	103.6	103.6
SW F-stat.: Oil & Gas	86.6	86.6	86.6	87.4	87.4	354.5	86.6	86.6
Observations	1,392	1,392	1,392	1,388	1,388	1,044	1,392	1,392
District clusters	348	348	348	347	347	348	348	348
Prov. × year clusters	111	111	111	111	111	83	111	111

Notes: This table reports IV estimates of the mean responses of public service delivery to the general grant, $\sum_{h\in\{0,3,6\}} \beta^h/3$, and to the oil and gas grant, $\sum_{h\in\{0,3,6\}} \delta^h/3$, obtained by replacing the outcome in Equation (9) with $\sum_{h\in\{0,3,6\}} Y_{d,t+h}/3 - Y_{d,t-3}$. Because the data on health care centers are missing in 2008, β^0 and δ^0 are not identifiable for this outcome, so the table reports $\sum_{h\in\{3,6\}} \beta^h/2$ and $\sum_{h\in\{3,6\}} \delta^h/2$. Each regression controls for island-by-year effects. The baseline mean of the outcome variable is measured in 2002. Adjusted p-values use the Holm correction for multiple hypothesis testing. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: Mean Responses of Public Service Delivery to Grants (Controlling for Special Grant)

	Public Schools per 10,000 People			Health Personnel & Facilities per 10,000 People			Share of Villages	Index
	(1) Kindergarten	(2) Primary	(3) Secondary	(4) Doctors	(5) Midwives	(6) Health Centers	(7) Paved Road	(8)
General Grant p.c.	0.331**	−0.729***	1.140***	0.453**	1.386**	0.828*	0.043**	0.553***
	(0.143)	(0.212)	(0.189)	(0.224)	(0.554)	(0.492)	(0.022)	(0.125)
Oil & Gas Grant p.c.	0.018	−0.154	−0.030	−0.029	−0.134	0.002	0.002	−0.044
	(0.048)	(0.095)	(0.205)	(0.105)	(0.209)	(0.173)	(0.017)	(0.111)
Baseline mean outcome	0.192	8.015	1.221	1.665	5.691	2.598	0.641	-0.001
H_0: Gen. = Oil & Gas								
Unadjusted p-value	0.039	0.005	0.000	0.047	0.018	0.097	0.074	0.000
Adjusted p-value	*0.157*	*0.030*	*0.000*	*0.141*	*0.091*	*0.097*	*0.149*	
SW F-stat.: Gen. Grant	69.7	69.7	69.7	69.5	69.5	48.3	69.7	69.7
SW F-stat.: Oil & Gas	156.6	156.6	156.6	156.4	156.4	267.3	156.6	156.6
Observations	1,343	1,343	1,343	1,340	1,340	995	1,343	1,343
District clusters	348	348	348	347	347	348	348	348
Prov. × year clusters	111	111	111	111	111	83	111	111

Notes: This table reports IV estimates of the mean responses of public service delivery to the general grant, $\sum_{h\in\{0,3,6\}} \beta^h/3$, and to the oil and gas grant, $\sum_{h\in\{0,3,6\}} \delta^h/3$, obtained by replacing the outcome in Equation (9) with $\sum_{h\in\{0,3,6\}} Y_{d,t+h}/3 - Y_{d,t-3}$. Because the data on health care centers are missing in 2008, β^0 and δ^0 are not identifiable for this outcome, so the table reports $\sum_{h\in\{3,6\}} \beta^h/2$ and $\sum_{h\in\{3,6\}} \delta^h/2$. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. The regressions also control for special grant revenue per capita. The baseline mean of the outcome variable is measured in 2002. Adjusted p-values use the Holm correction for multiple hypothesis testing. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: Mean Responses of Public Service Delivery to Grants (Allowing for Asymmetric Responses)

	Public Schools per 10,000 People			Health Personnel & Facilities per 10,000 People			Share of Villages	Index
	(1) Kindergarten	(2) Primary	(3) Secondary	(4) Doctors	(5) Midwives	(6) Health Centers	(7) Paved Road	(8)
General Grant p.c.	0.387^{**}	-0.675^{***}	1.335^{***}	0.573^{**}	1.558^{***}	0.938^{**}	0.077^{***}	0.683^{***}
	(0.157)	(0.232)	(0.208)	(0.233)	(0.504)	(0.420)	(0.025)	(0.149)
Oil & Gas Grant p.c.$^{+}$	0.129	-0.220^{**}	0.590^{**}	0.235	0.635^{***}	0.404^{**}	0.070^{***}	0.289^{**}
	(0.114)	(0.096)	(0.230)	(0.160)	(0.129)	(0.165)	(0.021)	(0.145)
Oil & Gas Grant p.c.$^{-}$	-0.157^{*}	-0.109	-0.896^{***}	-0.410	-1.167^{***}	-1.141^{***}	-0.101^{**}	-0.529^{***}
	(0.091)	(0.221)	(0.320)	(0.287)	(0.368)	(0.214)	(0.048)	(0.181)
Baseline mean outcome	0.192	8.015	1.221	1.665	5.691	2.598	0.641	-0.001
H_0: Symmetry								
Unadjusted p-value	0.148	0.708	0.001	0.092	0.000	0.000	0.003	0.003
Adjusted p-value	*0.297*	*0.708*	*0.005*	*0.276*	*0.000*	*0.000*	*0.012*	
H_0: Gen. = Oil & Gas^{+}								
Unadjusted p-value	0.105	0.010	0.005	0.096	0.034	0.122	0.817	0.023
Adjusted p-value	*0.315*	*0.067*	*0.040*	*0.383*	*0.170*	*0.244*	*0.817*	
SW F-stat.: Gen. Grant	86.4	86.4	86.4	86.3	86.3	83.5	86.4	86.4
SW F-stat.: Oil & Gas^{+}	269.0	269.0	269.0	266.5	266.5	280.3	269.0	269.0
SW F-stat.: Oil & Gas^{-}	100.5	100.5	100.5	100.3	100.3	219.5	100.5	100.5

Notes: This table reports IV estimates of the mean responses of public goods to the general grant, $\sum_{h\in\{0,3,6\}}\beta^h/3$, to increases in the oil and gas grant, $\sum_{h\in\{0,3,6\}}\delta^{h,+}/3$, and to decreases in the oil and gas grant, $\sum_{h\in\{0,3,6\}}\delta^{h,-}/3$, obtained from the regressions $Y_{d,t+h}-Y_{d,t-3}=\beta^h(\overline{G}_{d,t}-\overline{G}_{d,t-3})+\delta^{h,+}(\overline{R}_{d,t}-\overline{R}_{d,t-3})^{+}+\delta^{h,-}(\overline{R}_{d,t}-\overline{R}_{d,t-3})^{-}+\phi'(\boldsymbol{X}_{d,t}-\boldsymbol{X}_{d,t-3})+\lambda_{i(d),t}+\xi_{d,t}$. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. The baseline mean of the outcome variable is measured in 2002. Adjusted p-values use the Holm correction for multiple hypothesis testing. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table A.11: Mean Responses of Public Service Delivery to Grants (OLS)

	Public Schools per 10,000 People			Health Personnel & Facilities per 10,000 People			Share of Villages	Index
	(1) Kindergarten	(2) Primary	(3) Secondary	(4) Doctors	(5) Midwives	(6) Health Centers	(7) Paved Road	(8)
General Grant p.c.	0.192*	−0.244	0.387***	0.206*	0.251	0.448***	0.026**	0.235**
	(0.116)	(0.154)	(0.118)	(0.112)	(0.262)	(0.134)	(0.011)	(0.107)
Oil & Gas Grant p.c.	0.024	−0.135**	0.046	0.020	−0.234	0.061	0.014	−0.012
	(0.061)	(0.055)	(0.158)	(0.098)	(0.234)	(0.137)	(0.013)	(0.116)
Baseline mean outcome	0.192	8.015	1.221	1.665	5.691	2.598	0.641	-0.001
H_0: Gen. = Oil & Gas								
Unadjusted p-value	0.167	0.516	0.128	0.182	0.192	0.070	0.528	0.117
Adjusted p-value	*0.834*	*1.000*	*0.770*	*0.728*	*0.575*	*0.557*	*0.528*	
Observations	1,392	1,392	1,392	1,388	1,388	1,044	1,392	1,392
District clusters	348	348	348	347	347	348	348	348
Prov. × year clusters	111	111	111	111	111	83	111	111

Notes: This table reports OLS estimates of the mean responses of public service delivery to the general grant, $\sum_{h\in\{0,3,6\}} \beta^h/3$, and to the oil and gas grant, $\sum_{h\in\{0,3,6\}} \delta^h/3$, obtained by replacing the outcome in Equation (9) with $\sum_{h\in\{0,3,6\}} Y_{d,t+h}/3 - Y_{d,t-3}$. Because the data on health care centers are missing in 2008, β^0 and δ^0 are not identifiable for this outcome, so the table reports $\sum_{h\in\{3,6\}} \beta^h/2$ and $\sum_{h\in\{3,6\}} \delta^h/2$. Each regression controls for island-by-year effects and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. The baseline mean of the outcome variable is measured in 2002. Adjusted p-values use the Holm correction for multiple hypothesis testing. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.12: Effects of Grants on Political Competition

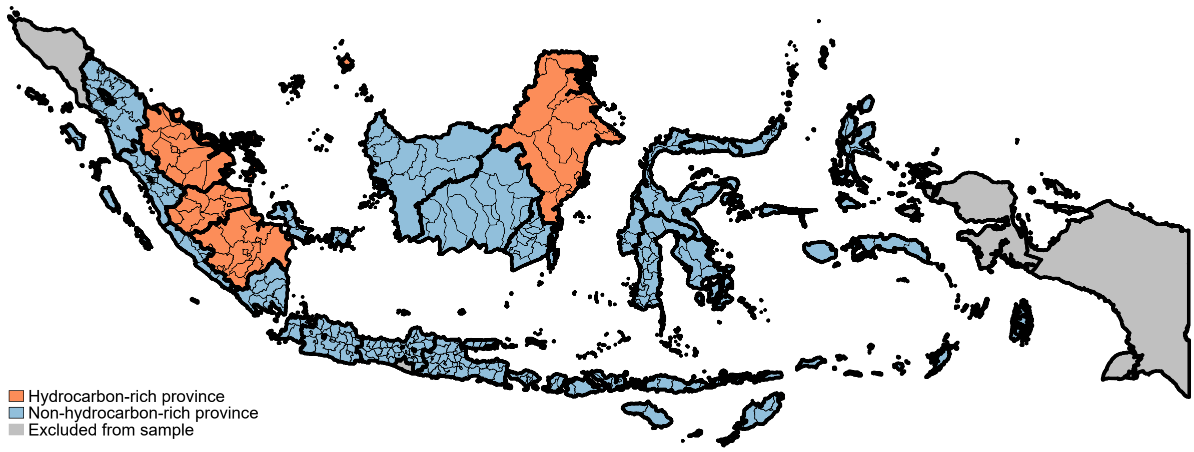
	Number of Candidates (1)	Herfindahl Index (2)	Number of Parties in Winning Coalition (3)	Incumbent Reelected (4)	Margin of Victory (5)
	Panel A: Effects of Grants in Election Year				
General Grant p.c.$_t$	−0.911	0.093	2.724**	0.037	1.247
	(0.565)	(0.101)	(1.233)	(0.217)	(10.798)
Oil & Gas Grant p.c.$_t$	−0.170	−0.002	0.227	0.033	0.172
	(0.140)	(0.012)	(0.259)	(0.040)	(1.658)
Dependent variable mean	4.18	0.37	3.12	0.56	18.21
p-value: Gen. = Oil & Gas	0.192	0.336	0.044	0.986	0.918
SW F-stat.: Gen. Grant	12.8	13.5	12.4	15.4	13.5
SW F-stat.: Oil & Gas	176.8	433.8	157.7	142.2	424.8
Observations	781	720	875	432	700
District clusters	306	284	349	201	276
Prov. × year clusters	197	187	212	145	178
	Panel B: Effects of Grants in Year Before Election				
General Grant p.c.$_{t-1}$	−0.677	0.055	1.070	0.187	1.983
	(0.539)	(0.073)	(1.446)	(0.233)	(8.292)
Oil & Gas Grant p.c.$_{t-1}$	−0.805**	0.041	0.689	0.023	2.290
	(0.363)	(0.045)	(1.020)	(0.142)	(5.197)
Dependent variable mean	4.18	0.37	3.12	0.56	18.21
p-value: Gen. = Oil & Gas	0.685	0.707	0.649	0.237	0.954
SW F-stat.: Gen. Grant	20.4	19.6	19.3	19.7	19.6
SW F-stat.: Oil & Gas	24.1	22.4	22.2	19.2	23.0
Observations	769	708	863	432	688
District clusters	304	282	347	201	274
Prov. × year clusters	196	186	211	145	177

Notes: This table reports IV estimates of β and δ in $Y_{d,t} = \beta G_{d,t-k} + \delta R_{d,t-k} + \phi' \boldsymbol{X}_{d,t-k} + \alpha_d + \lambda_{i(d),t} + \varepsilon_{d,t}$ for $k = 0$ (Panel A) and $k = 1$ (Panel B). Each regression controls for district fixed effects, island-by-year effects, and indicators for whether the district has split, defined separately for parent and child districts, as well as two lags of these indicators. Sanderson and Windmeijer (2016) first-stage F-statistics are reported for each endogeneous variable. Standard errors, reported in parentheses, are robust to heteroskedasticity and two-way clustering by district and province-by-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

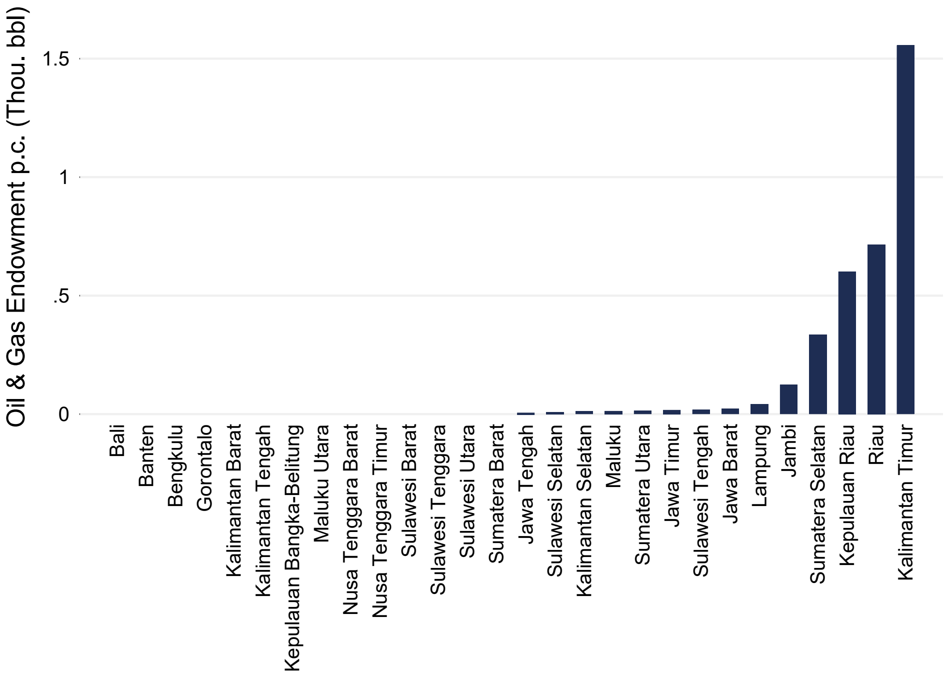
A.8 Figures

Figure A.1: Classification of Hydrocarbon-Rich Provinces

(a) Map of Hydrocarbon-Rich Provinces



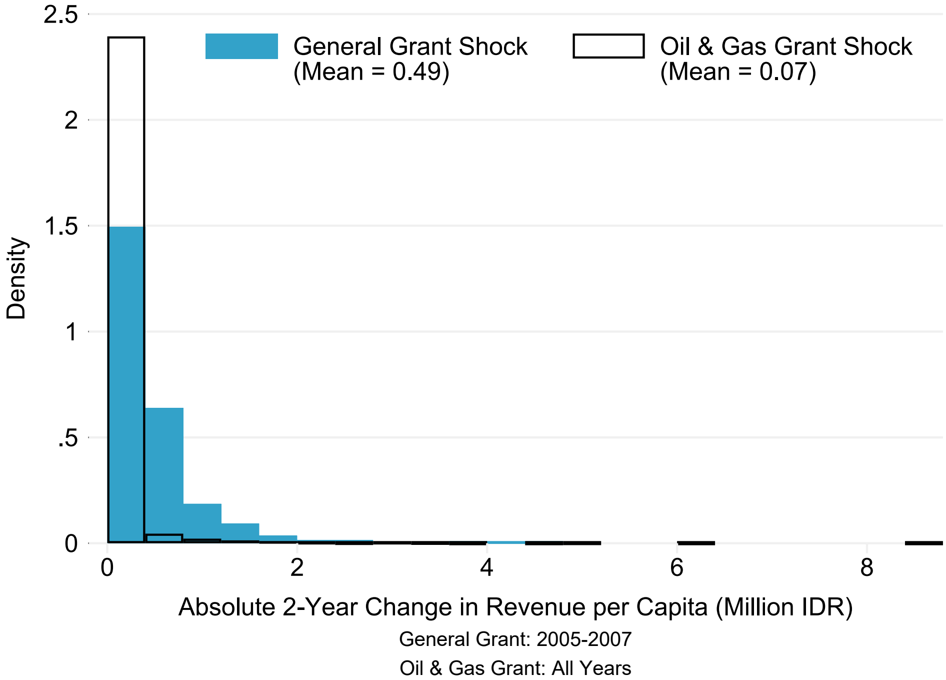
(b) Oil and Gas Endowment per Capita by Province



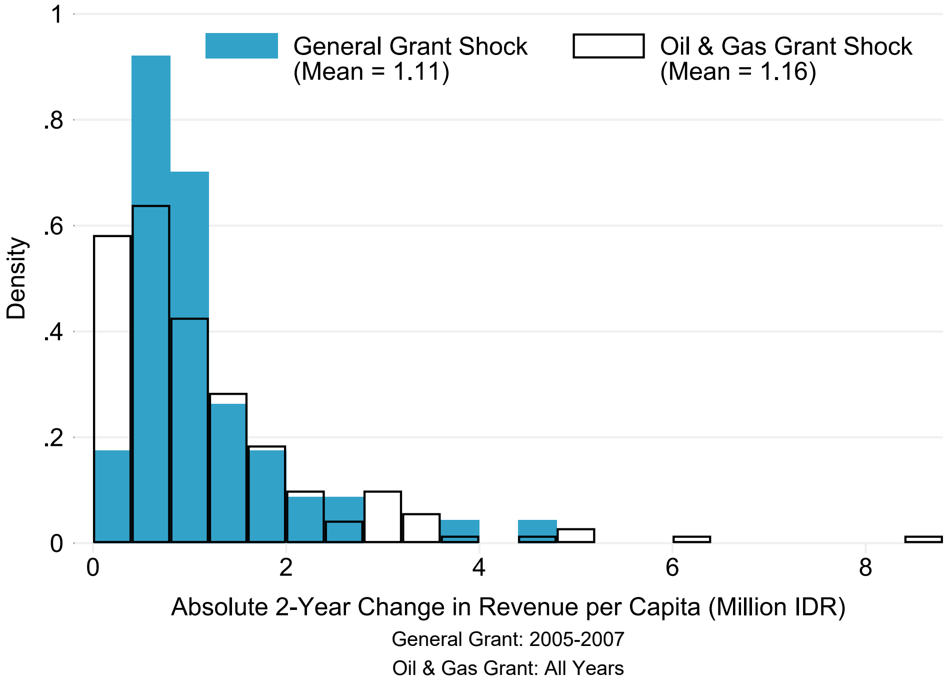
Notes: In Panel (a), district borders (thin lines) and province borders (thick lines) are displayed as they existed in 2006. The hydrocarbon-rich provinces are Riau, Kepulauan Riau, Jambi, Sumatera Selatan, and Kalimantan Timur. Panel (b) shows the oil and gas endowment per capita known in 2000 for each province based on 2014 population. Oil and gas endowment per capita is expressed in thousands of barrels of oil equivalent per capita. Kalimantan Utara is combined with its parent province, Kalimantan Timur, consistent with the national government's revenue-sharing policy through 2014.

Figure A.2: Distribution of Grant-Revenue Shocks

(a) All Districts



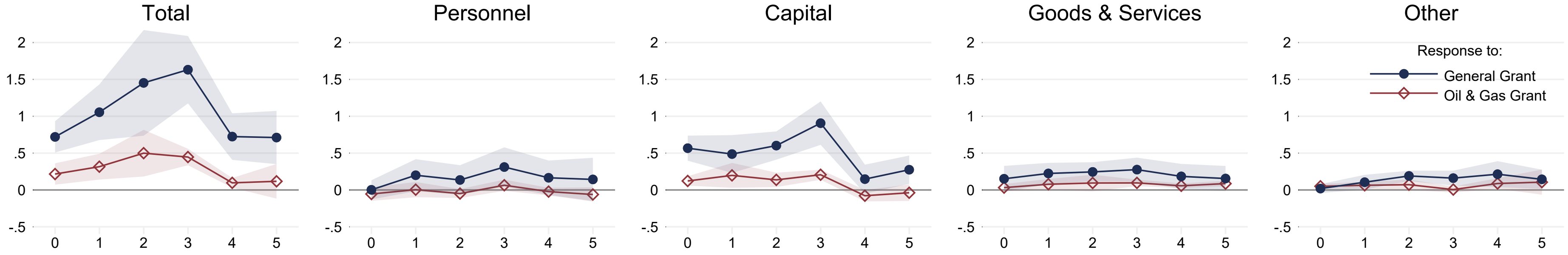
(b) Districts with High Exposure to Grant Shocks



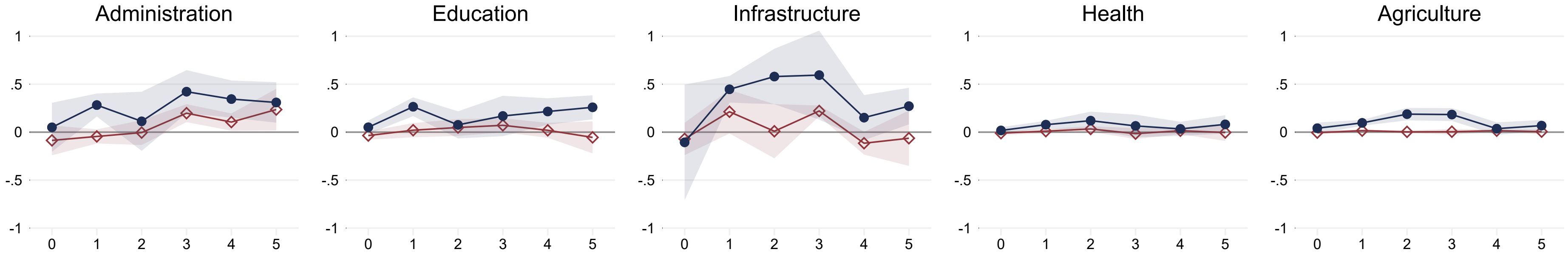
Notes: Each panel displays the distribution of the absolute two-year change in the general grant over 2005–2007 (solid bars) and the distribution of absolute two-year changes in the oil and gas grant over all years (hollow bars). Panel (a) uses the entire sample of districts, and Panel (b) uses the subsample of districts that were highly exposed to the grant shocks. High exposure to the general grant shock is defined as exceeding the 75th percentile in land area per capita in 2006 and not being located in a hydrocarbon-rich province. High exposure to the oil and gas grant shocks is defined as exceeding the 95th percentile in hydrocarbon endowment. Revenue is expressed in constant 2010 IDR per capita (millions).

Figure A.3: Dynamic Expenditure Responses to Grants

(a) Expenditure Broken Down by Economic Classification



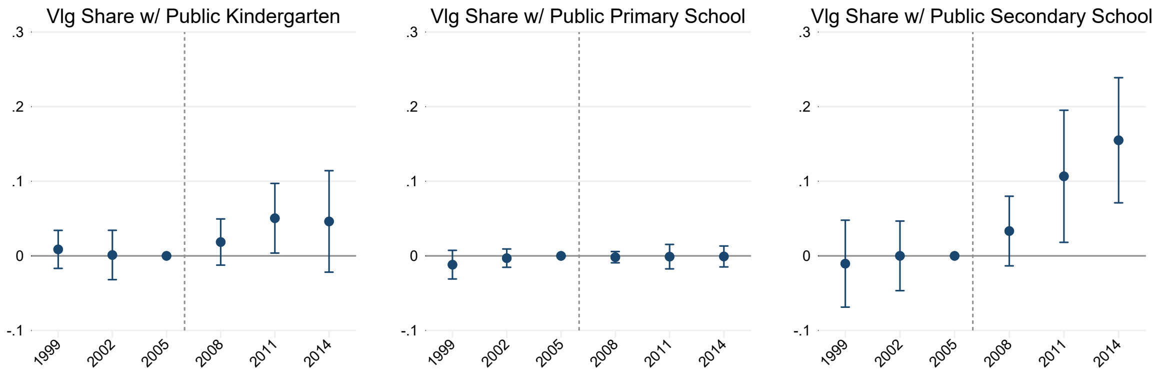
(b) Expenditure Broken Down by Function



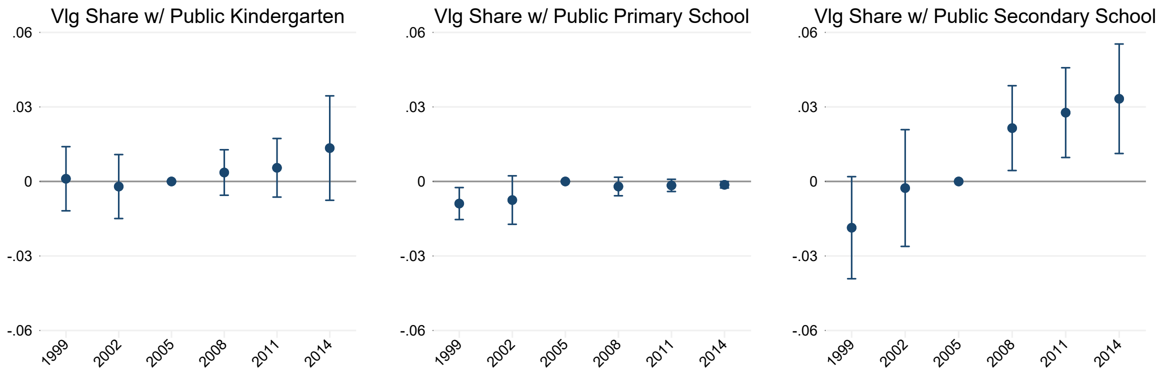
Notes: This figure displays IV estimates and 95-percent confidence intervals for β^h and δ^h from Equation (6), using one-year changes in grants ($k = 1$). Values of h are on the horizonal axis. Confidence intervals are robust to heteroskedasticity and two-way clustering by district and province-by-year.

Figure A.4: Reduced-Form Effects of Grant Exposure on Educational Access over Time

(a) Year-by-Year Gradient in *Area p.c. 2006* × *Non-Oil/Gas* Relative to 2005

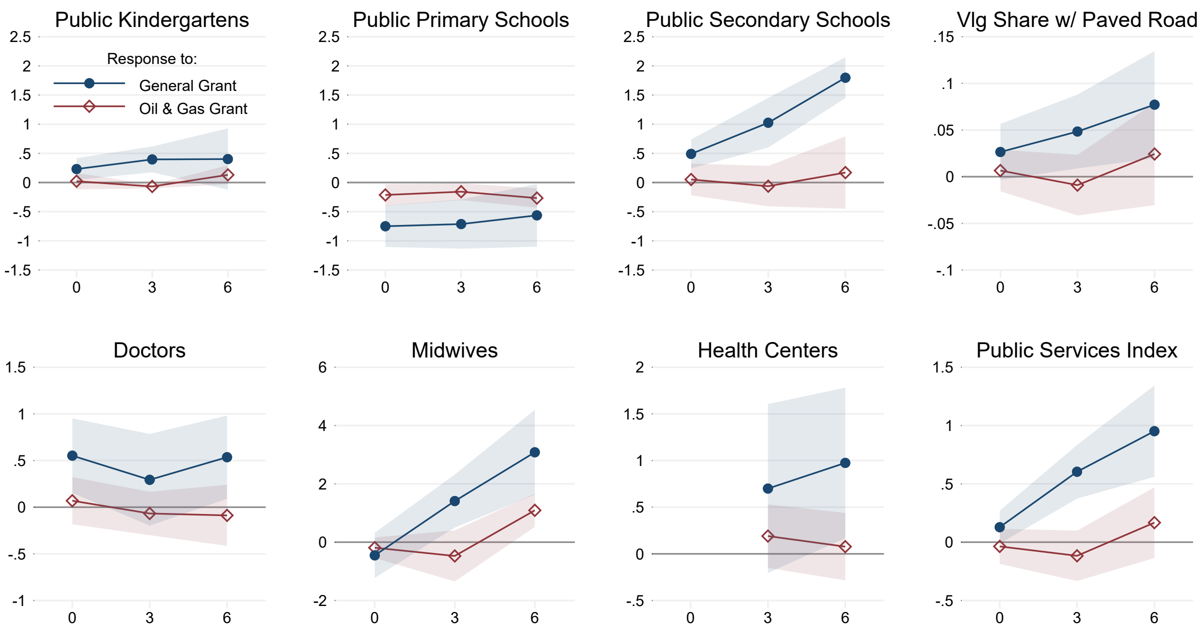


(b) Year-by-Year Gradient in *Endowment p.c.* Relative to 2005



Notes: This figure displays point estimates and 95-percent confidence intervals for $\{\theta_\ell\}_{\ell\in\mathscr{L}}$ (Panel (a)) and $\{\gamma_\ell\}_{\ell\in\mathscr{L}}$ (Panel (b)) in Equation (8). The reference year is 2005. Confidence intervals are robust to heteroskedasticity and two-way clustering by district and province-by-year.

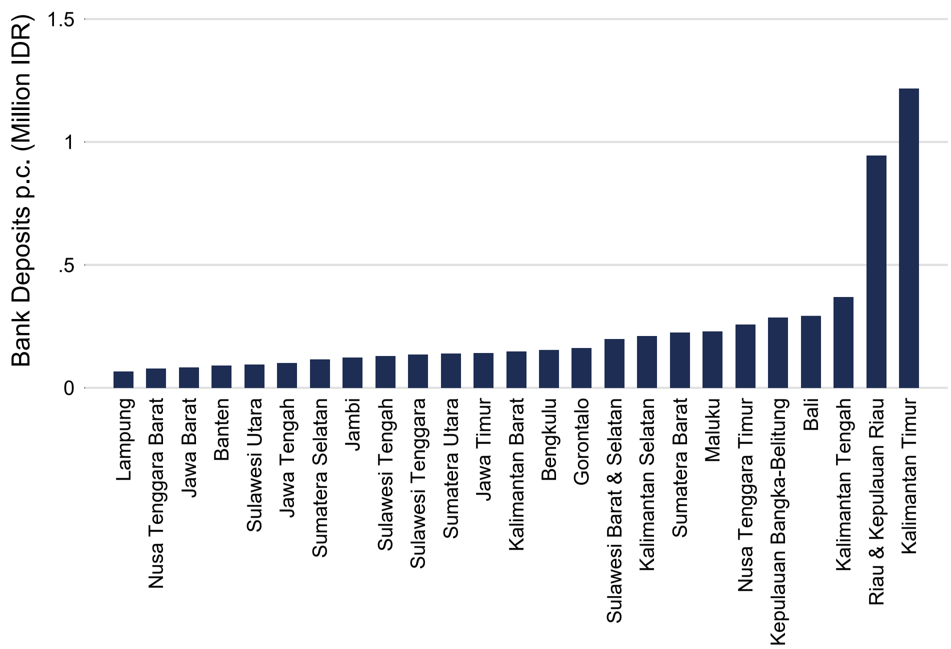
Figure A.5: Dynamic Responses of Public Service Delivery to Grants



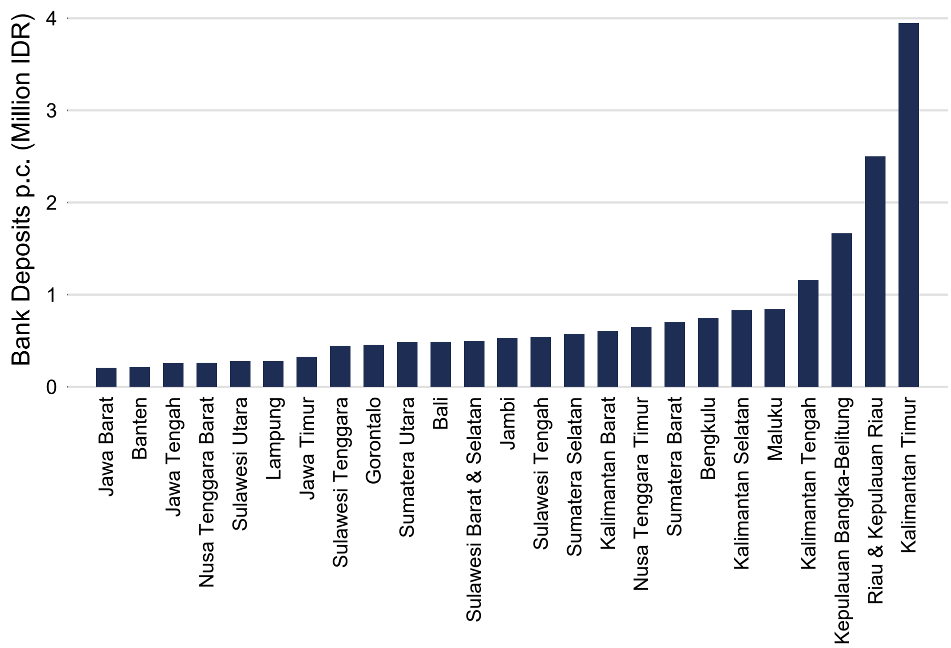
Notes: This figure displays IV estimates and 95-percent confidence intervals for β^h and δ^h from Equation (9). Values of h are on the horizonal axis. The parameters cannot be identified at $h = 0$ for health care centers, because this variable is missing in 2008. Confidence intervals are robust to heteroskedasticity and two-way clustering by district and province-by-year.

Figure A.6: 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.