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State-Owned Enterprises as Countercyclical Instruments

Experimental Evidence from the Infrastructure Sector

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Abstract

This paper examines the effects of a negative macroeconomic shock on the financial performance of state-owned enterprises (SOEs) in infrastructure. It exploits the differential effects of a drastic fall in oil prices (in 2014–15) on SOEs in energy-rich countries relative to SOEs in non-energy-rich countries, matching firms based on their fuel expense ratio. The results—based on a balanced sample using coarsened exact matching and a differences-in-differences estimation—indicate that fully owned SOEs (FSOEs) that suffered a negative macroeconomic shock performed worse than those that did not. FSOEs that suffered a shock also received large fiscal transfers from the government to cope with the shock for three years after the shock. Despite the transfers, they reduced their capital expenditures as a consequence of the shock.

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State-Owned Enterprises as Countercyclical Instruments: Experimental Evidence from the Infrastructure Sector[1]

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1 Introduction

Despite privatizations and reform efforts, state-owned enterprises (SOEs) are still key players in infrastructure around the world. As a result of failed privatizations, re-nationalizations, and failed reforms to open the sector to private investment, governments still own, control, and influence the operation of a large portion of the world's infrastructure firms. For example, Foster et al. (2017) find that in 2015, of the 88 countries whose energy reforms they tracked, a third had an SOE monopoly operator and 22 percent had a single-buyer model, which is almost always an SOE. The remaining half of the countries they study had hybrid models in which SOEs and private companies interact and compete with one another. This resilience of state ownership in infrastructure is in part a consequence of the haphazard or incomplete privatization process of large infrastructure firms, which left governments with full or partial ownership of what were often the politically sensitive, harder to sell SOEs (Estache, Gomez-Lobo, and Leipziger 2001; Nellis 2005).

A key policy question is whether these SOEs can play a countercyclical role during macroeconomic crises. Do negative shocks worsen performance and adversely affect the long-term health of these companies? The answer may not be straightforward, as SOEs use a variety of mechanisms to cope with negative shocks, including soft budget constraints (Kornai, Maskin, and Roland 2003; Musacchio and Lazzarini 2014). SOEs may also have access to soft loans from other SOEs or the Treasury, which they use to withstand a shock. They can borrow at below-market rates from the market or from other SOEs or financial intermediaries, and they can receive operational subsidies, tax breaks, and tax deferrals from the government (Herrera Dappe et al. 2022). Recent studies that use matching techniques to compare partially privatized SOEs (PPSOEs) and private firms in a variety of sectors show that during severe recessions, the former have a slower rate of reduction in labor than similar comparable private firms (Lazzarini and Musacchio 2018). Still, most of the discussions about the role of SOEs during crises lack experimental or quasi-experimental studies that shed light on how they behave during macroeconomic downturns.

This paper focuses on two issues. First, it examines whether SOEs follow policies that are consistent with a countercyclical role or whether they exacerbate the negative effect of the shock by generating fiscal risk. Second, it investigates whether these shocks have different effects on fully owned SOEs (FSOEs) and partially privatized SOEs (PPSOEs).[2]

The findings are relevant for the literature that documents how fiscal surprises from SOEs can be problematic for macroeconomic stability. One strain of the literature examines the fiscal cost of

[2] In this study, PPSOEs refer to firms that are majority-owned or controlled but not fully owned by the state. Full ownership is defined as state control of at least 99.5 percent of the share capital.

bailouts in a variety of countries after different types of macroeconomics shocks (Bova et al. 2016, 2019). Another warns about the fiscal risk from contingent liabilities that can arise during crises (Lewis and Mody 1998; Polackova Brixi 1998; Polackova Brixi and Mody 2002; Polackova Brixi and Schick 2002). This paper contributes to the literature by conducting a quasi-experiment that shows the fiscal cost of SOEs (that is, the fiscal risk of SOEs) during a negative macroeconomic shock using data from multiple countries in a differences-in-differences setting.

We examine the effects of the drastic fall in the price of oil in 2014 as a natural experiment that treated infrastructure SOEs in energy-rich countries with a negative macroeconomic shock, especially relative to similar SOEs in non-energy-rich countries. We use data from the World Bank Infrastructure SOEs Dataset, which tracks the financials of over 100 firms in 19 countries from 2000 to 2018 and includes a more balanced panel for 2009–18. We use data on three sectors—airports, airlines, and power—to maximize intrasector variation over time and across countries.

Ideally, we would like to isolate the negative macroeconomic effect of a drastic fall in the price of oil in energy-rich countries from any confounding effect that may come from having firms enjoy cheaper fuel inputs. Finding a large sample of SOEs for which the latter effect is null or insignificant is difficult, however. For that reason, we isolate the positive effects stemming from the fall in the price of oil by comparing firms in treatment countries and control countries matched according to fuel costs as a percent of expenses. That is, we compare firms with similar sensitivities to fuel costs within the same industry in treatment (energy-rich) countries and control (non-energy-rich) countries. Doing so allows us to capture the effect of the negative macroeconomic shock that is caused by the plummeting in the price of oil, as it negatively affects the demand of firms in energy-rich countries. Thanks to the detailed nature of our database, we can compare firms in multiple infrastructure sectors in a variety of treatment and control countries, controlling for fixed effects for industry and World Bank regions and income levels.

Infrastructure is a good setting in which to study the effects of large macroeconomic shocks on SOEs for at least four reasons. First, infrastructure SOEs are asset heavy and need continuous capital expenses to sustain and renew their existing capacity. Second, infrastructure SOEs are usually large, if not the largest, employers in the sectors and countries in which they operate. As such, their workers have significant political power, making it harder for managers and politicians to make painful adjustments to employment and expenses when they face a negative shock. Third, infrastructure SOEs are usually strategic suppliers of inputs for companies and households, making them more prone to having controlled tariffs, which can exacerbate the effects of a negative shock. Fourth, the infrastructure sector tends to be heterogeneous in terms of the ownership of large companies. It often includes some dominant firms with full state ownership as well as large firms with a mix of public and private ownership.

One would assume that reforms that facilitate cost recovery in infrastructure firms with more flexible (and less political intervention in) tariffs should lead to a faster recovery of these firms during a negative shock. For instance, partial privatization of infrastructure firms is usually accompanied by a full or partial liberalization of tariffs—by introducing a regulator to set tariffs, for example—as well as by investment and outreach conditions that improve the quality and reach of their services (see, for instance, Galiani, Gertler, and Schargrodsky 2005 and Andrés, Foster, and Guasch 2006). The problem is that during negative shocks, even in these partially privatized firms, the temptation of the government to intervene to control tariffs or to prevent these firms from firing redundant labor can be high (Lazzarini and Musacchio 2018).

Therefore, we pay particular attention to the heterogeneity of the effects of a negative shock in FSOEs and PPSOEs. Our working hypothesis is that FSOEs usually enjoy more guarantees than similar PPSOEs (Borisova and Megginson 2011; Borisova et al. 2015; Wagner et al. 2018) and arguably have easier access to government bailouts, providing them with a softer budget constraint, which allows them to respond differently to negative shocks relative to PPSOEs. In particular, the paper examines whether FSOEs in treated countries avoided cutting capital expenditures (CAPEX) or employment when faced with a negative shock, thus behaving like FSOEs in countries that did not suffer the negative shock.

We find that after a sharp decline in the price of oil, firms in energy-rich countries (the treated group) behaved differently from SOEs in the control group in at least three ways. First, treated infrastructure SOEs seem to have experienced worse performance for several years after the negative shock, particularly in terms of earnings before interest, taxes, depreciation, and amortization (EBITDA) net of the operations subsidies SOEs receive. Second, we find a decline in CAPEX in treated SOEs relative to the control group. Third, FSOEs performed much worse in treated countries than in the control group. We also find some evidence that they received larger fiscal injections. That is, we find evidence that FSOEs play a budget-contracting, rather than a budget-expanding, role during crises This finding is consistent with the fact that governments have to use many tools to help SOEs cope with negative shocks.

The rest of this paper is organized as follows. Section 2 summarizes the literature. Section 3 describes the data and the experimental setting. Section 4 describes the empirical methodology. Section 5 presents the findings. Section 6 summarizes the paper's main conclusions.

2 Literature Review

Until now, most of what we know about the weak performance of infrastructure SOEs comes from quasi-experimental settings that examines performance before and after privatization and reform. Studies of power utilities show that privatization can lead to improvements in productivity and service quality (Andrés, Foster, and Guasch 2006).[3] The literature also documents that in developing countries, reforms in the power sector have been slow and suffered significant reversals, leaving SOEs responsible for the bulk of the generation, transmission, and distribution of power (Eberhard et al. 2016; Foster et al. 2017). A companion paper (Herrera Dappe et al. 2022) studies the performance of infrastructure SOEs relative to comparable private infrastructure firms. It shows that infrastructure SOEs are larger relative to GDP, have larger liabilities relative to GDP, have higher employment costs as a share of revenues, are less efficient, and have worse returns on assets than comparable private firms.

This evidence suggests that infrastructure SOEs underperform similar private firms and can generate significant fiscal risk. But little is known about the countercyclical role they can play during macroeconomic crises. SOEs can take advantage of their soft budget constraint to promote employment and investment (Kornai, Maskin, and Roland 2003; Musacchio and Lazzarini 2014). How much they do so when facing negative shocks is not clear, however.

There is more evidence of the countercyclical role of state-owned banks than on nonfinancial SOEs. Under certain conditions, for example, state-owned banks lend more than private banks during a crisis (Coleman and Feler 2015), especially in developing countries. State-owned banks reduce the procyclicality of credit in developing countries (Panizza 2021), and during severe recessions, PPSOEs reduce the labor force at a slower rate than similar private firms (Lazzarini and Musacchio 2018).

This paper provides evidence that sheds light on the fiscal risk of infrastructure SOEs when they face common macroeconomic risks, such as a large drop in export prices. Until now, knowledge about the fiscal risks of infrastructure SOEs and public-private partnerships (PPPs) comes from studies of the aftermath of extremely large macroeconomic crises. For instance, Bova et al. (2019) identify 21 bailouts of infrastructure SOEs with costs above 1 percent of GDP, most of them occurring in the aftermath of a major financial crisis. The literature on fiscal risk warns that government guarantees for PPPs generate significant risk, as contingent liabilities can be sizable during negative macroeconomic shocks (Polackova Brixi 1998; Polackova Brixi and Mody 2002; Polackova Brixi and Schick 2002).

This paper contributes to the literature by examining how negative shocks can have heterogeneous effects in FSOEs and PPSOEs. The working hypotheses are that FSOEs usually enjoy more guarantees than similar PPSOEs (Borisova and Megginson 2011; Borisova et al. 2015, Wagner, Jara-Bertin, and Musacchio 2019) and arguably have easier access to government

[3] They use fixed effects and firm-specific time trends to disentangle improvements in efficiency that may be caused by ownership changes in the short and long terms.

bailouts, which provides them with a softer budget constraint than PPSOEs, allowing them to respond differently to negative shocks. For instance, FSOEs may have access to government transfers or credit without having to show good performance for it (Cull and Xu 2003).

The contribution of the paper to the literature is therefore threefold. First, it uses a quasi-experimental setting to study the behavior of SOEs treated with a negative macroeconomic shock relative to nontreated SOEs. Second, it studies heterogeneous effects on FSOEs and PPSOEs. Third, it uses detailed financials of infrastructure SOEs in multiple countries in the same time period.

3 Data and Experimental Setting

3.1 Database

The World Bank Infrastructure SOEs Database was compiled as part of a broader research project to analyze the fiscal costs and risks of infrastructure. The data come from financial statements from SOE websites, government websites that include SOE financial statements, annual reports, and other sources, such as the EMIS Intelligence database and stock exchange websites. The database covers all SOEs operating infrastructure assets in the power (generation, transmission, and distribution) and transportation (roads, railroads, and airlines and airports) sectors for 19 countries between 2000 and 2018. The countries were selected based on data availability and to maximize sectoral coverage. They include the following:

- East Asia and Pacific: Indonesia, Solomon Islands
- Europe and Central Asia: Albania, Bulgaria, Croatia, Georgia, Kosovo, Romania, Ukraine
- Latin America and Caribbean: Argentina, Brazil, Peru, Uruguay
- South Asia: Bhutan
- Sub-Saharan Africa: Burundi, Ethiopia, Ghana, Kenya, South Africa.

The database classifies an enterprise as an SOE if the state directly or indirectly owns more than 50 percent of its shares or the state is the ultimate controlling entity, through majority ownership of common stock or any other mechanisms of control. This definition is in line with the European Union's definition of public undertakings in Commission Directive 2006/111/EC.

The database provides panel data on the financials of SOEs in the power and transport sectors at the SOE/year level that are consistent over time and comparable across SOEs regardless of where they operate. To ensure consistency and reliability, researchers collected the data using a standardized accounting template that was populated using the information on financial statements. To ensure that quantities like earnings before interest, taxes, depreciation, and amortization (EBITDA) or operations subsidies in the database are comparable across SOEs and years, they identified each item as defined by the template using the notes to the financial statements rather than relying on the way such items are presented in the SOEs' main financial tables. Data reliability was further ensured through quality assurance checks by alternate analysts and accounting experts.

The database provides a standardized representation of the income statement, balance sheet, and cash flow statement of each SOE. It also contains supplementary items, including currency risk, debt/loan analysis, maturity profiles of assets and liabilities, and SOE ownership structure.

We restrict the sample to SOEs in the power, airlines, and airports sectors, in order to maximize comparability within sectors across countries. We focus on SOEs that depend heavily on demand for their output to produce income, in order to measure the effect of a macroeconomic shock on demand for their services. We exclude roads because of their dependence on budgetary transfers, and railways, for which there is no variability across treatment and control groups.

3.2 Variables

Table 1 lists the main variables of interest, which include indicators of size (assets); financial performance (EBITDA, returns on assets, CAPEX); and fiscal support (operational subsidies and total fiscal injections). To compare across firms, we normalized the variables by total assets. A mismatch could arise in the case of financial ratios that compare an income statement/cash flow amount (a cumulative amount during a period of time) in the numerator to a balance sheet amount like total assets (reported as the stock at the end of the period) in the denominator. To avoid such a mismatch, we express total assets as the average of the end of the previous year and the end of the observed year, in order to make it representative of each observed year. For example, the return on average assets (ROAA) = net income (*t*)/average of total assets (t, *t* –1). Because firms often receive operational and capital subsidies from the government, their net income is not an accurate depiction of their performance. For that reason, we create alternative measures of firm performance net of subsidies. Adjusted EBITDA over average assets uses EBITDA net of operational subsidies as the numerator and average total assets as the denominator. Adjusted ROAA uses total comprehensive income net of total subsidies as the numerator and average total assets as the denominator. To see whether SOEs treated with the negative shock receive more financial support from the government, we measure operational subsidies over average assets and create a variable called fiscal injections over average assets to capture different fiscal support instruments. The numerator of this variable is the sum of operational subsides, government equity injections, changes in loans from government and SOEs, and changes in deferred tax liabilities.

Table 1 Main variables used in the analysis

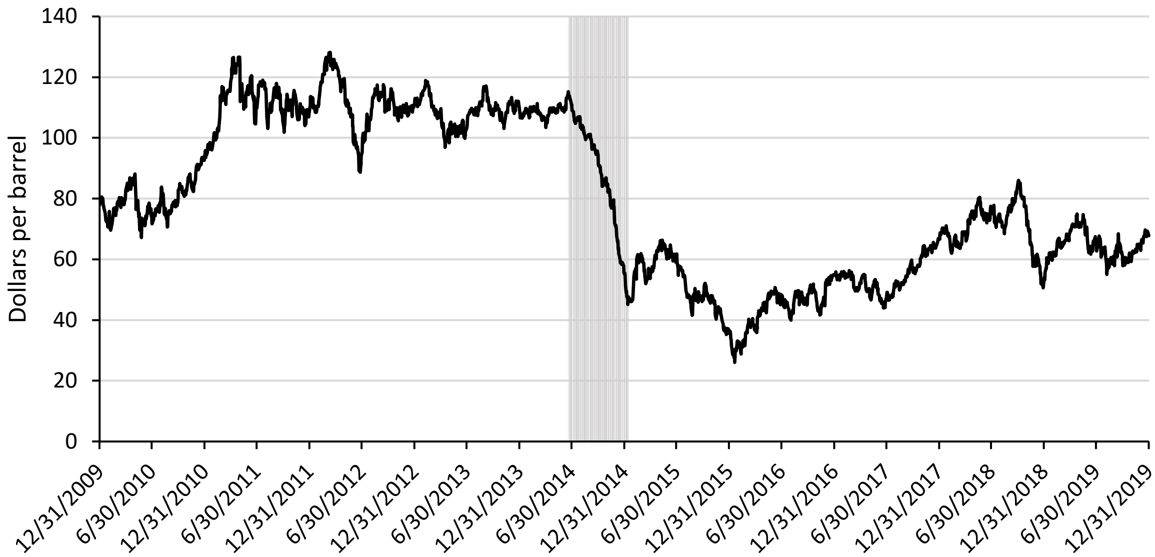
Variable	*Description*
Capital expenditure (CAPEX) to average assets (%)	Ratio of CAPEX in period *t*, measured by the purchase of property, plant, and equipment, to the average of total assets in *t* and *t* – 1
Earnings before interest, taxes, depreciation, and amortization (EBITDA) to average assets (%)	Ratio of EBITDA in period *t* to the average of total assets in *t* and *t* – 1
Adjusted EBITDA to average assets (%)	Ratio of EBITDA minus operational subsidies in period *t* to the average of total assets in *t* and *t* – 1
Return on average assets (%)	Ratio of annual net income in period *t* to average of total assets in *t* and *t* – 1
Adjusted return on average assets (%)	Ratio of annual net income minus total subsidies in period *t* to average of total assets in *t* and *t* – 1
Operating subsidies to average assets (%)	Ratio of operational subsidies in period *t* to average of total assets in *t* and *t* – 1
Fiscal injections to average assets (%)	Ratio of the sum of operational subsidies and government equity injections in period *t* plus changes in loans from government and SOEs and in deferred tax liabilities in period *t* to average of total assets in *t* and t-1
Operating expenditures to average assets (%)	Ratio of operating expenditures *t* to average of total assets in *t* and *t* – 1
Operating income to average assets (%)	Ratio of operating income in period *t* to average of total assets in *t* and *t* – 1
Size (Log)	Natural logarithm of total assets
Leverage (%)	Ratio of debt to total assets in period *t*

3.3 Experimental Setting

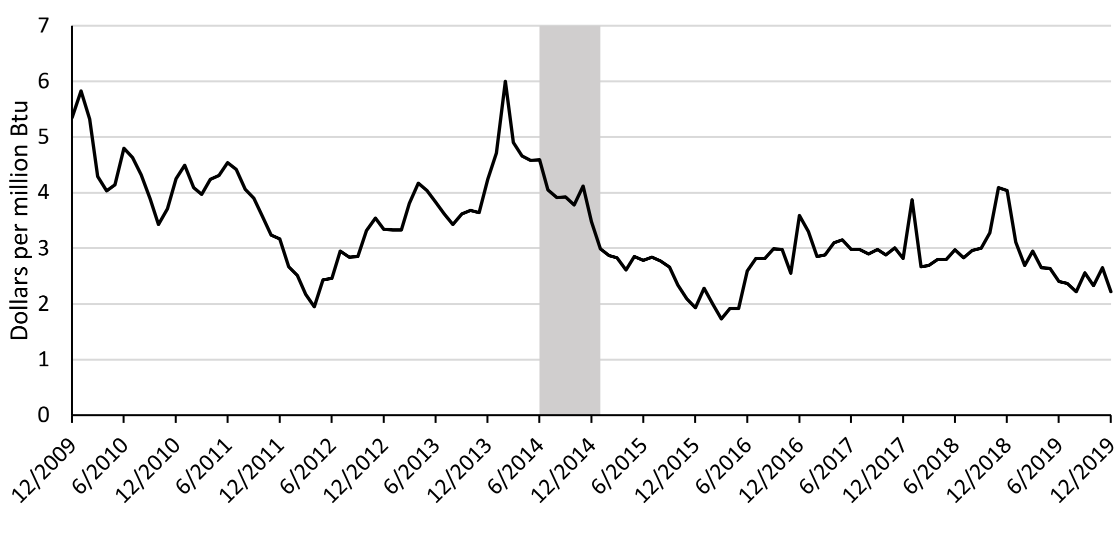
We exploit the oil and gas price collapse of mid-2014 as an unanticipated negative shock to the infrastructure SOEs in our database and examine its effects on performance. Brent prices plummeted from $115 a barrel in June 2014 to $55 by the end of the year; after a short initial recovery in early 2015, they declined throughout 2015, hitting a low of $27 in early 2016 before bouncing back to more than $60 a barrel (figure 1, panel a). Gas prices show the same pattern (figure 1, panel b).

Figure 1 Oil and natural gas prices, 2009–19

a. Europe Brent spot price for oil



b. Henry Hub natural gas spot price



Source: Energy Information Administration.
Note: Oil prices are FOB (freight on board).

This oil shock affected countries differently based on their oil- and gas-exporting status and energy reserves. To estimate the effects of a negative shock on the performance of SOEs, we take advantage of the difference in energy exports and energy reserves across countries. The premise is that countries that are energy rich will experience a negative shock to their economies with the price collapse of these commodities vis-à-vis other countries. We categorize countries represented in the sample as energy-rich and non-energy rich. We set a threshold based on both exports and total reserves of crude oil and gas. Countries whose oil and gas exports are above 0.5 percent of total exports and have reserves of 1 million or more barrels of oil or 700 billion cubic meters of gas are categorized as energy rich. Table 2 shows the resulting classification.

Table 2 SOEs in energy-rich and non-energy-rich countries in the sample

Treatment category/ SOE	*Sector*	*Country*	*Type*
Energy-rich			
OSHEE	Power	Albania	PPSOE
INFRAERO	Airlines and airports	Brazil	FSOE
CEMIG	Power	Brazil	PPSOE
CELESC	Power	Brazil	PPSOE
ECG	Power	Ghana	FSOE
Angkasa Pura II	Airlines and airports	Indonesia	FSOE
CORPAC	Airlines and airports	Peru	FSOE
EGASA	Power	Peru	FSOE
EGESUR	Power	Peru	FSOE
Electro Puno	Power	Peru	FSOE
ELSE	Power	Peru	FSOE
San Gaban	Power	Peru	FSOE
Bucharest Airport	Airlines and airports	Romania	PPSOE
Transelectrica	Power	Romania	PPSOE
Dnipro CHP	Power	Ukraine	FSOE
Odessa CHP	Power	Ukraine	FSOE
Cntr Energo	Power	Ukraine	PPSOE
Kharkiv OE	Power	Ukraine	PPSOE
Ternopil OE	Power	Ukraine	PPSOE
Mykolaiv OE	Power	Ukraine	PPSOE
Zaporizhia OE	Power	Ukraine	PPSOE
Non-energy-rich			
BPC	Power	Bhutan	FSOE
Sofia Airport	Airlines and airports	Bulgaria	FSOE
Plovdiv Airport	Airlines and airports	Bulgaria	FSOE
GOA	Airlines and airports	Bulgaria	FSOE
Maritsa	Power	Bulgaria	FSOE
NEK	Power	Bulgaria	FSOE
NPP Kozloduy	Power	Bulgaria	FSOE
ESO	Power	Bulgaria	FSOE
Zadar Airport	Airlines and airports	Croatia	FSOE
Rijeka Airport	Airlines and airports	Croatia	FSOE
Croatia Airlines	Airlines and airports	Croatia	PPSOE
HE	Power	Croatia	FSOE
KETRACO	Power	Kenya	FSOE
Ken Gen	Power	Kenya	PPSOE
KPLC	Power	Kenya	PPSOE
KEK	Power	Kosovo	FSOE
KOSTT	Power	Kosovo	FSOE

Solomon Airlines	Airlines and airports	Solomon Islands	FSOE
SIEA	Power	Solomon Islands	FSOE
UTE	Power	Uruguay	FSOE

Note: FSOE: Fully owned state-owned enterprise. PPSOE: Partially privatized state-owned enterprise.

Our criteria for defining energy-rich countries include both exports and reserves, so that our sample of treated countries includes gas re-exporters from Eastern Europe (such as Ukraine). As a drastic fall in the price of oil (and gas) negatively affects these re-exporters, we want to make sure our definition of energy rich includes them in the treatment group. Leaving them in the non-energy-rich group would pollute our control group, as they experience a negative macroeconomic shock when the price of oil drops.[4]

The experimental setting relies on the fact that the negative shock to the price of oil in 2014 severely affected the balance of payments of some major oil or gas exporters, creating a recession—precisely the negative macroeconomic shock we want for the treatment group (table 3). Other countries that rely less heavily on oil or gas experienced milder to no effects. In fact, there is no significant difference in real GDP growth rates or the current account deficit in the control group before and after the shock, whereas the treated group had significantly slower GDP growth after the shock (statistically significant at the 5 percent level). There is also heterogeneity in the effect on oil importers. The shock benefited emerging economies that heavily subsidize energy, such as India; the effect on advanced economies was minimal, in part because it occurred during a period of high savings and low demand.

Table 3 Macroeconomic variables for the treatment and control groups

	2010–13		*2015–18*		
Variable	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*	*T-statistic of mean difference*
Control group (nine countries)					
Current account balance to GDP (% annual variation)	–0.28	6.03	0.64	2.24	–0.85
Real GDP growth rate (% annual)	4.67	3.58	3.65	3.08	1.28
Treatment group (nine countries)					

[4] Most of the re-exporting countries in Eastern Europe derive income from the gas pipelines that come from the Russian Federation, in part because the gas is used domestically and in part because the re-exported gas generates income for local firms and tax revenue for the government. We examine re-exporting countries separately, finding that there was a severe shock to the current account and aggregate demand in 2014–15, justifying the logic that their economies behave like those of oil and gas exporters. The price of gas coming from Russia, which crosses the pipelines of many of the countries of our sample in Eastern Europe, is determined using a moving average of the price of oil. See Gazprom's pricing policy at https://www.gazprom.com/about/marketing/europe/.

Current account balance to GDP (% annual variation)	–0.38	2.04	0.25	1.74	–1.40
Real GDP growth rate (% annual)	4.67	3.43	2.72	3.36	2.43**

Source: International Monetary Fund, World Economic Outlook (April 2021), and own calculations.
Note: * p < 0.1, ** p < 0.05, *** p < 0.01.

SOEs in the energy-rich countries are expected to be hurt by a fall in the price of oil or gas through a macroeconomic demand shock. Countries below the threshold of exports and reserves are categorized as non-energy-rich. SOEs in these countries are used as the control group, as we would expect them not to be adversely affected by a fall in fuel prices. A concern is that the declines in fuel prices not only negatively affect net exporters but also positively affect net importers. If this is the case, the control group may not be a valid counterfactual. Table 3 shows clear differences in the macroeconomic impact of the shock after the fall in oil prices. Therefore, the differences in outcomes between the two groups should capture the effects of the negative macroeconomic shock on the performance of SOEs. All countries in the sample are price-takers in the international oil and gas markets.

Another concern about the way we create the treatment and control groups is that confounding effects could arise from changes in the firms' cost structures. For instance, the decline in the price of oil could benefit firms that have high fuel costs (like airlines), attenuating the negative effects that might be observed from reduced sales or fiscal tightening, especially if these types of firms are more heavily concentrated in energy-rich countries. In order to avoid potential biases and accurately identify the effects of interest, we initially restricted the sample to infrastructure firms with low fuel costs as a percent of total expenses (firms below the 20th percentile of the distribution of fuel costs as a share of total expenses). This approach yielded fewer than 15 observations. To enlarge our sample, we performed a matching exercise, using the coarsened exact matching (CEM) algorithm (Iacus et al. 2012), to include firms above the 20th percentile of the share of fuel costs, such that we are comparing firms within bins in which fuel costs to total expenses are relatively similar.

We rely on the CEM methodology to create bins that are balanced across the treatment and control groups using this ratio of fuel costs to expenses. We believe this method neutralizes the possible positive effects stemming from the reductions in fuel costs for infrastructure SOEs. We also prefer the CEM methodology because it minimizes the imbalances between the treated and control groups without requiring a prespecified size of the matching solution (as propensity score matching does). It operates by creating coarsened treated and control groups (as in stratification) and then implementing exact matching with the coarsened data. The main advantages of the method are its computational efficiency, especially in large datasets, and the fact that it maximizes the number of matches achieved. We run the matching algorithm on fuel costs and sectors, as we control for size in the regressions.

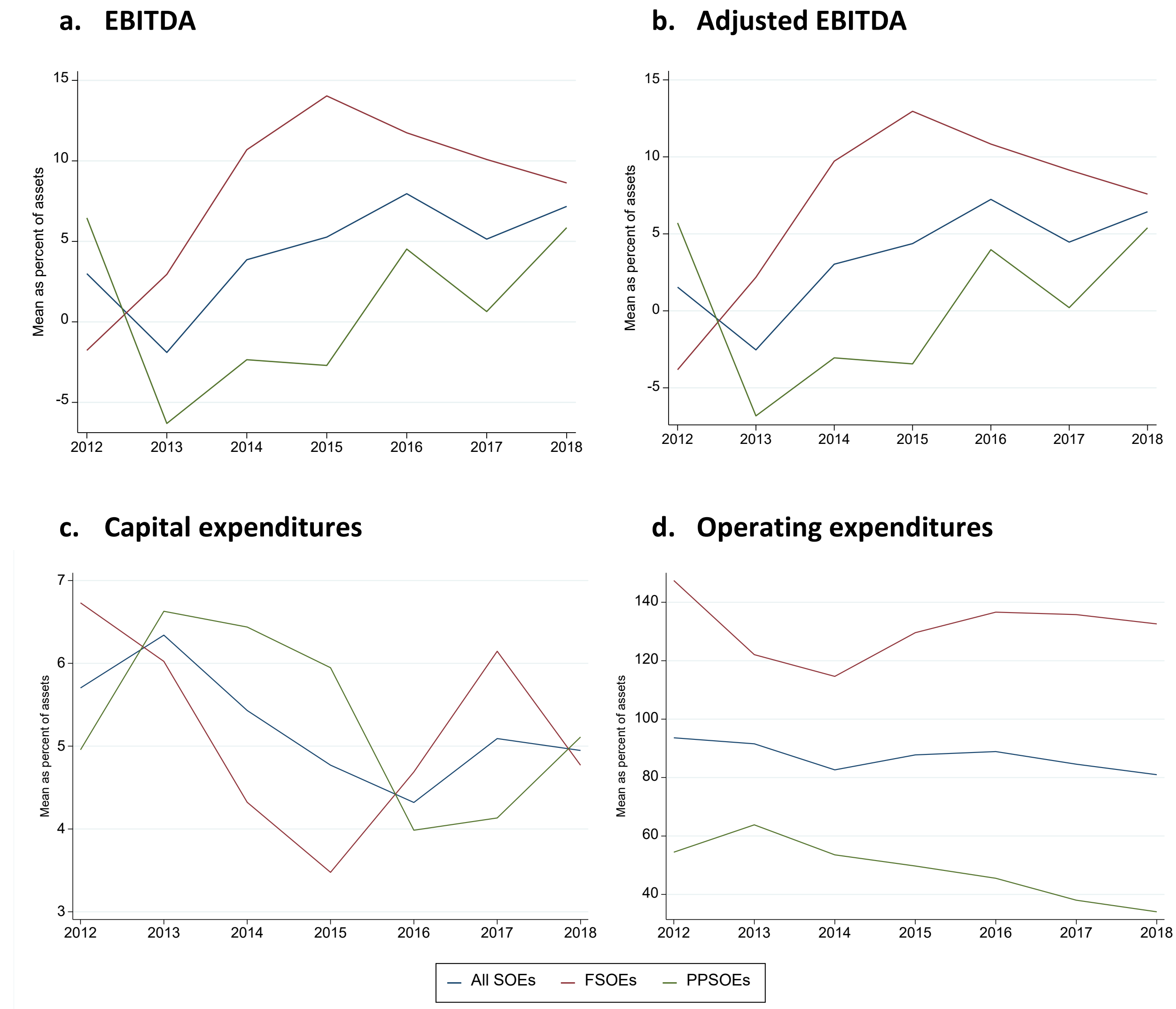
3.4 Descriptive Statistics

Both the mean EBITDA over assets and the adjusted EDITDA over assets are positive in most years. The distributions are skewed to the left, with a few firms experiencing very large losses. The median firm has positive EBITDA over assets and adjusted EDITDA over assets in all years. The margins—income and cost—reflect the commercial nature of these SOEs. Operational subsidies seem to be moderate. About a third of the SOEs in the sample received no subsidies, and the median subsidy (when considering only firms that received subsidies) was 2.4 percent of average assets. However, the distribution is skewed rightward, with large subsidies—above 100 percent of assets in some cases—and a mean of 11.5 percent of assets.[5]

Figure 2 shows the trends for several indicators of financial performance in energy-rich countries. Panels a and b show the mean EBITDA and the adjusted EBITDA over average assets. Both began to increase in 2013, with some volatility, particularly in the case of PPSOEs, which showed weaker performance than FSOEs. Capital expenditures (CAPEX) decreased sharply during and immediately after the shock for the mean SOE, with a sharper decrease for FSOEs than for PPSOEs, leading the former to invest less than PPSOEs as a share of average assets (panel c). Operating costs as share of average assets of the mean FSOE are at least twice as large as the mean PPSOEs (panel d).

[5] One reason why these firms may perform better, and be less dependent on subsidies, than the typical SOEs in developing countries is that the sample includes mostly SOEs from middle-income countries and mostly from countries in which the World Bank has implemented programs that include reforms to the main infrastructure sectors we study, which may have improved the efficiency of the national companies.

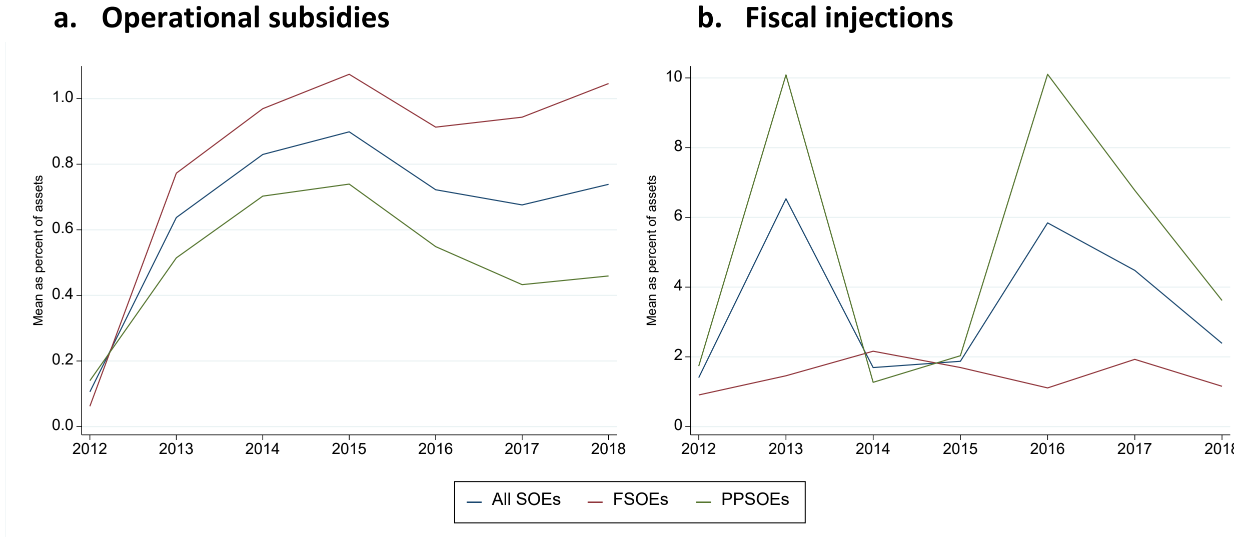
Figure 2 Financial performance of SOEs in energy-rich economies, 2012–18



Source: World Bank Infrastructure SOEs Database and authors' calculations.
Note: EBITDA: Earnings before interest, taxes, depreciation, and amortization. FSOE: Fully owned state-owned enterprise. PPSOE: partially privatized state-owned enterprise.

Figure 3 shows the evolution of fiscal support for PPSOEs and FSOEs in energy-rich countries. The average FSOE has received more operations subsidies as percent of assets than the average PPSOEs since 2013 (panel a.). Operational subsidies over assets increased sharply in 2012–14 for all SOEs, reaching almost 90 percent of average assets for the mean SOE, followed by a slight decrease after 2014. In the case of overall fiscal injections, there is significant volatility in the period of analysis, particularly for PPSOEs, with the mean fiscal injections to average assets for all SOEs ranging between 2 and 6 (panel b.).

Figure 3 Fiscal transfers to SOEs in energy-rich economies, 2012–18



Source: World Bank Infrastructure SOEs Database and authors' calculations
Note: Fiscal injections are the sum of operational subsides, equity injections, changes in loans from government and other SOEs, and changes in deferred tax liabilities.

Table 4 presents descriptive statistics of the dependent variables for the treatment and control groups for the pre-shock period. It shows that before 2013, on average, firms in the treatment group (energy rich countries) perform similarly in terms of EBITDA, adjusted EBITDA over average assets, ROAA, and adjusted ROAA as those in the control group. They also have similar CAPEX, OPEX, operating income over average assets, and sizes (log of assets). SOEs in energy-rich countries, however, have lower leverage than those in non-energy-rich countries. This difference is not problematic, because we control for leverage in our regression analysis.

Table 4 Descriptive statistics and mean differences between SOEs in energy-rich and non-energy rich countries, pre-shock

	Non-energy-rich economies			*Energy-rich economies*			
Variable	*Observations*	*Mean*	*Standard deviation*	*Observations*	*Mean*	*Standard deviation*	*T-statistic of mean difference*
EBITDA (% of average assets)	20	4.90	6.62	21	–1.90	30.09	0.99
Adjusted EBITDA (% of average assets)	20	–7.43	43.74	21	–2.54	29.90	–0.42
ROAA (%)	20	0.40	7.11	21	–6.85	29.63	1.07
Adjusted ROAA	15	–0.08	3.90	14	–10.93	35.35	1.18

CAPEX (% of average assets)	19	8.50	10.01	21	6.34	5.07	0.87
Operations subsidies (% of average assets)	20	12.33	42.80	21	0.64	1.34	1.25
Fiscal injections (% of average assets)	16	16.47	47.42	17	6.53	22.71	0.77
OPEX (% of average assets)	20	59.48	73.10	21	91.57	87.10	–1.27
Operating Income (% of average assets)	20	52.03	62.12	21	88.72	76.66	–1.68
Size (log of total assets)	20	13.07	2.55	21	13.58	1.47	–0.79
Leverage (debt-to-assets ratio, %)	20	12.31	11.44	21	6.14	10.37	1.81*

Note: Sample includes SOEs in the power, airlines, and airports sectors.
p* < 0.1,*p* < 0.05, and ****p* < 0.01

Table 4 also reveals that SOEs in energy-rich and non-energy-rich countries have similar ratios of subsidies to average assets and fiscal injections to average assets. Our setting thus reveals whether governments react to negative shocks by increasing subsidies and fiscal injections beyond their traditional levels.

4 Empirical Analysis

To identify the causal effect from the negative macroeconomic shock of the decline in oil and gas prices in the world markets, we employ a difference-in-differences technique that takes advantage of the fact that the price shock reduced aggregate demand in energy-rich countries relative to non-energy-rich countries. We estimate the following equation:

$$Y_{it} = \alpha + \beta_1 Post_t + \beta_2 Energy\ Rich_i + \beta_3 Energy\ Rich_i * Post_t + \varphi * ln(Assets_{it}) + \tau * Leverage_{it} + Industry_i + Industry_i * Post_t + Region_i + Region_i * \mathrm{Post_t} + \mathrm{Income\ Group_i} + \mathrm{Income\ Group_i} * \mathrm{Post_t} + \pi_i + \epsilon_{it},$$

where i denotes the SOE, t denotes the year, and Y_{it} denote the outcomes of interest. $Energ\ Rich$ is a dummy variable equal to 1 if the firm is in a country classified as a net oil exporter with high oil reserves before the shock in 2013. $Post_t$ is a dummy variable equal to 1 if the observation is from the post-shock period and 0 if the observation is from the pre-shock period. The coefficient of interest is β_3, which identifies the average treatment effect on the treated. It captures the differences in outcomes before and after the shock between the treated (T) and control groups (C):

$$\hat{\beta}_3 = (\overline{\Delta Y})_T - (\overline{\Delta Y})_C$$

We also include industry, region, and income group fixed effects, which we interact with the $Post_t$ variable to capture any sector, region, and income group–specific trends that could be driving changes in the dependent variables. Although differences in firm characteristics between treated and control groups are expected to be constant over time, we control for firm size using the log of assets and the leverage ratio. We run this estimation using firm-level fixed effects, π_i.

We focus on the following financial performance outcomes: return on assets, return on assets net of subsidies (adjusted ROAA), EBITDA to average assets, EBITDA net of operational subsidies (adjusted EBITDA) to average assets, and investment (CAPEX over average assets). We also look at government support through (a) operational subsidies over average assets and (b) total fiscal injections (the sum of operational subsidies, government equity injections, changes in loans from the government and other SOEs, and changes in deferred tax liabilities) over average assets.

We expect that infrastructure SOEs would give up performance and CAPEX during a negative shock while preserving employment, with a consequent drop in productivity. But it could also be the case that these firms show more resilience, by taking advantage of their soft budget constraint (by, for example, accessing more subsidies, deferring payment of taxes, or exercising their privileged access to capital to continue paying CAPEX and employment costs). In this case, we would expect to find that treated firms would have an increase in fiscal injections.

Initially, we look at the immediate reaction post shock, by comparing outcomes in 2013 and 2014. However, as SOEs often hide or delay losses, we also examine whether the changes in SOE policies happened in the years right after the shock. For that purpose, we run regressions in which we assume the post-shock period extends to 2015 or 2016.

Doing so is important because SOEs have the capacity to borrow from other SOEs and from state-owned banks and can ask governments to defer tax liabilities as a way to withstand a negative shock or hide losses. As these tactics are often just ways of delaying the accounting loss, we check to see whether the coefficient for the post-shock years is significant for treated SOEs. The delaying or coping tactics can end up manifesting themselves in the accounting in other ways, such as losses down the road, smaller investments, and greater government support.

Agency theories of SOE inefficiency predict that negative shocks should hurt financial performance and productivity (Megginson and Neter 2001). But the soft budget constraints of SOEs allow them to buffer some of the shock and continue to pay for government priorities such as sustained CAPEX and employment costs (Kornai 2003). Given that the direction of causality between a negative shock and our dependent variables is not clearly determined, we prefer to let the data speak, to find the actual behavior of the infrastructure SOEs in our treated group relative to the infrastructure SOEs in the control group.

We explore a few mechanisms through which the negative shock might affect revenues and operating expenses. In treated countries, the negative macroeconomic shock could reduce revenues for infrastructure SOEs through lower demand, with untreated firms expected to remain unaffected. Regarding operating expenses, we do not have a clear prediction, because we are matching firms by industry and fuel cost in the pre-shock period. There could, however, be different reactions in terms because the shock depends on the pass-through of oil prices.

In a separate regression, we restrict our sample to include only FSOEs. We expect these firms to have additional means of coping with the shock, in particular using their access to the government and other SOEs as lenders of last resort, especially when governments ask SOEs to undertake quasi-fiscal operations, as it is usually understood that in exchange the government will be there to help when needed (Musacchio and Pineda Ayerbe 2019; Ter-Minassian 2019).

5 Findings

Table 5 displays the effects of the negative shock on all our outcomes of interest for the fixed-effects estimation of our difference-in-differences model using the CEM sample. It does not show evidence of a decline in financial performance in the aftermath of the shock for treated SOEs. It does show an increase in subsidies over average assets in the first year after the shock and a substantial increase in the overall measure of fiscal injections (i.e., through a range of instruments beyond subsidies) two and three years after the shock.

Table 5 Baseline estimations of differences-in-differences with matching: Effects for treated SOEs one, two, and three years after the oil shock of 2014

Item	*(1)* *EBITDA/AA*	*(2)* *Adjusted EBITDA/AA*	*(3)* *ROAA*	*(4)* *Adjusted ROAA*	*(5)* *CAPEX/AA*	*(6)* *Operational subsidies/AA*	*(7)* *Fiscal injections/AA*	*(8)* *OPEX/AA*	*(9)* *Operating Income/AA*
2013–14	8.634	7.403	7.330	10.59	–1.047	1.231*	2.956	–4.447	2.951
Standard error	(8.012)	(8.139)	(7.302)	(13.20)	(1.400)	(0.619)	(4.147)	(4.656)	(5.806)
Observations	82	82	82	58	80	82	66	82	82
Mean of dependent variable	3.362	–2.566	–1.951	–2.828	7.545	5.928	9.359	70.53	67.93
2013–15	17.38	13.33	17.29	24.98	–1.122	4.042	15.07***	–11.96	0.510
Standard error	(18.91)	(19.57)	(18.21)	(25.78)	(1.530)	(2.339)	(3.482)	(11.02)	(13.35)
Observations	80	80	80	58	78	80	62	80	80
Mean of dependent variable	3.835	–2.036	–1.068	–2.129	7.423	5.872	9.072	72.65	70.77
2013–16	11.16	–2.333	12.75	14.62	–2.572	13.50	15.89**	9.424	6.775
Standard error	(13.72)	(16.16)	(13.78)	(20.24)	(3.411)	(8.972)	(6.464)	(10.98)	(8.791)
Observations	80	80	80	58	78	80	60	80	80
Mean of dependent variable	4.513	–0.442	–0.514	–1.173	7.722	4.955	10.03	71.57	71.24

Note: EBITDA: Earnings before interest, taxes, depreciation, and amortization. AA: Average assets. ROAA: Return on average assets. CAPEX: Capital expenditures. OPEX: Operating expenses. Robust standard errors are in parentheses. Regressions include a constant, a control for ln(assets), leverage, and fixed effects for industry and World Bank region and income groups. Matching is done using industry and fuel cost expense over total expenses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A possible problem of mixing PPSOEs and FSOEs in the same sample is that the PPSOEs may behave more like private firms than FSOEs and could be receiving less support from the government to cope with the shock. PPSOEs may be able to adjust more rapidly than FSOEs to a shock, perhaps reducing the labor force at a faster pace and thus not showing a decline in return on assets. They may also have less access to subsidies or cheap financing. Finally, one would expect that both types of firms would reduce CAPEX, causing us to pick up a negative and significant coefficient in some of the specifications.

To avoid some of these confounding effects, we exclude PPSOEs from the sample and focus exclusively on FSOEs (table 6). The results seem to be more robust statistically and point to the following effects. First, there is a clear decline in profitability. Column 1 shows no change on EBITDA over assets after the oil shock. However, the result can be masked by operational subsidies from the government. Column 2 shows a significant decrease in adjusted EBITDA over average assets one and three years after the shock. In the first year, adjusted EBITDA over average assets decreased by 3.9 percentage points, with a mean EBITDA over average assets of –4.9 percent. Three years after the shock the impact is even stronger, with a decrease of 15.7 percentage points in EBITDA over average assets and a mean of –2.2 percent for the sample. Adjusted EBITDA over average assets is negative but insignificant two years after the shock. Columns 4 and 5 show that adjusted ROAA decreased two years after the shock.

Second, we would expect to find a reduction in capex in both PPSOEs and FSOEs. Yet none of the coefficients in column 5 in Table 5 is significant. Looking exclusively at the negative shock for FSOEs in column 5 of Table 6, however, reveals a significant difference in the CAPEX of the treated and control firms two and three years after the shock. CAPEX as a percent of average assets decreased by 3.2 percentage points two years after the shock, which is close to half the mean of the sample. The decrease is even larger three years after the shock, with a coefficient of –7.2 and a mean of 8.1. These findings indicate that the negative shock led to a progressive reduction in CAPEX of FSOEs in treated countries, which likely led to a decrease in productivity and operational performance over several years after the shock.

Table 6 Matching estimates of the difference-in-differences for the fully owned SOE sample

Item	(1) EBITDA/AA	(2) Adjusted EBITDA/AA	(3) ROAA	(4) Adjusted ROAA	(5) CAPEX/AA	(6) Operational subsidies/AA	(7) Fiscal injections/AA	(8) OPEX/AA	(9) Operating Income/AA
2013–14	–2.351	–3.897**	–2.718	–3.873	–0.807	1.546*	7.962**	0.528	–3.680
Standard error	(1.381)	(1.487)	(1.811)	(2.728)	(2.344)	(0.763)	(2.624)	(7.646)	(7.388)
Number of observations	56	56	56	42	54	56	46	56	56
Mean of dependent variable	2.829	–4.874	–1.420	–2.200	7.787	7.704	11.34	52.10	47.29
2013–15	0.995	–3.240	0.280	–4.585*	–3.231**	4.235	15.27***	–11.80	–16.02
Standard error	(4.245)	(5.054)	(2.910)	(2.283)	(1.236)	(2.400)	(3.253)	(12.19)	(9.490)
Number of observations	56	56	56	42	54	56	46	56	56
Mean of dependent variable	2.687	–4.707	–1.425	–2.436	7.857	7.395	10.77	51.74	47.38
2013–16	–2.913	–15.68*	–2.595	–7.706	–7.158**	12.77	17.44*	8.923	–7.288
Standard error	(4.144)	(8.547)	(3.950)	(5.836)	(2.496)	(8.551)	(8.601)	(17.22)	(13.17)
Number of observations	56	56	56	42	54	56	44	56	56
Mean of dependent variable	3.981	–2.179	–0.373	–0.746	8.079	6.160	12.37	49.06	47.09

Note: *Note*: EBITDA: Earnings before interest, taxes, depreciation, and amortization. AA: Average assets. ROAA: Return on average assets. CAPEX: Capital expenditures. OPEX: Operating expenses. Robust standard errors are in parentheses. Regressions include a constant, a control for ln(assets), leverage, fixed effects for industry, and World Bank region and income groups. Matching is done using industry and fuel cost expense over total expenses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

We explore the effect of the oil price shock on operational subsidies as a percentage of average assets and fiscal injections as a percentage of average assets. Operational subsidies as a percentage of average assets increase by 1.55 percentage points immediately after the shock, with a mean of 7.7 (column 6). Governments used different instruments to support SOEs after the shock, with support increasing over time (column 7). Fiscal injections as a percentage of average assets increased by 8.0–17.4 percentage points one, two, and three years after the shock, with the increases in the last two years 41 percent above the respective sample means for each of the regressions. The fiscal injections needed by the treated firms were thus large, even three years after the shock.

We believe that the main mechanism making treated firms underperform control firms is the decrease in demand in treated countries as a result of the macroeconomic shock. But the confounding effect of a decrease in the cost of fuel inputs could be reducing operating expenses in both treatment and control firms. One possible outcome is that operating expenses may fall more in control firms and do not fall significantly in energy exporters, because a national oil or gas company is key for fiscal purposes and SOEs that buy energy inputs do not get the passthrough effect of the fall in energy prices. We checked to see whether part of our findings are explained by the differentials in the fall of operating expenses to average assets in column 8 of Table 6. As expected, the coefficient is not significant, signaling that there are no differences in the passthrough of oil prices between the treated and control groups.

6 Conclusions

Hit with negative shocks, infrastructure SOEs incur losses and require government support, in the form of fiscal transfers. In times of crisis, when governments want to use countercyclical fiscal policy to stimulate the economy, infrastructure SOEs do not help the government by using their buffer reserves to withstand the shock. On the contrary, they seem to operate with little financial slack, such that they need significant fiscal resources to survive following a large macroeconomic shock. Better-performing SOEs would help cushion negative shocks by not acting as a fiscal drag.

Recent discussion in the infrastructure literature suggests subsidizing energy as an efficient countercyclical measure during crises. Our results suggest that SOEs would not be able to help buffer a crisis and that aid would end up being funded by the government. In our findings, the bill comes back to the government in year 1 of the shock.

The negative effects of the macroeconomic shock we observe are stronger for FSOEs, which perform worse than comparable PPSOEs. We find evidence of the soft budget constraint for both FSOEs and PPSOEs, as we document significant increases in subsidies and other fiscal injections to both types of SOEs in the immediate aftermath of the shock.

Our evidence suggests that SOEs can amplify negative macroeconomic shocks and increase fiscal risk. This finding is particularly important because the effect happens precisely when governments are under pressure from the fall in total tax revenues. The losses of FSOEs after the negative shock are significant. Moreover, these firms require economically significant levels of support to continue financing operations at the very time that belt tightening is important. FSOEs reduce CAPEX significantly, even after receiving substantial fiscal support, which can lead to lasting effects of the negative macroeconomic shock.

Our findings provide more evidence for the debate over the advantages and disadvantages of government ownership of infrastructure. Much of the literature on fiscal risks and negative shocks has focused on the incompleteness of contracts in PPPs. The Asian financial crisis showed that negative shocks usually led to bailouts, extensions of contracts, and debt guarantees for PPPs.[6] This discussion rarely extended to the fiscal costs of having to come to the aid of infrastructure SOEs during a crisis, at least not with systematic empirical evidence of the fiscal costs of SOEs and usually not using experimental techniques. This paper shows that SOEs also suffer from negative shocks. Their effects shocks are persistent, because of the difficulties SOEs have cutting expenses. We also document how a negative shock increases fiscal risk, by increasing contingent liabilities for the government, which has to send subsidies immediately, in amounts that are large in economic terms.

The debate on the fiscal costs of negative shocks in infrastructure needs to be expanded to include the costs that SOEs impose on governments versus the costs that PPP guarantees impose on governments during negative shocks.[7] We hope that our paper represents a step in that direction.

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[6] See, for instance, Hemming and staff (2006); Lewis and Mody (1998); and Mody (2000).

[7] For some initial discussions of the topic, see Engel, Fischer, and Galetovic (2010, 2019).

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