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Discussion Paper

The Role of Ownership Structure in Oil and Gas Production After the Paris Agreement



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Abstract

This paper investigates the role of state ownership in oil and gas production after the Paris Agreement, comparing national oil companies (NOCs) with international oil companies (IOCs). Using firm-level panel data spanning from 2010 to 2021 in a difference-in-differences setting, it was found that IOCs increased their oil production by approximately 30%-35% relative to NOCs in the post-Paris era. This gap has been driven by the declining oil production from NOCs outside the OPEC+ bloc and the rising oil output from IOCs, suggesting that rising oil demand has been fulfilled by IOCs. These production trends are partly driven by long-term structural differences and market dynamics, rather than being a direct consequence of the Paris Agreement. In contrast to the oil market, no significant divergence is observed in gas production because NOCs and IOCs uniformly expanded their output, highlighting the role of natural gas as a transitional fuel. These findings underscore the necessity of considering corporate ownership structures and their unique market incentives in global climate governance and energy transition.

Keywords: Energy Transition, Oil and Gas, Ownership Structure, National Oil Company, International Oil Company

1. Introduction

The adoption of the Paris Agreement in 2015 marked a pivotal moment in global climate governance, bringing nations together to commit to limiting global temperature rise to below 2°C, with efforts to be made to stay within 1.5°C above pre-industrial levels.

This commitment has placed increasing pressure on governments and corporations to transition towards low-carbon economies. Governments, in particular, have a critical role to play in achieving this transition, as they must balance the urgent need to decarbonize their economies with the imperative of ensuring energy security.

Oil and gas companies, which occupy a central position in global energy markets, have increasingly drawn the attention of policymakers and the public. *The Production Gap Report* (2023) underscores the growing tension between climate goals and coal, oil, and gas output, revealing that governments collectively plan to produce more than twice the amount of coal, oil, and gas in 2030 than would be compatible with limiting warming to 1.5°C (SEI et al. 2023). This disparity – commonly referred to as the "production gap" – highlights a profound misalignment between stated climate objectives and actual production strategies. As a result, debates have intensified over how national oil companies (NOCs) and international oil companies (IOCs) are responding to climate policies, given their distinct ownership structures, mandates, and financial pressures.

NOCs, which are fully or majority-owned by a national government, account for roughly half of global oil production and an even larger share of known reserves today (IEA 2021). Governments often rely on these companies for public revenues, which can complicate efforts to shift toward low-carbon energy despite ongoing attempts at economic diversification. By contrast, IOCs are driven more directly by shareholder interests and face different incentives and constraints (e.g., Hartley and Medlock III 2008; Eller et al. 2011). These divergent institutional frameworks mean NOCs and IOCs are likely to adjust their operations in different ways under intensifying climate actions and discussions.

In this paper, we examine how NOCs and IOCs have altered their oil and gas production patterns in response to the Paris Agreement. We use panel data on 102 companies worldwide covering the 2010-2021 period and employ a difference-in-differences estimator. The findings indicate that IOCs increased their oil production by about 30%-35% relative to NOCs following the Paris Agreement. The widening gap in the oil market was mainly driven by declining production among NOCs outside the OPEC+ bloc and by rising output from IOCs, suggesting that the increase in oil demand has been met by IOCs during this period. However, the divergence in oil production between NOCs and IOCs began to emerge to some extent even before the Paris Agreement, suggesting that the observed differences are at least partly driven by pre-existing structural factors and market dynamics rather than direct responses to the Agreement itself. Meanwhile, no significant divergence occurred in gas production because it has uniformly increased among both types of companies, reflecting its strategic role as a transition fuel.

The paper is organized into four additional sections. Section 2 reviews the relevant literature. Section 3 describes the data sources and provides descriptive evidence. Section 4 introduces the empirical model and discusses the results. Finally, Section 5 concludes.

2. Literature Review

A growing body of work has explored the divergent objectives and behaviors of NOCs versus IOCs. NOCs often fulfill not only commercial mandates but also political ones, serving broader policy objectives such as energy security, fiscal revenue stabilization, employment generation, and environmental considerations. Their decision-making is typically shaped by geopolitical interests, domestic economic priorities, and national development goals.

By contrast, IOCs are primarily profit-driven and subject to market forces; they allocate resources based on financial returns and investor expectations. Indeed, IOCs have been under growing scrutiny from stakeholders – particularly those focusing on environmental, social, and governance (ESG) issues – which pushes them to reduce investments in high-carbon projects and shift capital toward cleaner energy ventures. In recent years, this has manifested in ambitious climate strategies, including pledges to reach net-zero emissions by 2050 and increased investments in renewables.

Empirical evidence on the environmental and operational performance differences between state-owned and investor-owned companies remains mixed. While one strand of research shows that state-owned firms sometimes outperform private ones in environmental metrics (e.g., Earnhart and Lizal 2006; Calza, Profumo, and Tutore 2016; Clò, Ferraris, and Florio 2017; Dong, Dong, and Lv 2022), another body of literature finds that public ownership is associated with poorer environmental outcomes (e.g., Meyer and Pac 2013; Andersson, Opper, and Khalid. 2018). In terms of financial and operational metrics, earlier studies have established that investor-owned enterprises often benefit from better allocation of resources, higher productivity, greater profitability, and lower indebtedness (e.g., Boardman and Vining 1989; Frydman et al. 1999; Ehrlich et al. 1994; Karpoff 2001; DeWenter and Malatesta 2001; La Porta, Lopez-de Silanes, and Shleifer 2002; Harrison et al. 2019). However, other papers observe no significant performance gap between state-owned and private firms (e.g., Caves and Christensen 1980; Kole and Mulherin 1997), suggesting that the influence of ownership structure may depend on contextual, industry-level, or country-level factors.

In the oil and gas sector specifically, prior work has shown that NOCs typically pursue broader objectives, such as political and social goals, compared to the IOCs (e.g., Wolf 2009; Hartley and Medlock III 2013; Ohene-Asare, Turkson, and Afful-Dadzie 2017; Gong 2020). Theoretical analysis by Hartley and Medlock III (2008) demonstrates that these differences stem from the institutional and political nature of the NOCs, and Eller, Hartley, and Medlock (2011) provide empirical evidence in support of this argument. Gong (2020) also shows that NOCs and IOCs responded differently to global shocks such as the Shale Revolution, the 2008 global financial crisis, and the 2014 oil price crash. These findings underscore the role of institutional and strategic differences in shaping the corporate behavior of oil and gas companies and market outcomes.

Since the Paris Agreement, the gap in responsiveness to ESG pressures between NOCs and IOCs appears to have widened. IOCs, facing direct investor and public scrutiny, are generally considered to be more reactive to climate-related risks and transition pressures. The rise in ESG-focused investing has increased the financial risks for IOCs that fail to adjust their portfolios, as evidenced by the reduction in funding and the more stringent evaluation of carbon-intensive projects (Bogmans, Pescatori, and Prifti 2024). Meanwhile, the ESG agenda may also affect NOCs (Palacios 2021), though to a lesser degree, given that NOCs often retain strong government backing and operate within broader national policy frameworks.

Against this backdrop, scholars continue to debate whether ownership structure inherently determines a firm's environmental strategies and outcomes. On the one hand, some state-owned firms – particularly state-owned electric utilities – have been found to lead in

deploying renewables (Steffen, Karplus, and Schmidt 2022), while on the other, investor-owned utilities have proven more proactive in adopting new technologies earlier that improve efficiency, such as high and very high pressure supercritical generating units (Rose and Joskow 1990). Thus, the national context, policy environment, and specific sector dynamics all contribute to heterogeneous patterns of energy investment and production.

Guo et al. (2023) highlight that due to their domestic energy security and state priorities, NOCs are typically expected to be slower to decarbonize than IOCs driven by shareholder pressure and international scrutiny. Existing studies highlight strategic, cost, and stakeholder-related differences between NOCs and IOCs (e.g., Hartley and Medlock III 2008; Wolf 2009; Hartley and Medlock III 2013; Ohene-Asare et al. 2017; Prag, Rottgers, and Scherrer 2018; Gong 2020). Furthermore, Bogmans et al. (2024) find that climate policies reduced investments of publicly traded oil and gas companies around the world between 2015 and 2019. As the first empirical study to our knowledge, we contribute to the literature and broader discourse on the energy transition by investigating the oil and gas output of NOCs and IOCs across the world following the Paris Agreement.

Recent studies examining the role of OPEC+ and non-OPEC supply sources underscore distinct mechanisms through which these actors influence global oil markets. Frondel and Horvath (2019) find that the expansion of U.S. shale oil production, driven by IOCs, has played a pivotal role in reducing oil prices, signaling the diminishing market power of OPEC. However, Quint and Venditti (2023) discover that OPEC+ announcements can effectively shape market expectations even in the absence of immediate production changes, reaffirming its ongoing relevance in global price formation. Our findings build on this literature by showing that oil production by IOCs has increased significantly, while NOCs outside the OPEC+ bloc have scaled back output in the post-Paris era. This dynamic underscores the growing role of IOCs' supply in shaping global oil markets.

3. Data

The main dataset used in this paper comes from Carbon Majors. It provides the annual production levels of companies distinguished by the ownership type – that is, state-owned NOCs vs. investor-owned IOCs. Gas is reported as billion cubic feet per year (Bcf/yr) and oil is reported as million barrels per year (million bbl/yr), and we therefore multiply them with 10^9 and 10^6, respectively. We use the period 2010-2021 to obtain comparable time ranges for before and after the Paris Agreement. The dataset incorporates coal and cement producers, but we exclude them from the analysis as the study focuses only on oil and gas companies.[1]

We additionally use other datasets as control variables (these are country-level datasets, since most NOCs do not disclose their financial information). Fuel exports as a share of total exports, inflation (GDP deflator as annual %), GDP per capita growth (annual %), and renewable energy consumption (% of the total final energy consumption) come from the World Bank. We also utilize the explicit fossil fuels subsidy data from the Fossil Fuel Subsidy Tracker platform.[2] The data on weekly crude oil WTI futures price and natural gas futures are obtained from the "Investing" database.[3] The data for the annual consumption of oil products and natural gas are provided by Enerdata. When we combine all of these datasets, we end up with 34 NOCs and 68 IOCs across 29 countries, as presented by country in Table 1. Additionally, Table A1 (in the Appendix) shows the number of companies by their country's OPEC and OPEC+ membership.

Table 1. Number of firms across countries.

Country	NOC	IOC
Algeria	1	0
Angola	1	0
Australia	0	4
Bahrain	3	0
Brazil	1	0
Canada	0	9
Ecuador	2	0
Egypt	1	0
Germany	0	3
Iran	1	0
Italy	0	1
Japan	0	1
Kuwait	1	0
Malaysia	1	0
Netherlands	0	2
Nigeria	2	0
Norway	3	0
Oman	2	0
Qatar	3	0
Russia	2	3
Saudi Arabia	1	0
Spain	0	3
Switzerland	0	1
Thailand	1	1
Turkmenistan	2	0
United Arab Emirates	2	0
United States of America	0	40
Ukraine	3	0
Venezuela	1	0
Total	34	68

Notes: The table presents the number of state-owned and investor-owned companies across the countries.

Table 2. Oil and gas production before and after the Paris Agreement.

	Before Paris Agreement (2010-2015)					After Paris Agreement (2016-2021)					Two-sample t-tests	
	Mean	SD	Min.	Max	Obs.	Mean	SD	Min.	Max	Obs.	$\mu_1 - \mu_2$	p-value
Panel A: Oil												
NOCs	19.36	1.47	15.27	22.11	137	19.29	1.62	14.93	22.20	132	0.07	0.716
IOCs	17.51	1.82	11.18	20.60	303	17.85	1.59	11.17	20.59	278	-0.34	0.017
Panel B: Gas												
NOCs	27.61	1.61	22.86	30.53	131	27.70	1.60	23.08	30.56	131	-0.09	0.650
IOCs	26.38	1.47	20.61	29.20	298	26.52	1.41	20.85	29.00	279	-0.14	0.252

Notes: The table presents mean, standard deviation, minimum and maximum of production in natural logarithm, number of observations, and t-test results of oil- (Panel A) and gas- (Panel B) producing NOCs and IOCs before and after the Paris Agreement. $\mu_1 - \mu_2$ indicates the difference in means between pre-Paris production (μ_1) and post-Paris production (μ_2), and p-values of them.

Table 2 presents summary statistics of oil and gas production by NOCs and IOCs before and after the Paris Agreement. Panel A shows that, on average, NOCs had lower oil production in the post-Paris Agreement period while IOCs exhibited an increase in oil production during the period after the Agreement. This divergent trend between NOCs and IOCs may be due to the alignment of NOCs with shifting national strategies and leveraging market opportunities. Panel B presents trends in gas production, showing that both NOCs and IOCs increased their output in the post-Paris period.

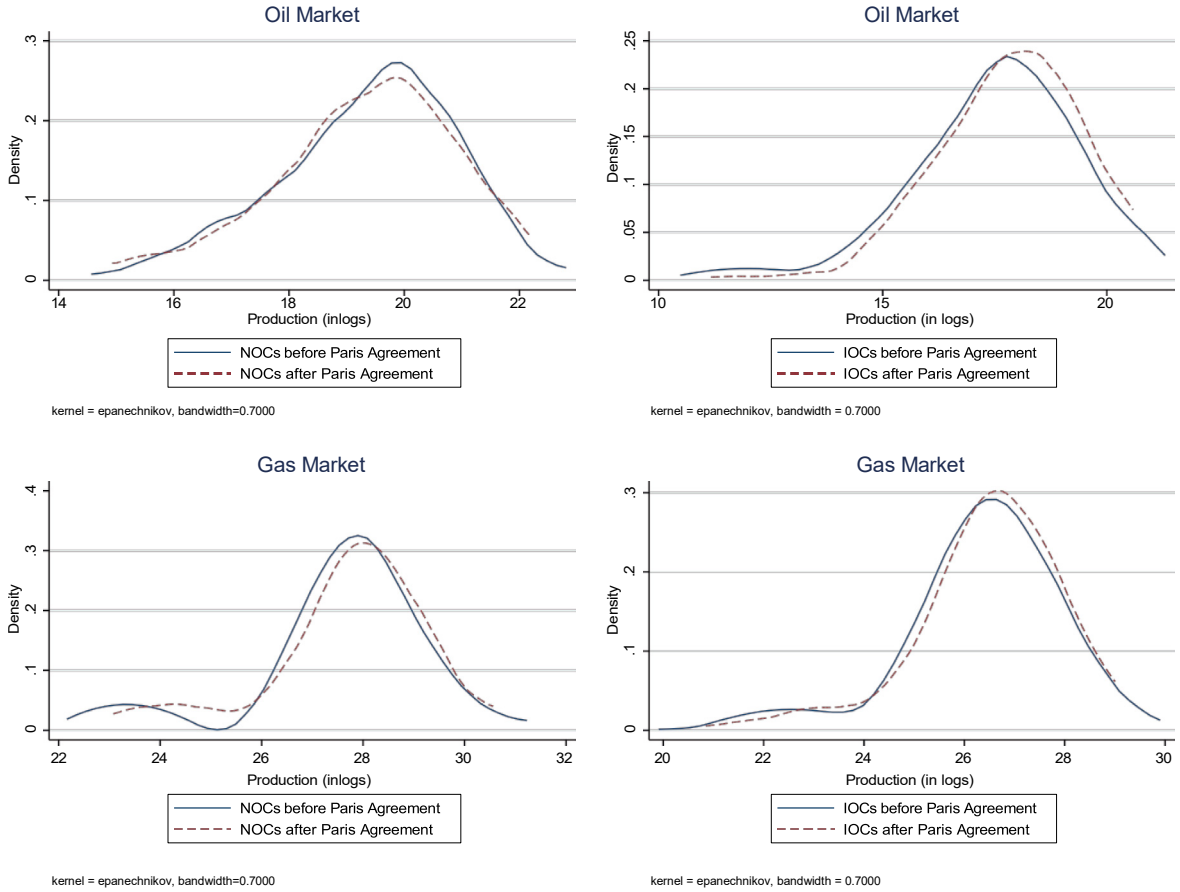
This growth might reflect that natural gas has been increasingly positioned as a transition fuel in the shift toward lower-carbon energy systems. The expansion in gas production could be attributed to rising global demand, technological advancements, and policy incentives supporting gas as a cleaner alternative to coal and oil. We find no statistically significant change in mean oil production by NOCs after the Paris Agreement, but the difference in mean oil production by IOCs is statistically significant at the 5% level ($p = 0.017$) – that is, they increased oil production modestly following the Paris Agreement. However, even though post-Paris mean gas production is slightly higher than the pre-Paris period for both NOCs and IOCs, the observed change is not statistically meaningful.

The kernel density plots in Figure 1 illustrate the distribution of oil and gas production for NOCs and IOCs, comparing periods before and after the Paris Agreement. In the oil market, NOCs exhibit a modest leftward shift of production in the post-Paris Agreement, indicating a slight decline in output. In contrast, IOCs show a more noticeable increase, suggesting an expansion in oil production. In the gas market, the distribution of NOCs and IOCs in the post-Paris era is positioned to the right of their distribution in the pre-Paris era, implying marginal increases in production distributions following the Paris Agreement. Overall, these charts are aligned with the evidence in Table 2.

Figure 2 illustrates the trends in oil and gas production for NOCs and IOCs from 2010 to 2021. In the oil sector displayed in the left panel, NOCs (in the orange line) exhibit a relatively stable production trajectory throughout the sample period and even a slight decline following the Paris Agreement. In contrast, IOCs (in blue line) show an increasing trend in production after 2015, diverging from the relatively flat trend observed before the Agreement.

This pattern suggests that NOCs expanded production despite the heightened regulatory focus on emissions reduction, potentially in response to market dynamics. For the gas sector, shown in the right panel, NOCs again maintain a generally stable production level, with a slight upward trend, and so do IOCs following the Paris Agreement.

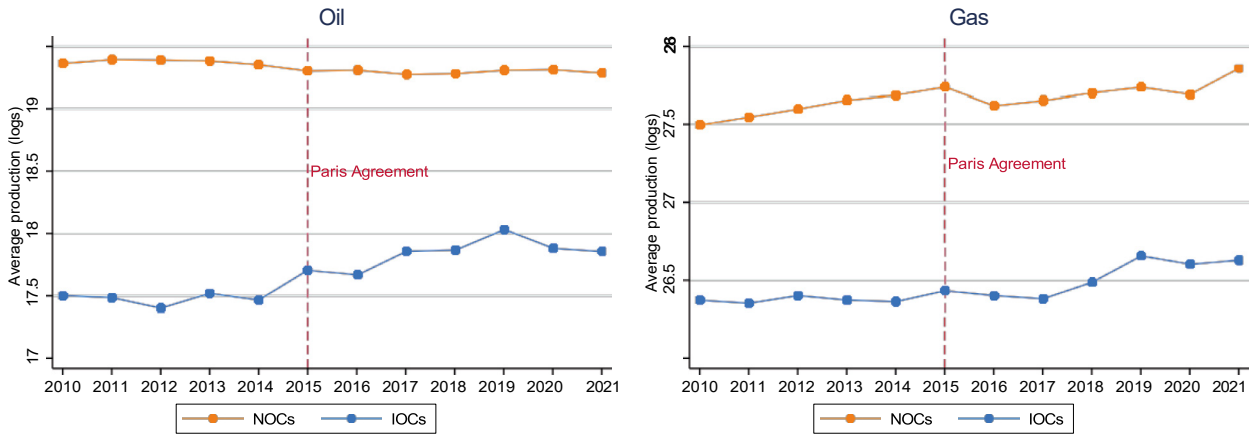
Figure 1. Distribution of oil and gas production of NOCs and IOCs.



Source: Author.

Note: This figure presents the kernel distributions of production of the NOCs and the IOCs before and after the Paris Agreement. The x-axis shows the log of production levels for oil (barrels per year) and gas (cubic feet per year).

Figure 2. Oil and gas production of NOCs and IOCs.



Source: Author.

Note: This figure shows the oil (on the left panel) and gas (on the right panel) production of NOCs and IOCs. y-axis shows the log of average production levels for oil (barrels per year) and gas (cubic feet per year).

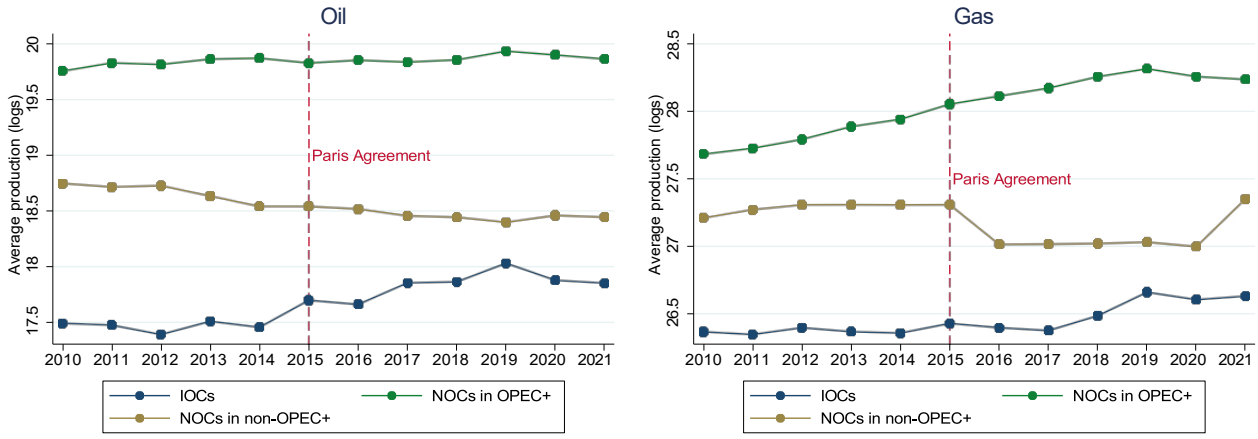
Figure 3 presents the trends in oil (left panel) and gas (right panel) production for NOCs and IOCs, distinguishing NOCs by whether their home countries are members of OPEC+. In the oil market, NOCs from OPEC+ member countries maintained relatively stable production levels, while those from non-OPEC+ countries slightly reduced their output following the Paris Agreement. More notably, IOCs significantly increased their oil production during this period. In the gas market, both IOCs and NOCs from OPEC+ countries expanded their production, whereas NOCs from non-OPEC+ countries consistently produced less.

The left panel in Figure 4 shows that oil consumption continued to increase following the Paris Agreement despite a temporary decline due to the COVID-19 pandemic. Moreover, the right panel shows that the consumption of natural gas steadily increased in the same period.

Additionally, Figure 5 illustrates the weekly future prices of oil and gas from January 31, 2010 to December 26, 2021. The oil price increased from $34.73 on December 13, 2015 to $75.21 on December 26, 2021, and this is equivalent to a 117% rise in the period following the Paris Agreement. Similarly, the gas price increased from $1.77 to $3.73 during the same period, which is a 111% rise. This illustrative evidence reflects an increased oil and gas demand even after the Paris Agreement.

Overall, descriptive evidence indicates a distinction in production behavior between NOCs and IOCs in the post-Paris Agreement era. These patterns suggest that while NOCs and IOCs have responded differently in terms of oil production, there is a more consistent trend in the expansion of gas production across both ownership types. This distinction may have implications for long-term energy market dynamics, investment decisions, and policy frameworks aiming to align fossil fuel production with climate objectives.

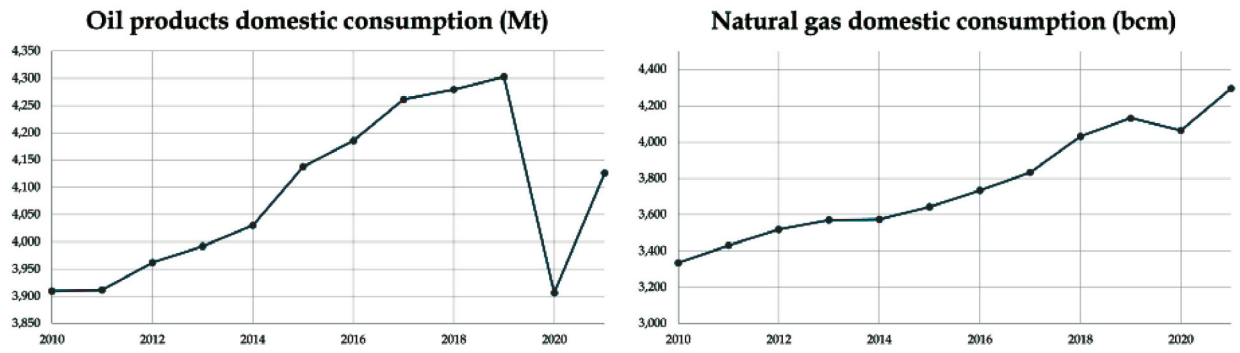
Figure 3. Oil and gas production of by OPEC+ membership.



Source: Author.

Note: This figure shows the oil (on the left panel) and gas (on the right panel) production of IOCs and NOCs in OPEC+ member countries and outside of OPEC+ bloc. y-axis shows the log of average production levels for oil (barrels per year) and gas (cubic feet per year).

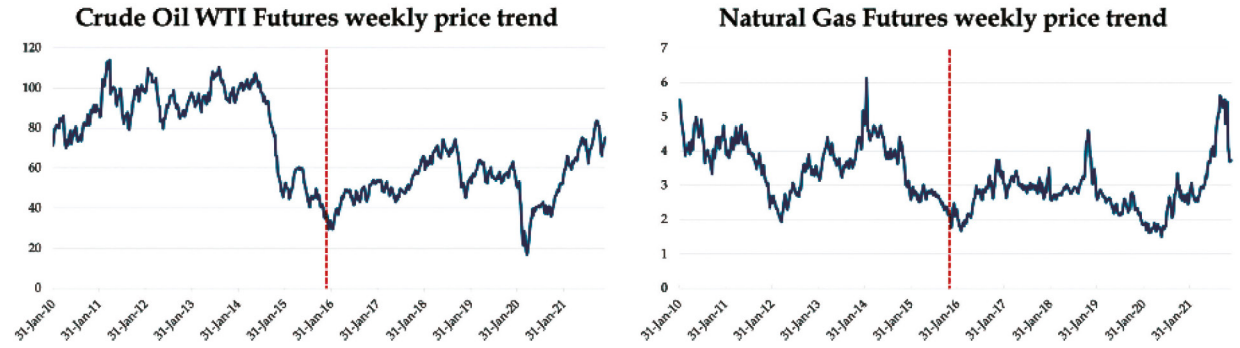
Figure 4. Oil and gas consumption.



Source: Author.

Note: This figure displays the annual global consumption of oil and gas over time.

Figure 5. Oil and gas prices.



Source: Author.

Note: This figure presents the weekly price of oil and gas. The dotted line in red represents 2016, the first year following the Paris Agreement's adoption.

4. Empirical Analysis

In this section, we present the empirical analysis. We explain the identification strategy and the results of the regression models.

4.1 Identification Strategy

We estimated the following regression using a difference-in-differences approach:

$$\ln(Y_{ict}) = \delta_i + \beta * State_{ict} * PostParis + \eta X_{ct} + \omega_t + \varepsilon_{ict} \quad (1)$$

where Y_{ict} denotes the production of oil or gas producer i in country c in year t; $State_{ict}$ is a dummy variable that takes 1 for NOC and 0 for IOC; *Post-Paris* is the dummy for the Post-Paris era, which takes 1 for the 2016-2021 period and 0 for the 2010-2015 period; X_{ct} represents the control variables; and ε_{ict} is the error term.

The establishment of state-owned companies in the past may have reflected deliberate policy choices made by governments in response to domestic economic or political factors. This may create a simultaneity bias, where the ownership structure is not exogenous but is jointly determined with the outcome variable. For instance, countries with large reserves of fossil fuels may establish NOCs in order to exploit these resources directly. Governments may want to maintain control over significant natural resources to ensure national interests are prioritized. To overcome this problem, we include various country-level controls. Moreover, as shown in Figure 2 above, the parallel trends assumption appears to be valid because of the absence of pre-trends. This means that we can assume that the average change in production for NOCs would have been identical to that of IOCs if the Paris Agreement had not occurred. Hence, any divergence observed after the Paris Agreement can be attributed to its effect, rather than underlying differences in trends before its adoption.

We also conducted parallel trend tests and plotted the yearly coefficients together with 95% confidence intervals (as shown in Figure 6) using the following equation:

$$\ln(Y_{ict}) = \sum_{j \in \{-5,\ldots,0,\ldots,6\}} \gamma_j * D_{i,t-j} + \theta * State_{ict} + \delta * Post - Paris + \varepsilon_{ict} \quad (2)$$

where $D_{i,t-j}$ is a dummy variable that indicates that the event took place j periods before or after the treatment occurred in 2016.

We controlled for various factors other than ownership that might affect the fossil fuel production of NOCs and IOCs differently. In net-exporting countries with significant fossil fuel production, high global energy prices can lead to increased government revenues, which can result in greater incentives to increase production. Increased fossil fuel production can enhance GDP per capita through higher revenues from exports and fund large-scale government spending, but rapid spending of resource revenues can fuel inflation. Finally, input cost and demand shocks can affect inflation and economic growth. To control for these factors, we incorporated inflation and GDP per capita growth in the estimation.

On the one hand, large-scale fossil fuel production may reduce policy incentives for renewable energy in some contexts, particularly when fossil fuel revenues form a significant share of public budgets, or when fossil fuel energy incumbents exert strong political influence. On the other hand, political will, diversification strategies, and international influence can mediate or even reverse that trend. For example, countries like Saudi Arabia and the UAE are actively investing in renewables despite fossil fuel dependence, which suggests that state capacity, leadership priorities, and geopolitical strategy can override fossil rent dependence. To consider these factors, we include the share of renewables in energy consumption as controls. Furthermore, countries with abundant fossil fuel resources, such as those that have NOCs and large fossil fuel sectors, often have higher levels of energy-related subsidies as a share of GDP. We additionally controlled for fossil fuel subsidies in order to consider that direct subsidies or tax breaks can significantly reduce the costs of fossil fuel production or increase profitability.[4]

A greater reliance on fossil fuels for both export and domestic energy needs is likely to correlate with higher CO_2 intensity. The carbon intensity of a country's economy may influence regulatory pressure on fossil fuel production. More carbon intensive countries may have reduced their oil and gas production after the Paris Agreement, especially if they are state-owned, in order to achieve their NDCs.

4.2 Results

Panel A in Table 3 below presents the results of estimating Equation (1), examining the relationship between corporate ownership and oil production across the 2010-2021 period.

Control variables were sequentially added across columns 2 to 7. The point estimate on *State* indicates that, before the Paris Agreement, NOCs on average produced substantially more oil annually than IOCs. The coefficient on *Post-Paris* indicates that IOCs increased their oil output between $e^{0.270} - 1 \approx 31\%$ and $e^{0.341} - 1 \approx 40.6\%$ in the post-Paris period relative to the pre-Paris period. The key coefficient of interest is the interaction term $State_{ict} * Post\text{-}Paris$, which is consistently negative and statistically significant at conventional levels. Point estimates ranging from -0.361 to -0.433 imply that conditional on the included controls, NOCs reduced their production between $e^{-0.361} - 1 \approx -30.30\%$ and $e^{-0.433} - 1 \approx -35.14\%$ relative to IOCs in the post-Paris period.

Table 3. Oil and gas production and corporate ownership: NOCs versus IOCs.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Oil						
State*Post-Paris	-0.409**	-0.361*	-0.397**	-0.433**	-0.409**	-0.372**
	(0.177)	(0.194)	(0.177)	(0.180)	(0.176)	(0.170)
State	1.855***	1.941***	1.758***	1.853***	1.850***	1.900***
	(0.379)	(0.377)	(0.381)	(0.378)	(0.397)	(0.358)
Post-Paris	0.341**	0.325**	0.335**	0.338**	0.339**	0.270*
	(0.152)	(0.154)	(0.152)	(0.152)	(0.152)	(0.160)
Fossil fuel subsidies (logs)		0.131				
		(0.082)				
Inflation			1.894			
			(1.831)			
GDP per capita growth				-2.756		
				(1.953)		
Renewable energy cons.					0.096	
					(0.850)	
CO_2 per GDP (logs)						-1.760
						(1.604)
Observations	850	850	850	850	850	850
R-squared	0.183	0.199	0.188	0.185	0.183	0.194
Adjusted R-squared	0.180	0.196	0.184	0.181	0.179	0.190
Panel B: Gas						
State*Post-Paris	-0.048	-0.010	-0.047	-0.036	-0.061	-0.074
	(0.262)	(0.278)	(0.262)	(0.266)	(0.271)	(0.254)
State	1.234***	1.307***	1.216***	1.235***	1.342***	1.224***
	(0.393)	(0.390)	(0.379)	(0.393)	(0.369)	(0.392)

Table 3. Continued.

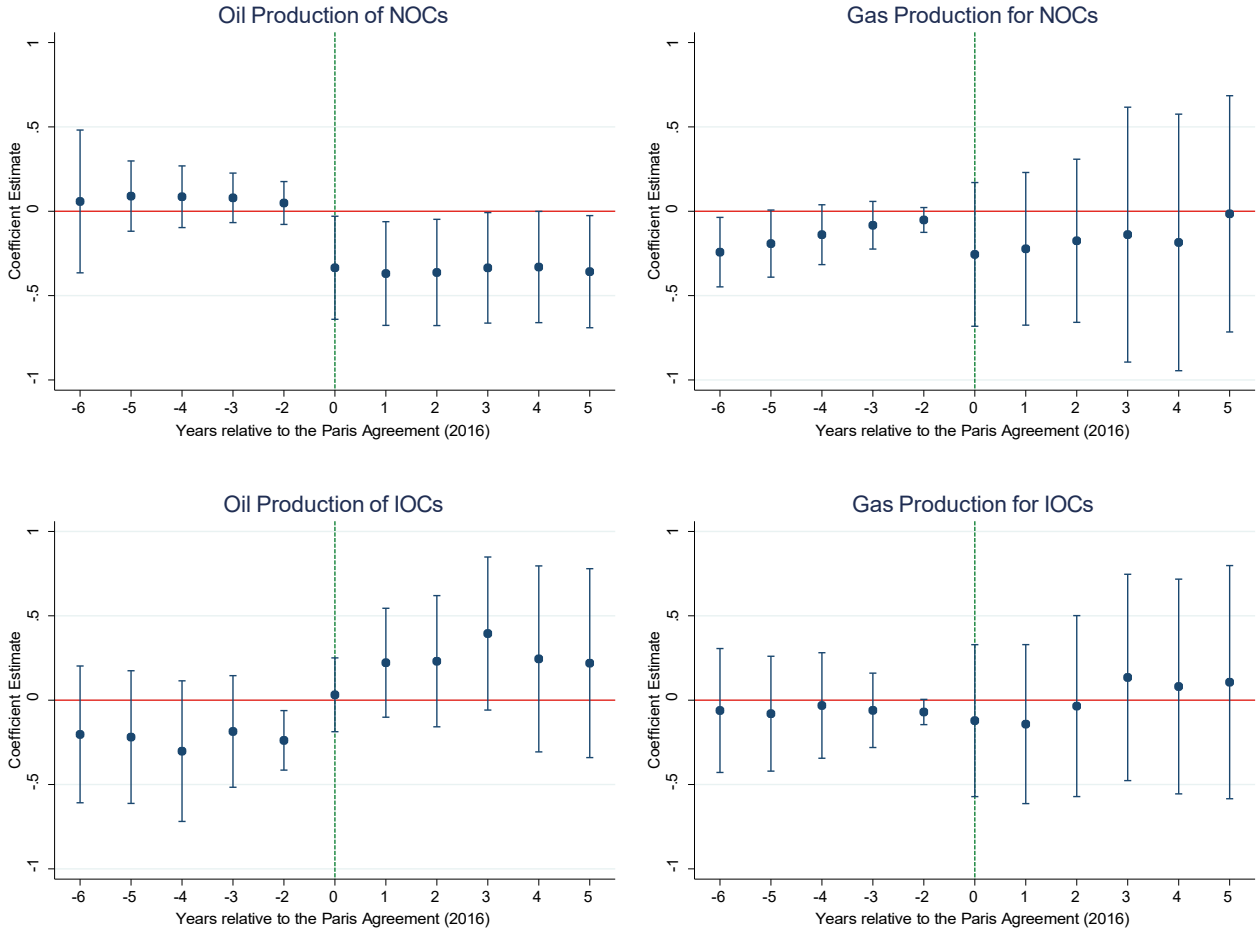
	(1)	(2)	(3)	(4)	(5)	(6)
Post-Paris	0.138	0.125	0.137	0.139	0.166	0.175
	(0.142)	(0.144)	(0.142)	(0.143)	(0.141)	(0.152)
Fossil fuel subsidies (logs)		0.109				
		(0.084)				
Inflation			0.346			
			(1.758)			
GDP per capita growth				1.439		
				(2.153)		
Renewable energy cons.					-1.807	
					(1.126)	
CO_2 per GDP (logs)						0.911
						(1.388)
Observations	839	839	839	839	839	839
R-squared	0.126	0.141	0.126	0.126	0.152	0.129
Adjusted R-squared	0.123	0.137	0.122	0.122	0.148	0.125

*Notes: This table presents the baseline results for oil- (Panel A) and gas- (Panel B) producing NOCs and IOCs from 2010 to 2021. The dependent variable is the natural logarithm of oil output. "State" is a dummy variable that takes 1 for NOC and 0 for IOC. "Post-Paris" is a dummy variable, 1 indicates the period 2016-2021, and 0 indicates the period 2010-2015. "Fossil fuel subsidies" denotes the size of subsidies provided for fossil fuel production in natural logarithm. "Inflation" is the GDP deflator as annual %. "Renewable energy cons." denotes the share of renewable energy in total final energy consumption, i.e., defined in percentage. CO_2 per GDP is carbon dioxide emissions per GDP. ***, **, and * represent statistical significance at 1, 5 and 10% level, respectively. Standard errors are clustered at the firm level and shown in parentheses.*

Panel B in Table 3 presents the analogous estimates for natural gas producers in the 2010-2021 period. In all six specifications, the coefficient on the interaction term ($State_{ict} * Post\text{-}Paris$) is small in magnitude (ranging from -0.010 to -0.074) and statistically indistinguishable from zero, indicating that the NOCs did not exhibit a systematically different post-Paris growth trajectory relative to the IOCs. *State* is positive and highly significant in every column, implying that the gas production of NOCs is substantially larger than IOCs in the pre-Paris period, similar to oil production. The *Post-Paris* dummy is also positive but not statistically significant, suggesting that IOCs did not significantly increase (or decrease) gas output after 2015 relative to the baseline. These findings are robust to the inclusion of various controls. In sum, unlike the oil sector, where NOCs curtailed growth relative to IOCs after the Paris Agreement, there is no evidence of a differential response in gas production between NOCs and IOCs.

Figure 6 plots the event study regression results. The pre-treatment coefficients (-6 to -2 on the x-axis) on NOCs were stable relative to those on IOCs before 2016 and close to zero, supporting the validity of the parallel trends assumption. On the other hand, we see a clear distinction between the relative oil production of NOCs and IOCs, where the coefficients are negative for NOCs and positive for IOCs. However, such divergence is not observed in the gas market.

Figure 6. Event study plots for oil and gas production.



Source: Author.

Note: Figure 6 plots the impact of the Paris Agreement on the production of NOCs and IOCs from event study estimation. We consider an 11-year window, spanning from 5 years before the Paris until 6 years after it. The solid lines represent 95% confidence intervals. Specifically, we report estimated coefficients from regression Equation (2). We set 2016 as a base year and exclude the year of adoption of the Agreement (i.e., -1 in the horizontal axis), estimating the dynamic effects relative to the year of 2016, i.e. inception of the Paris Agreement.

Table 4 reports the results of estimating Equation (1) by using OPEC+ membership as the key classification criterion instead of state ownership. Thus, NOCs from non-OPEC+ countries – such as Brazil, Ecuador, Egypt, Norway, Qatar, Thailand, Turkmenistan, and Ukraine – were excluded from this analysis. Since OPEC+ members are typically large-scale oil producers with state-owned firms, this specification serves as a robustness check. Across columns 1-6, the coefficients for being in an OPEC+ country are statistically insignificant for both oil producers (Panel A) and gas producers (Panel B).

Table 4. Oil and gas production by the OPEC+ membership.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Oil						
OPEC+ member*Post-Paris	-0.265	-0.260	-0.241	-0.272	-0.262	-0.152
	(0.189)	(0.186)	(0.184)	(0.192)	(0.187)	(0.183)
OPEC+ member	2.324***	2.337***	2.220***	2.319***	2.326***	2.634***
	(0.396)	(0.385)	(0.446)	(0.397)	(0.391)	(0.383)
Post-Paris	0.343**	0.334**	0.335**	0.342**	0.340**	0.192
	(0.159)	(0.161)	(0.160)	(0.159)	(0.158)	(0.169)
Fossil fuel subsidies (logs)		0.078				
		(0.058)				
Inflation			1.425			
			(1.418)			
GDP per capita growth				-1.006		
				(1.852)		
Renewable energy cons.					0.183	
					(0.762)	
CO_2 per GDP (logs)						-3.622*
						(2.085)
Observations	741	741	741	741	741	741
R-squared	0.273	0.279	0.275	0.273	0.273	0.298
Adjusted R-squared	0.270	0.275	0.271	0.269	0.269	0.295
Panel B: Gas						
OPEC+ member*Post-Paris	0.168	0.170	0.153	0.188	0.134	0.188
	(0.189)	(0.201)	(0.184)	(0.202)	(0.186)	(0.167)
OPEC+ member	1.462***	1.471***	1.525***	1.475***	1.452***	1.507***
	(0.425)	(0.417)	(0.360)	(0.419)	(0.397)	(0.561)
Post-Paris	0.158	0.147	0.162	0.159	0.196	0.130
	(0.149)	(0.151)	(0.149)	(0.149)	(0.149)	(0.189)
Fossil fuel subsidies (logs)		0.066				
		(0.065)				
Inflation			-0.829			
			(1.985)			
GDP per capita growth				2.825		
				(2.744)		
Renewable energy cons.					-2.538	
					(1.965)	
CO_2 per GDP (logs)						-0.648
						(2.982)
Observations	721	721	721	721	721	721

Table 4. Continued.

	(1)	(2)	(3)	(4)	(5)	(6)
R-squared	0.185	0.191	0.186	0.187	0.223	0.186
Adjusted R-squared	0.182	0.187	0.182	0.183	0.218	0.182

*Notes: This table presents the results of comparing oil producers (Panel A) and gas producers (Panel B) in OPEC+ member and non-OPEC+ member countries. The dependent variables are the natural logarithm of oil and gas output. "OPEC+ member" is a dummy variable that takes 1 for firms in OPEC+ members and 0 otherwise. "Post-Paris" is a dummy variable, 1 indicates the period 2016-2021, and 0 indicates the period 2010-2015. "Fossil fuel subsidies" denotes the size of subsidies provided for fossil fuel production in natural logarithm. "Inflation" is the GDP deflator as annual %. "Renewable energy cons." denotes the share of renewable energy in total final energy consumption, i.e., defined in percentage. CO_2 per GDP is carbon dioxide emissions per GDP. Non-OPEC+ countries that have NOCs (Brazil, Ecuador, Egypt, Norway, Qatar, Thailand, Turkmenistan, and Ukraine) are excluded. ***, **, and * represent statistical significance at 1, 5, and 10% level. Standard errors are clustered at the firm level and shown in parentheses.*

We further refine the analysis in Table 5 below by excluding NOCs from OPEC+ countries and comparing only NOCs outside the OPEC+ bloc with IOCs. The results mirror those in Table 3. The coefficient on the interaction term is negative and statistically significant at conventional levels for oil producers, but it remains indistinguishable from zero for gas producers. This pattern suggests that the post-Paris Agreement divergence in oil production between NOCs and IOCs is primarily driven by decreasing oil production of NOCs from non-OPEC+ countries and by increasing the oil supply of IOCs.

Table 5. Oil and gas production: NOCs in non-OPEC+ countries vs. IOCs.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Oil						
State*Post-Paris	-0.528**	-0.676**	-0.561**	-0.548**	-0.533**	-0.473**
	(0.253)	(0.307)	(0.266)	(0.247)	(0.265)	(0.234)
State	1.248**	1.159**	1.434***	1.265**	0.983*	1.150***
	(0.494)	(0.518)	(0.429)	(0.499)	(0.499)	(0.396)
Post-Paris	0.337**	0.358**	0.361**	0.335**	0.294*	0.144
	(0.160)	(0.165)	(0.160)	(0.159)	(0.161)	(0.166)
Fossil fuel subsidies (logs)		-0.182				
		(0.173)				
Inflation			-4.407			
			(3.834)			
GDP per capita growth				-2.110		
				(2.062)		
Renewable energy cons.					2.366*	
					(1.382)	
CO_2 per GDP (logs)						-4.587**
						(1.927)
Observations	653	653	653	653	653	653
R-squared	0.056	0.066	0.065	0.057	0.077	0.118
Adjusted R-squared	0.052	0.060	0.059	0.051	0.072	0.112

Table 5. Continued.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Gas						
State*Post-Paris	-0.346	-0.408	-0.345	-0.350	-0.344	-0.270
	(0.449)	(0.471)	(0.445)	(0.446)	(0.447)	(0.423)
State	0.971*	0.930*	1.022*	0.974*	0.950	0.915
	(0.545)	(0.550)	(0.600)	(0.540)	(0.613)	(0.581)
Post-Paris	0.133	0.142	0.139	0.133	0.130	0.034
	(0.151)	(0.155)	(0.151)	(0.151)	(0.149)	(0.166)
Fossil fuel subsidies (logs)		-0.077				
		(0.152)				
Inflation			-1.223			
			(2.152)			
GDP per capita growth				-0.428		
				(1.893)		
Renewable energy cons.					0.180	
					(1.240)	
CO_2 per GDP (logs)						-2.323
						(2.011)
Observations	654	654	654	654	654	654
R-squared	0.043	0.045	0.043	0.043	0.043	0.062
Adjusted R-squared	0.038	0.039	0.038	0.037	0.037	0.056

*Notes: This table presents the results of comparing oil producers (Panel A) and gas producers (Panel B) in OPEC+ member and non-OPEC+ member countries. The dependent variables are the natural logarithm of oil and gas output. "OPEC+ member" is a dummy variable that takes 1 for firms in OPEC+ members and 0 otherwise. "Post-Paris" is a dummy variable, 1 indicates the period 2016-2021, and 0 indicates the period 2010-2015. "Fossil fuel subsidies" denotes the size of subsidies provided for fossil fuel production in natural logarithm. "Inflation" is the GDP deflator as annual %. "Renewable energy cons." denotes the share of renewable energy in total final energy consumption, i.e., defined in percentage. CO_2 per GDP is carbon dioxide emissions per GDP. Non-OPEC+ countries that have NOCs (Brazil, Ecuador, Egypt, Norway, Qatar, Thailand, Turkmenistan and Ukraine) are excluded. ***, **, and * represent statistical significance at 1, 5, and 10% level, respectively. Standard errors are clustered at the firm level and shown in parentheses.*

The COVID-19 pandemic significantly disrupted global oil and gas production, exposing both NOCs and IOCs to distinct yet overlapping challenges. The sharp decline in demand and the ensuing price collapse might have compelled many IOCs to scale back capital expenditures, postpone projects, and intensify their focus on operational efficiency. In contrast, NOCs might have maintained production despite economic pressures in order to balance market fluctuations with national interests like energy security and employment. Although both types of firms encountered supply chain disruptions and workforce constraints, IOCs might have rapidly adapted to a dynamic market environment, while NOCs might have managed these challenges within the framework of broader strategic mandates and state support.

To test the robustness check for the baseline results, we excluded the COVID-19 pandemic years (2020 and 2021). Panel A and Panel B in Table 6 report regression estimates for oil and gas producers, respectively.

Table 6. Robustness of results to COVID-19 pandemic.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Oil						
State*Post-Paris	-0.406***	-0.372**	-0.388**	-0.459***	-0.405***	-0.382**
	(0.153)	(0.165)	(0.155)	(0.159)	(0.153)	(0.147)
State	1.855***	1.929***	1.751***	1.851***	1.848***	1.903***
	(0.379)	(0.378)	(0.383)	(0.377)	(0.397)	(0.358)
Post-Paris	0.335***	0.331**	0.339***	0.344***	0.333***	0.275**
	(0.126)	(0.127)	(0.126)	(0.127)	(0.126)	(0.130)
Fossil fuel subsidies (logs)		0.112				
		(0.076)				
Inflation			2.034			
			(2.106)			
GDP per capita growth				-5.811*		
				(3.437)		
Renewable energy cons.					0.156	
					(0.858)	
CO_2 per GDP (logs)						-1.859
						(1.620)
Observations	720	720	720	720	720	720
R-squared	0.191	0.204	0.195	0.195	0.191	0.203
Adjusted R-squared	0.187	0.199	0.191	0.191	0.186	0.198
Panel B: Gas						
State*Post-Paris	-0.036	-0.013	-0.037	-0.031	-0.050	-0.054
	(0.230)	(0.243)	(0.230)	(0.242)	(0.240)	(0.227)
State	1.234***	1.292***	1.246***	1.234***	1.346***	1.225***
	(0.393)	(0.390)	(0.384)	(0.393)	(0.367)	(0.394)
Post-Paris	0.095	0.093	0.094	0.093	0.116	0.121
	(0.123)	(0.124)	(0.123)	(0.123)	(0.121)	(0.131)
Fossil fuel subsidies (logs)		0.087				
		(0.077)				
Inflation			-0.233			
			(1.848)			
GDP per capita growth				0.610		
				(3.701)		
Renewable energy cons.					-1.879	
					(1.185)	
CO_2 per GDP (logs)						0.814
						(1.442)
Observations	710	710	710	710	710	710

Table 6. Continued.

	(1)	(2)	(3)	(4)	(5)	(6)
R-squared	0.127	0.137	0.127	0.127	0.154	0.129
Adjusted R-squared	0.123	0.132	0.122	0.122	0.150	0.124

*Notes: This table presents the baseline results for oil (Panel A) and gas (Panel B) producers by excluding 2020 and 2021, i.e., the years of COVID-19 pandemic. The dependent variable is the natural logarithm of oil output. "State" is a dummy variable that takes 1 for NOC and 0 for IOC. "Post-Paris" is a dummy variable, 1 indicates the period 2016-2021, and 0 indicates the period 2010-2015. "Fossil fuel subsidies" denotes the size of subsidies provided for fossil fuel production in natural logarithm. "Inflation" is the GDP deflator as annual %. "Renewable energy cons." denotes the share of renewable energy in total final energy consumption, i.e., defined in percentage. CO_2 per GDP is carbon dioxide emissions per GDP. ***, **, and * represent statistical significance at 1, 5, and 10% level. Standard errors are clustered at the firm level and shown in parentheses.*

Across all columns in Panel A, the coefficient on the interaction term between the state ownership dummy (*State*) and the post-Paris period (*Post-Paris*) dummy remains negative and statistically significant at conventional levels. The coefficient estimates range from about -0.459 to -0.372, which are very close to baseline estimates. The persistence of statistically significant negative coefficients for oil and statistically insignificant coefficients for gas after the exclusion of the COVID-19 years indicates that the lower post-Paris production performance of NOCs relative to IOCs is robust to pandemic-induced shocks.

In fact, the behavior of NOCs and IOCs might not have begun to change before the Paris Agreement. To validate and assess whether NOCs and IOCs were already on diverging trajectories (specifically for oil production) prior to the Agreement, we conducted a placebo test using pre-treatment data. We ran the placebo test assuming that the Paris Agreement was adopted in 2014. Given that oil and gas prices declined substantially in 2014 and stayed low for several years, considering that year as a potential shock that might lead to differential responses of NOCs and IOCs is plausible. Table 7 presents the results for this test.

Table 7. Role of structural differences in production trends.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Oil						
State*Post-2013	-0.381**	-0.368*	-0.288	-0.441**	-0.381**	-0.347*
	(0.191)	(0.208)	(0.228)	(0.200)	(0.190)	(0.183)
State	1.910***	2.012***	1.753***	1.934***	1.904***	1.951***
	(0.383)	(0.384)	(0.397)	(0.379)	(0.400)	(0.364)
Post-2013	0.304*	0.296*	0.309*	0.304*	0.302*	0.229
	(0.160)	(0.161)	(0.160)	(0.160)	(0.159)	(0.168)
Fossil fuel subsidies (logs)		0.133				
		(0.081)				
Inflation			1.979			
			(1.934)			
GDP per capita growth				-2.987		
				(2.001)		
Renewable energy cons.					0.108	
					(0.848)	

Table 7. Continued.

	(1)	(2)	(3)	(4)	(5)	(6)
CO_2 per GDP (logs)						-1.795
						(1.605)
Observations	850	850	850	850	850	850
R-squared	0.181	0.198	0.186	0.183	0.181	0.193
Adjusted R-squared	0.178	0.194	0.182	0.179	0.177	0.189
Panel B: Gas						
State*Post-2013	0.023	0.030	0.044	0.054	0.005	0.002
	(0.232)	(0.250)	(0.249)	(0.241)	(0.237)	(0.227)
State	1.197***	1.283***	1.157***	1.184***	1.309***	1.188***
	(0.402)	(0.404)	(0.397)	(0.404)	(0.379)	(0.402)
Post-2013	0.113	0.107	0.114	0.112	0.139	0.149
	(0.147)	(0.148)	(0.147)	(0.147)	(0.146)	(0.157)
Fossil fuel subsidies (logs)		0.109				
		(0.084)				
Inflation			0.485			
			(1.821)			
GDP per capita growth				1.606		
				(2.205)		
Renewable energy cons.					-1.800	
					(1.123)	
CO_2 per GDP (logs)						0.893
						(1.388)
Observations	839	839	839	839	839	839
R-squared	0.126	0.141	0.126	0.126	0.152	0.129
Adjusted R-squared	0.122	0.137	0.122	0.122	0.147	0.125

*Notes: This table presents the placebo test results for oil (Panel A) and gas (Panel B) producers. The dependent variable is the natural logarithm of oil output. "State" is a dummy variable that takes 1 for NOC and 0 for IOC. "Post-2013" is a dummy variable, 1 indicates the period 2014-2021, and 0 indicates the period 2010-2013. "Fossil fuel subsidies" denotes the size of subsidies provided for fossil fuel production in natural logarithm. "Inflation" is the GDP deflator as annual %. "Renewable energy cons." denotes the share of renewable energy in total final energy consumption, i.e., defined in percentage. CO_2 per GDP is carbon dioxide emissions per GDP. ***, **, and * represent statistical significance at 1, 5, and 10% level. Standard errors are clustered at the firm level and shown in parentheses.*

The placebo estimates are weakly statistically significant in some cases while indistinguishable from zero in others, depending on the model specification. These findings suggest that to some extent, the diverging pattern in oil production between NOCs and IOCs in the post-Paris era was partly driven by some pre-existing structural differences in production trends as opposed to the Paris Agreement itself. However, it does not negate our results because the slope coefficient still changes after the Paris Agreement.

5. Conclusion

This paper has examined the role of state ownership in oil and gas production in the context of the Paris Agreement by comparing NOCs and IOCs. Focusing on the period from 2010 to 2021, we have demonstrated that IOCs increased their oil production by about 30%-35% relative to NOCs in the post-Paris period. The widening gap in the post-Paris era was due to declining oil production from NOCs outside the OPEC+ bloc and increasing oil output from IOCs, reflecting that IOCs have been more responsive to evolving market dynamics by meeting the rising oil demand.

Moreover, the divergent responses between NOCs and IOCs took place before the adoption of the Paris Agreement, suggesting that this divergence is partly influenced by structural and pre-existing market dynamics rather than direct policy responses to the Paris Agreement. In contrast, such divergence did not occur in gas production, and both groups uniformly increased their output, reinforcing the role of gas as a transitional fuel.

The divergence in oil production of NOCs and IOCs revealed in this paper highlights that efforts to steer the energy transition must consider the inherent differences in corporate governance and national strategies. Understanding the factors that drive these differing responses is crucial for designing effective energy and climate policies that address production-side challenges. Overall, this paper contributes to the broader discourse on the energy transition by demonstrating that a one-dimensional view of producers' responses to climate and energy policies is insufficient.

Endnotes

1 For more information about the dataset, see https://carbonmajors.org/.

2 See https://fossilfuelsubsidytracker.org/.

3 See https://www.investing.com/.

4 Regarding the concern over perfect collinearity between renewable share in energy consumption and fossil fuel subsidies, they may not be necessarily substitutes. In fact, supply of fossil fuel may increase while renewable deployment is increasing in both domestic economy and in fossil fuel importing countries if energy demand growth is surpassing the growth of renewables deployment.

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Appendix: Tables

Table A1. Number of firms by OPEC membership.

Country	OPEC	OPEC+	Non-OPEC	Number of firms
Algeria	Yes	Yes	No	1
Angola	Yes	Yes	No	1
Australia	No	No	Yes	4
Bahrain	No	Yes	Yes	3
Brazil	No	No	Yes	1
Canada	No	No	Yes	9
Ecuador	No	No	Yes	2
Egypt	No	No	Yes	1
Germany	No	No	Yes	3
Iran	Yes	Yes	No	1
Italy	No	No	Yes	1
Japan	No	No	Yes	1
Kuwait	Yes	Yes	No	1
Malaysia	No	Yes	Yes	1
Netherlands	No	No	Yes	2
Nigeria	Yes	Yes	No	2
Norway	No	No	Yes	3
Oman	No	Yes	Yes	2
Qatar	No	No	Yes	3
Russia	No	Yes	Yes	5
Saudi Arabia	Yes	Yes	No	1
Spain	No	No	Yes	3
Switzerland	No	No	Yes	1
Thailand	No	No	Yes	2
Turkmenistan	No	No	Yes	2
United Arab Emirates	Yes	Yes	No	2
United States	No	No	Yes	40
Ukraine	No	No	Yes	3
Venezuela	Yes	Yes	No	1

Note: This table shows the number of firms by country and their corresponding OPEC and OPEC+ membership status.

About the Author



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Akin Cilekoglu is a Postdoctoral Researcher in the Climate and Sustainability program at KAPSARC. Using micro-level datasets, his research focuses on firm-level analysis, primarily in climate change and energy-related topics. He holds a Ph.D. in Economics from the University of Barcelona, an M.Sc. in Economics from the Catholic University of Milan, and a bachelor's degree in Business Administration from Dokuz Eylul University in Izmir. Previously, he worked as a Climate Policy Consultant and as a Lecturer at Istanbul Bilgi University.

About the Project

This project investigates how different ownership structures – specifically, national oil companies (NOCs) and international oil companies (IOCs) – have influenced oil and gas production patterns following the 2015 Paris Agreement. Utilizing a panel data from 102 firms across 29 countries between 2010 and 2021, the study finds that IOCs increased oil production by 30%-35% relative to NOCs in the post-Paris era, a divergence primarily driven by declining output from NOCs outside the OPEC+ bloc. In contrast, natural gas production rose uniformly among both firm types, reinforcing gas's role as a transitional energy source. These findings suggest that structural and market dynamics – not solely climate policy – underpin the observed shifts in production, highlighting the need to tailor energy transition strategies according to ownership models and geopolitical contexts.

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