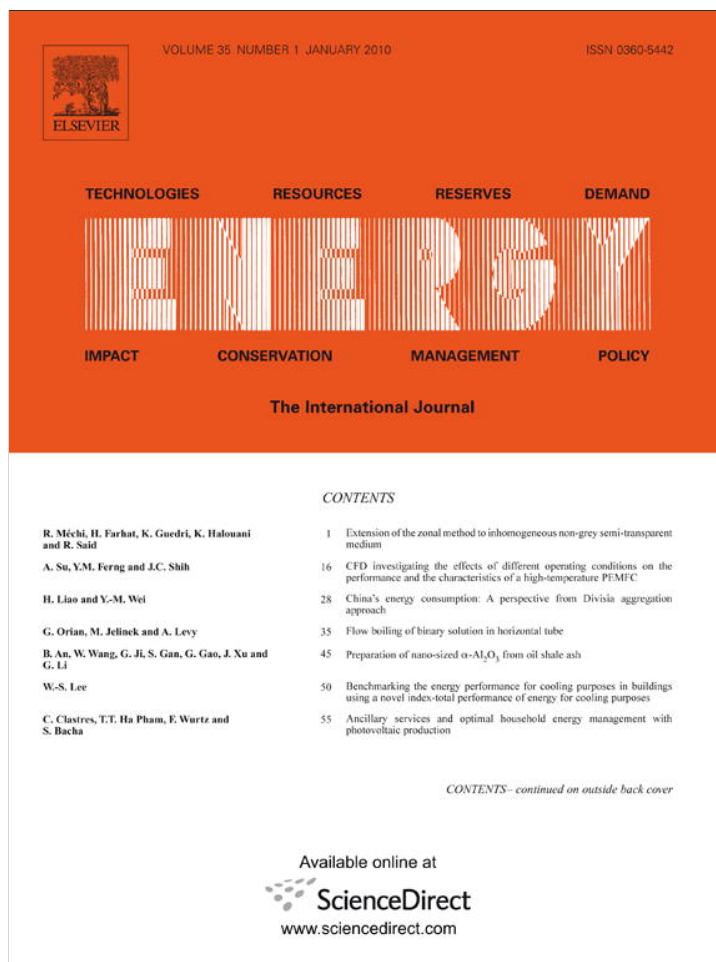


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Limits to international diversification in oil & gas – Domestic vs foreign asset control

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ABSTRACT

We provide evidence that international diversification in the oil and gas sector comes at an important cost; lower control over foreign oilfield assets (and therefore reduced control over oilfield cash-flows). This work examines the factors that drive companies to diversify despite the loss of control over oilfields. Detailed worldwide data for 293 companies owning 6633 field stakes enable us to demonstrate that diversification increases with firm size but results in lower asset control – with an important caveat – companies seek to retain minimum control blockholdings in ‘foreign oilfield assets’. We conclude, therefore, that companies seeking reserve replacement are forced to diversify but need to accept lower control over foreign asset cash-flows.

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1. Introduction

This study examines the effect of global oil and gas diversification on asset control, adding contrary insights into the strategic value of blockholdings for the important oil and gas (O&G) extractive industry. We find that geographic diversification leads to diminished control over oilfield cash-flows, highlighting a hitherto unexplored but important cost for companies following international diversification strategies. This work emphasises an important link between global diversification and control over oilfield assets. Findings follow prior work in this journal by Gowdy and Julia [8], who call into question the capacity of current oilfield assets to meet future oil demand. It is precisely the aggressive pattern of accelerated global depletion noted by Gowdy and Julia [8] that makes the concept of reserve replacement, international investment and oilfield cash-flow control both topical and strategically important.

The existing body of literature dealing with control focuses, in the main, on equity voting blocks – and infers that equity stock blockholders are, under certain circumstances, able to use control blockholdings to exercise undue influence over companies. Findings suggest that corporate equity ‘control’ blockholdings come at a premium. Interestingly for listed corporates these blockholdings typically comprise between 5 and 10% of shares (see Holderness

[10]) – this contrasts with oil and gas assets where this level of ownership would traditionally be viewed as insufficient to exercise asset control (certainly our data shows that this is the case for oilfields outwith the Organization for Economic Co-operation and Development area (OECD)). Prior equity research has, however, also made the point that blockholding value premia tend to occur particularly in high risk countries (where minorities are not protected). This result is consistent with our finding of the need for higher levels of asset participation in risky oil and gas countries (an issue covered by Durnev and Kim [5] in a discussion of minority investor protection).

In this study we do not examine the market value of control, rather the focus is on the strategic value of ‘oilfield cash-flow control’. Certainly, in O&G, we observe few benefits for globalizing companies; global diversification in the O&G industry actually increases political risk, particularly for OECD based producers. Additionally, cross border cost reductions are difficult to achieve (and complex to analyze) in that they combine widely different technical field risks and fiscal regimes. Simply put, we suggest that in O&G there seem to be many reasons not to diversify. So, why then do O&G companies diversify? The simple answer seems to be that they have to; in order to replace reserves and sustain earnings. Our contribution is to suggest that for the O&G industry diversification gives rise to an important and hitherto unexplored effect; reduced control over foreign assets.

Our O&G findings contrast with prior work that focuses on the tobacco industry, Beneish et al. [1], who document that diversifying acquisitions by tobacco firms are positive net present value (NPV)

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investments, and that wealth creation increases with the degree of domestic geographic expansion. Apparently this occurs as a result of increasing tobacco firms' influence in political districts. Rose [16] also studies geographic diversification and the cost effects of interstate banking in the US. He finds that when firms are grouped into different levels of geographic diversification, highly diversified banks appear to achieve reductions in risk exposure, operating costs and therefore benefit from geographic diversification.

O&G industry assets are unique in that they are, in the main, held in Joint Assets No Entities (JANEs). In these JANEs, the majority or dominant stakeholder is often able to exercise control over the development strategy of the oilfield asset. The majority holder is therefore able to maximize value, control and optimize cash-flows. Oilfield NPV behavior is therefore uniquely asset based and usually controlled by majority or controlling asset stakeholders. It is, for example, precisely this control principle that is at the heart of the TNK-BP dispute, where BP and TNK each hold 50% of the venture, resulting in a strategic stalemate for the asset development. In O&G, minorities are exactly that – minorities with secondary influence over asset cash-flows and strategic decision making.

We show, therefore, that companies seeking to grow or sustain earnings, are forced to replace consumed reserves by acquiring positions – often in risky foreign assets. They do this despite the fact that they are typically only able to acquire minority stakes in these assets – effectively relegating them to the position of junior partner in the asset. Like Rose [16], who examines the apparently contradictory behavior of banks, we seek therefore to examine and understand the contradictory behavior of O&G companies that acquire minority stakes in international assets.

Ownership ebbs and flows from international diversification have been well documented through studies examining the value of pay off, notably Berger and Ofek [2], Comment and Jarrell [4], Laeven and Levine [15], and Singh et al. [18]. The problem that these prior studies highlight is a lack of due regard in the literature as to the effects of diversification on asset control. By contrast, our resource sector study is characterized by two notable attributes: the location of reserves (which enables us to isolate asset ownership structure by country; secondly, oil and gas are, as noted by Stiglitz [19], homogenous and uniformly non-renewable (enabling a global comparison of the attribute of ownership). These attributes of location and homogeneity enable us to isolate country specific effects of globalization on corporate asset control.

Despite the above insights, the strategic resource extractive industry is neither efficient nor transparent in its market structure for oilfield assets. We know little about the ownership of these assets nor is there much research into these closely held assets. To complicate matters the sector is often subject to political, fiscal, and economic protectionism as companies use opaque and secretive special purpose vehicles to control global assets (see Kretzschmar and Kirchner [11]). The largest and most important oil and gas reserves are state owned, directly limiting corporate access to these reserves, consistent with Victor [21]. Explicit limits to corporate geographic expansion have already been observed in the O&G sector with numerous host countries (Non OECD in particular) tend to retain control over domestic assets through national oil companies. As result, corporates compete for the balance of field assets in these countries, see Kretzschmar et al. [13]. Hence while we measure the average majority stake by company grouping, it is clear that NOCs dominate domestic holdings with an average of 57.59% of domestic fields. Because these NOCs control large fields they actually control 94.18% of domestic reserves. The main focus in this paper is therefore on the extent to which companies are able to attain control over non-NOC oilfield cash-flows, by gaining asset blockholdings greater than 25%. The 25% blockholding cut off we use in this paper is informed by the generally accepted industry

practice that enables the operator involvement in the operation of the field.

Detailed global oilfield asset ownership data enable us to analyze the percentage of reserves owned outside the country of company's primary operation. Ownership of physical reserves entitles companies to oil revenues in proportion to their holdings in the field (see Errunza and Senbet [6]). We perform an extended empirical analysis of international diversification effects on ownership and document that diversification is directly related to a reduction of control on internationally diversified assets. Domestic reserve holdings exceed foreign holdings, comprising 64.3% of company reserves owned, with the balance held in foreign reserves. This domestic bias is especially pronounced for NOCs, which own 94.2% of their physical reserve assets in their home countries. In contrast, we show that only 10.5% of the reserves owned by oil majors are domestic while 89.5% are foreign, a preponderance of foreign asset exposure that makes clear the extent of the globalization necessary for the largest oil and gas companies seeking reserve replacement.

Furthermore, we demonstrate that company control over domestic oil and gas assets exceeds that for foreign oilfield assets. Even the largest listed oil companies, oil majors, own on average 49.8% in domestic reserve assets but own on average only 35.6% in foreign fields. Listed NOCs on average own 57.6% of domestic fields and only 30.6% in foreign oilfields. Findings highlight the loss of oilfield cash-flow control that occurs with international diversification. Yet, despite the diminishing control over foreign oilfield cash-flows, diversifying companies do seek to retain minimum blockholdings in their foreign assets. We show that 25.5% of domestic assets and even higher, 32.6%, of foreign assets are held in blockholdings. This trend is particularly pronounced for large cap majors for which 44.91% of foreign holdings are blockholdings vs only 10.18% for domestic reserves.

We conclude that diversification in the oil and gas sector comes at an important and hitherto unmeasured cost, the loss of control over strategically important resource assets. Global insights demonstrate that control over asset cash-flows (commensurate to percentage stakes in oilfield assets) diminishes with increasing geographic diversification, an outcome that stems primarily from new entrants, inability to compete against host National Oil Companies. Importantly, we note that there is a lower limit to the oilfield asset ownership loss that diversifying companies are prepared to tolerate. This is reflected in the retention of minimum blockholdings (above 25%) in foreign oilfield assets.

2. Data and key concepts

Our definitions of ownership rely on the sector principle that majority stake (or at least a minimum blockholding) is required to exercise control over oilfield cash-flow, with majority stakeholders determining oilfield strategy and therefore NPV profile. Ownership attributable to cash-flow rights has previously been emphasized in equity studies by Faccio and Lang [7] and Holderness [10]. For the O&G industry, ownership of cash-flows is commensurate to ownership in the field, but with blockholdings able to determine asset strategy. In this study *Ownership* therefore is measured as the percentage of remaining reserves attributable to company's holding. We therefore use percentage ownership and percentage stake terms interchangeably. A majority stake is defined as 50% ownership of the oilfield, while blockholdings are measured as 25% field ownership.

We analyze ownership in these categories for the three main groups of owners, *national oil companies (NOC)*, *large cap majors*, and *North American and international independents (NAII)*. A *national oil company* is defined as a company, joint venture or

Table 1
Geopolitical overview of reserve ownership.

Region	All companies ownership				Listed companies ownership					
	N	Reserves		Fields	N	Reserves		Stakes		Ownership
		(mmboe)	% Global Reserves			(mmboe)	% Global Reserves	N	%	
Global	2181	2,575,743	100%	8911	337	902,982.5	35.06%	6633	42.93%	
1 Africa	474	175,830.9	6.8%	1977	3	76,103.17	2.95%	1428	39.39%	
2 North America	355	132,383.8	5.1%	1184	183	127,300.9	4.94%	1155	17.40%	
3 South/Central America	248	426,379.4	16.6%	913	3	56,455.36	2.19%	470	40.67%	
4 Asia Pacific	331	88,025.81	3.4%	1171	64	65,813.35	2.56%	990	34.07%	
5 Eurasia	351	662,963.3	25.7%	1926	19	485,665.9	18.86%	1071	61.87%	
6 Europe	275	58,326.01	2.3%	1058	59	35,175.35	1.37%	926	44.42%	
7 Middle East	147	1,031,834	40.1%	682	6	47,479.4	1.84%	218	50.47%	

The table presents the companies' reserve holdings by geographic region. This study divides world reserves into seven regions including Africa, North America, South/Central America, Asia Pacific, Eurasia, Europe and Middle East, all listed along the vertical axis in the table. Oilfield locations are grouped into regions on the basis of geographic proximity. The table differentiates between 'All companies' and 'Listed companies', which are included in the study. We present total number of companies, reserve ownership in mmboe and as a percentage of global reserves for all O&G companies and only listed O&G companies. Subsidiaries' reserves are consolidated with parent companies and companies with no reserves are excluded from ownership analysis. Listed companies own 35% of global reserves, the remaining 65% are controlled by unlisted National Oil Companies which do not disclose reserve and market data. Number of fields presented for 'All companies' reflects the total number of oilfields above 5 mmboe globally, where the number of stakes for 'All listed companies' reflects the number of oilfield stakes owned by listed companies, which does not reconcile to the number of distinct oilfields. Ownership reflects the percentage of remaining reserves listed company owns in a given field.

organization owned by a government [9], a *large cap major* category includes the 12 large cap integrated oil companies, engaged in the upstream O&G sector, as well as at least one other significant activity in the downstream sector and which are also classified as oil majors by the Society of Petroleum Engineers.¹ Companies that are not in the above categories are included in *NAII* category. Companies that are not publicly listed are not included in the study for the simple reason that the NOCs which dominate this category clearly control reserves in their own countries. This feature should be borne in mind as a limitation for readers seeking to understand the influence of unlisted NOCs.² The imposition of this condition in interpreting our results does assume that NOCs like Saudi Aramco, Emirates National Oil company control all reserves in their countries and seek to maximize economic rents from domestic reserves.

Global reserve and ownership data as at January 2008 are hand-collected and updated quarterly by specialist research teams through interviews with operating companies.³ Global reserve data reflect the size of the remaining reserves of the fields and their ownership structures as at year-end 2007. For example, as at 2007 the oil major Total owns a total of 364 stakes in oilfields globally with 34,866 million barrels of oil equivalent (mmboe) in physical reserves attributable to all stakes combined. We examine asset ownership of each company in the dataset. For example, if a company X owns 60% of company Y, which in turn owns 30% of field Z, then we calculate that company X owns 18% of field Z. Using an example from the dataset, Repsol-YPF owns 66% of company Pluspetrol, which owns 55% of Block 1-AB field in Peru, we posit that Repsol-YPF owns 36.3% of field Block 1-AB. Our study focuses on material oilfield assets with a minimum of 5 million barrels of oil equivalent in remaining reserves. This lower limit to asset size enables us to overcome ownership idiosyncracies associated with small oilfield assets previously identified by Kretzschmar and Moles [12]. Additionally, the existence on non-economic reserves (below 5 million barrels of oil) results in limited commercial interest – and a preponderance of state ownership.

Table 1 presents the summary of reserve holdings across seven regions identified in this study owned by the listed oil and gas companies included in this study.

¹ 12 oil majors include BP, Chevron, ConocoPhillips, ENI, ExxonMobil, Hess, Marathon, Murphy Oil, Occidental, PetroCanada, Shell and Total.

² This limitation was noted by an independent reviewer.

³ Reserve and reserve ownership data are commercially available from the Energy Research House Wood Mackenzie.

With reference to Table 1 we start with a total population of 2181 oil and gas companies owning a total of 8911 oilfields which account for 100% of global reserves and then use several filters to construct the dataset we use for this study. We select only listed firms to be included in our study and remove all private NOCs (which own a sizable majority of global reserves in the oil and gas sector) and other private unlisted oil and gas firms. Listed companies own a total of 6633 stakes in oilfields worldwide comprising 902,983 mmboe of physical reserves, which account for 35% of world's total reserves (see Table 1).

For the final dataset of 293 publicly listed firms, market data and geography of primary listing are collected from Thomson Financial Datastream. We use market data for the year-end closest to December 31, 2007. We split reserve location into seven geographic oil producing regions where companies own oilfield assets: Africa, North America, South/Central America, Asia Pacific, Eurasia, Europe, and Middle East. This geographic segmentation into proximate regions allows us to measure the extent of company's international diversification based on the number of different regions where companies own oilfield assets. This global geographic metric is included in the variable description in Table 4.

3. Geographic diversification and ownership

3.1. Data analysis – domestic and foreign ownership

In Table 2 we compare ownership characteristics between foreign and domestic asset holdings for the complete dataset of listed O&G companies and for the three company groupings (*NOCs*, *Large Cap Majors*, *NAII*). Domestic reserves include reserves owned in the country of primary listing, whereas foreign reserves encompass ownership outside the country of primary listing. To capture the effect of economies of scale from operating large fields, we distinguish domestic and foreign involvement for large fields. Large fields in this study contain in excess of 60 million barrels of oil equivalent in remaining reserves. Differentiating between large fields and total ownership allows us to identify economies of scale as a separate explanatory variable used in the regression analysis, defined in Table 4. We adopt an analysis of blockholdings consistent with the ownership study by Holderness [10]. Ownership stakes are classified as blockholdings when ownership in a particular field exceeds 25% threshold.

Fig. 1a illustrates the percentage of reserves attributable to domestic and foreign reserve holdings. Fig. 1b summarizes the

Table 2
Domestic and foreign acquisitions and reserve ownership.

	Listed companies			Listed NOCs			Large cap majors			NAII		
	Total	Dom	Foreign	Total	Dom	Foreign	Total	Dom	Foreign	Total	Dom	Foreign
Reserves (mmboe)	902,983	580,264	322,718	444,649	418,785	25,864	258,713	27,247	231,465	199,621	134,232	65,390
% of Global holdings		64.26%	35.74%		94.18%	5.82%		10.53%	89.47%		67.24%	32.76%
%Ownership	40.69%	41.69%	39.52%	42.71%	57.59%	30.59%	36.70%	49.76%	35.63%	40.72%	39.00%	40.57%
%Ownership (Large fields)	41.13%	48.86%	36.35%	43.36%	54.30%	32.48%	38.40%	43.91%	38.09%	41.07%	48.32%	36.66%
Number of fields	6633	2609	4024	1002	709	293	2534	418	2116	3097	1482	1615
Number of large fields	2248	808	1440	512	363	149	940	116	824	796	329	467
Large fields (%)	33.89%	12.18%	21.71%	51.10%	36.23%	14.87%	37.10%	4.58%	32.52%	25.70%	10.62%	15.08%
Blockholdings	3852	1691	2161	794	650	144	1396	258	1138	1662	783	879
%Blockholdings	58.07%	25.49%	32.58%	79.24%	64.87%	14.37%	55.09%	10.18%	44.91%	53.66%	25.28%	28.38%

The table presents the summary of reserve ownership grouped into total, domestic and foreign reserves and differentiated by company type. We demonstrate the comparative summary of domestic and foreign reserves owned by the companies; physical reserves attributable to companies' holdings globally, domestic by primary listing and foreign, outside of home country. Reserves reflect physical reserves in mmboe and percentage of domestic and foreign reserves relative to reserves owned globally. Ownership reflects the average ownership across all fields owned by the companies; ownership in large fields reflects average ownership in fields that by definition of large fields exceed 60 mmboe in remaining reserves; number of stakes reflects total count of stakes owned by the companies; number of stakes in large fields in absolute and percentage terms as a fraction of total number of stakes attributable to the companies. Blockholdings reflect the number of stakes which own in excess of 25% of the field. %Blockholdings reflects the number of blockholding stakes as a fraction of the total number of stakes owned by the company. All variables are grouped according to company groupings, including a summary for all listed companies, National Oil Companies, large cap majors and North American and International Independents.

average ownership in domestic and foreign oilfields calculated from the average stake size for each company in foreign and domestic fields. Fig. 1c presents the proportion of reserves held in blockholdings, calculated as the number of blockholdings divided

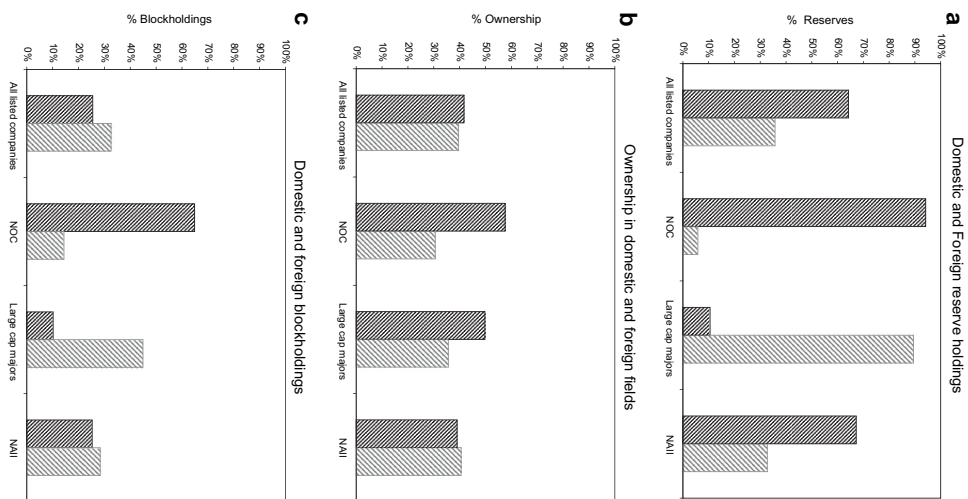


Fig. 1. Domestic and foreign reserve ownership and blockholdings at 2007. 1a–1c present a graphical summary of the comparisons of domestic and foreign reserve holdings, average reserve ownership, and blockholdings. 1a illustrates the percentage of reserves attributable to domestic and foreign reserve holdings. For example, third set of bars in 1a demonstrates that only 10.5% of the reserves owned by large cap majors are domestic and 89.5% are foreign reserves. 1b summarizes the average ownership in domestic and foreign oilfields calculated from the average stake size for each company in foreign and domestic fields. The third set of bars in 1b illustrates that large cap majors ownership on average 49.8% of the reserves in domestic fields and only 35.6% of the reserves in foreign fields. 1c presents the number of blockholdings as a proportion of total stakes owned by the companies, demonstrating that blockholdings owned by large cap majors predominantly consist of foreign blockholdings, which when read together with 1a and 1b suggest that despite the preponderance of foreign reserves, average ownership is low, but blockholdings are retained.

Table 3
Diversification.

Diversification			Size			Ownership structure	
Regions <i>N</i>	Companies <i>N</i>	%Foreign Reserves	Reserves	Economies of Scale	MC	%Ownership	%Blockholdings
Panel A: All listed companies – 293							
1	184	67%	22,877	30%	4,059,309	43.59%	57.59%
2	50	48%	204,028	29%	10,259,710	36.30%	50.87%
3	17	36%	507,074	25%	25,959,168	37.73%	56.15%
4	15	47%	544,494	33%	23,891,408	36.92%	52.73%
5	12	59%	3,506,427	47%	49,880,004	38.84%	55.55%
6	6	100%	413,637	67%	43,387,396	30.68%	56.40%
7	9	58%	1,427,725	16%	183,018,445	34.99%	57.87%
Panel B: Listed NOCs – 20							
1	4	25%	5085	25%	1,024,510	24.96%	35.12%
2	4	60%	2,095,745	60%	30,710,711	38.63%	37.50%
3	3	50%	1,446,109	50%	56,575,033	57.97%	71.35%
4	4	48%	137,099	48%	21,784,029	36.16%	49.31%
5	4	41%	10,478,154	41%	108,927,672	55.09%	77.25%
6	1	0%	2,041,549	0%	99,035,341	36.61%	35.72%
7	0	0%	0	0%	0	0%	0%
Panel C: Large cap majors – 12							
1	0	0%	0	0%	0	0%	0%
2	0	0%	0	0%	0	0%	0%
3	1	100%	57,231	100%	32,335,700	35.83%	62.90%
4	2	95%	1,052,643	95%	44,909,185	41.09%	68.87%
5	1	94%	64,078	94%	16,056,640	41.33%	42.86%
6	1	96%	35,244	96%	32,335,700	37.22%	59.15%
7	7	78%	1,815,716	78%	219,984,019	32.81%	56.14%
Panel D: NAII – 261							
1	180	67%	23,272	28%	4,126,749	44.01%	58.09%
2	46	37%	39,531	26%	8,481,362	36.10%	52.03%
3	13	55%	324,977	41%	17,565,629	32.87%	52.12%
4	9	78%	612,637	51%	20,157,404	36.33%	50.66%
5	7	100%	14,347	48%	20,970,389	27.59%	44.97%
6	4	31%	101,257	28%	32,238,333	27.63%	54.73%
7	2	50%	69,757	0%	53,638,936	42.61%	63.91%

The diversification level of 293 companies in the study is measured by the number of regions where the company owns oilfield assets. All companies are classified into 7 diversification bands. Companies which are not diversified, own assets within a single region, are included in band 1. Companies which own assets across all seven geographic regions are included in diversification band 7 respectively. Size category variables listed on the horizontal axis of the table include average physical reserves owned by the companies; scale economies reflecting the average count of stakes owned in large fields as a proportion of total number of stakes owned by each company, and an average market capitalization (MC). The table is split into Panels to demonstrate diversification level for all listed companies in the study in Panel A and for listed NOCs, *large cap majors* and *NAII* in Panels B, C, and D, respectively.

by the number of all oilfield stakes held by each company grouping and for the whole dataset. Data are interpreted below. From Table 2 and Fig. 1a we observe that based on proportion of reserves held by all listed O&G companies, domestically owned reserves dominate foreign reserves. Domestic reserves comprise 64.3% of total reserves owned, with the balance encompassing foreign reserve holdings. This finding is particularly pronounced for NOCs, for which domestic reserves comprise 94.2% of the total reserves owned by NOCs. In contrast, only 10.5% of reserves owned by large cap majors are domestic and the remaining 89.5% are foreign, suggesting that the ownership structures for the 89.5% of foreign reserves are of strategic importance.

With reference to Table 2 we find that across all listed companies average ownership in domestic and foreign assets is about the same. By contrast, there is clear evidence illustrated in Fig. 1b that NOCs reduce their average ownership stakes from 57.6% in domestic fields to 30.6% in foreign assets. Similarly, largest listed companies, *large cap majors*, are able to own on average 49.8% in domestic reserve assets and only 35.6% in foreign fields. Data for both company groupings suggest control over assets diminishes as a direct result of international diversification.

From Table 2, the decline in ownership is particularly pronounced for average ownership in large foreign fields vs large domestic fields. The number of stakes in large fields on the contrary increases from domestic to foreign holdings, suggesting that companies try to gain

access to economies of scale derived from operating large fields; however, fierce NOC competition for large fields does not allow large ownership stakes in foreign markets.

Despite the diminution in ownership of foreign assets, diversified listed companies strive to retain a minimum blockholding (25%) in international assets. Table 2 and Fig. 1c demonstrate that companies have more blockholdings *outside* the country of primary listing compared to blockholdings in domestic oilfield assets. This characteristic is most pronounced for *large cap majors* for which 44.9% of the ownership stakes are foreign blockholdings and only 10.2% are domestic blockholdings. For the population of listed oil and gas companies 32.6% of their foreign reserve holdings are blockholdings vs 25.5% of domestic blockholdings. The exception is demonstrated by NOCs, which enjoy privileged position in domestic markets resulting in majority, 64.9%, of all stakes owned by NOCs being blockholdings of domestic assets and only 14.4% blockholdings of foreign reserves.

3.2. Diversification, size, and cash-flow ownership

We seek to investigate the link between firm's geographic diversification, market size and control over its assets. Existing research uses different ways of measuring geographic diversification, we follow Rose [16] and use a regional diversification measure, which simply counts the number of regions where the company owns oilfield assets. We split companies into seven diversification

Table 4
Variable definitions.

Variable	Notation	Description
Panel A: dependent variables: ownership structure		
%Ownership		Percentage ownership in oilfield assets, measure to capture ownership structure similar to the measures used to study the relationship between the methods of diversification and ownership structure in Ruiz-Moreno et al. [17] Source: Wood Mackenzie, ownership data as of 2007.
%Blockholding		Number of blockholding stakes divided by the number of all stakes owned by the company. Ownership stake in excess of 25% of the field reserves is classified as blockholding. Use of blockholding is informed by Holderness [10] study of ownership. Source: Wood Mackenzie, ownership data as of 2007.
Panel B: explanatory variables: diversification		
Foreign reserves density	X_1	Percentage of foreign reserves as a fraction of total reserves owned by the company divided by the number of regions where they are held. This cardinal variable allows to combine the information gained from the categorical measure of number of regions and the interval measure of the percentage of foreign reserves and allows this study to analyze the effect of geographic dispersion of foreign reserve holdings. There is a total of seven regions the companies can diversify their asset holdings across, grouped on the basis of geographic proximity. This variable is informed by previous diversification studies by Rose [16] who uses percentage of foreign assets as well as the count of regions of asset holdings; Singh et al. [18] use foreign sales/total sales to capture similar effects. Source: Wood Mackenzie, ownership data as at 2007.
Panel C: Explanatory Variables: Size		
Ln (Res/MC)	X_2	The natural logarithm of each company's total reserves divided by the company's market capitalization. This variable isolates the effect of company size and the size of reserve holdings. We use natural logarithm transformation to mitigate the effect of extreme observations in reserve size and market capitalization. The linear combination of the two measures $\ln(\text{Res})$ and $\ln(\text{MC})$ is used in order to reduce multicollinearity due to strongly correlated regressors. Source: Wood Mackenzie, ownership data as at 2007, Thomson Financial Datastream.
Economies of scale	X_3	Number of stakes owned in large fields divided by the total stakes count owned by the company. Large fields include oil and gas fields in excess of 60 mmbob. Source: Wood Mackenzie, ownership data as at 2007.
Panel D: Model sensitivity check		
NOC dummy	X_4	This binary dummy variable takes the value of 1 if the company in the dataset is classified as NOC and 0 otherwise. Concerned with the quantitative dominance of <i>NAIL</i> companies in the dataset, which can potentially bias the findings, we include this variable to test the sensitivity of the model to the NOC companies grouping in the regressed dataset. Source: Wood Mackenzie, ownership data as at 2007, investor information on companies' corporate websites.

The table illustrates explanatory variables used for linear regressions with OLS estimates on measures of control and ownership %Ownership and %Blockholding. This table presents the definitions and sources of dependent and explanatory (independent) variables used in this study.

bands according to the number of regions across which assets are diversified based on geographic proximity of the regions. Where one region signifies undiversified firm and seven regions reflect maximum level of geographic diversification. Table 3 presents the summary of company characteristics arranged according to the diversification bands.

Variables listed along the horizontal axis of Table 3 are split into three main categories, testing international diversification, size and reserve ownership structure. Previous studies have suggested

multiple ways of measuring the degree of internationalization, examples of most complete studies include Christophe and Lee [3] and Sullivan [20], who use percentage of foreign sales as a fraction of total sales, foreign assets as a percentage of total assets, foreign profit as a percentage of total profit and other parameters. We use the percentage of foreign reserves as a fraction of total reserves.

Size variables include average physical reserves owned by the companies, economies of scale and market capitalization (MC). Economies of scale are defined as the number of stakes owned in large fields divided by the total stakes count. Large fields are defined to be those in excess of 60 mmbob in remaining reserves.

Table 3 Panel A summarizes listed companies, indicating a positive interaction between firm size and level of diversification, suggesting that large companies are more diversified. This positive relationship between size and level of diversification is strongest for the *large cap majors*. These are found to be diversified across at least three geographic regions. With reference to Table 3 the majority of all companies in the study are not diversified and own assets in a single region. Of 184 undiversified companies 180 are *NAIL*, which include predominantly smaller cap independent oil and gas companies lacking financial resources to access foreign reserves. Similarly, for *NAIL* summarized in Panel D of Table 3, the level of diversification also increases with size. The anomaly to this pattern is *NOCs*, which show no apparent linear relationship between geographic diversification and firm size (see Appendix Table 8 for the details on regional diversification and firm level characteristics for each NOC). The reason for this anomaly is clear; if a country has large reserves its NOC is large as well.

All listed companies demonstrate decreasing control over oilfield assets with a reduction in average stake size where the average stake size is 43.6% for undiversified companies and lower 34.9% average stake size for highly diversified companies. Table 3 illustrates that overall the relationship between diversification and asset control is strong for *NAIL* and less for *large cap majors*. In Panel D of Table 3 the two companies diversified across all seven geographic regions in the *NAIL* grouping deviate from this trend. These extreme observations are driven by large ownership stakes held by two large diversified companies BG and Anadarko. *NOCs* show no linear relationship between their level of diversification and asset ownership, an attribute we ascribe to the precondition of *NOCs* needing political alliances to enable *NOCs'* strategic resource acquisitions in foreign countries. This limitation of foreign entry was recently illustrated by the failure of the Chinese NOC CNOOC Ltd. effective takeover of the US California based firm Unocal forcing CNOOC Ltd to withdraw its 18.5 billion US dollar takeover bid. Washington argued that the deal would threaten US national security and violate the rules of fairtrade.⁴

From Table 3 we also observe the diminishing ability of *large cap majors* to access large foreign fields concurrent with increasing diversification. Table 3 shows that 100% of all stakes owned by least diversified *large cap majors* are held in large fields compared to only 78% of the stakes being in large fields for most diversified companies suggesting the decreasing economies of scale from diversification. This limitation to corporate access of large fields is perhaps explained by greater host country NOC awareness of the need to retain ownership of economic rents for strategically important assets, limiting opportunities for globalizing companies.

In summary, our data analysis shows limited evidence of a positive relationship between firm size and level of diversification and a negative relationship with asset control.

⁴ Washington Post.

Table 5
Pairwise correlation matrix for dependent and explanatory variables.

	% Ownership	%Blockholding	Foreign res density	Ln(Res/MC)	Economies of scale	NOC dummy
Panel A: All listed companies						
% Ownership	1.000					
% Blockholding	0.827	1.000				
Foreign res density	0.050	0.000	1.000			
Ln(Res/MC)	0.351	0.381	-0.150	1.000		
Economies of scale	0.006	-0.032	0.179	0.130	1.000	
NOC dummy	0.019	-0.018	-0.174	0.067	0.160	1.000
Panel B: Large companies [MC ≥ Median(MC)]						
% Ownership	1.000					
% Blockholding	0.874	1.000				
Foreign res density	-0.105	-0.181	1.000			
ln(Res/MC)	0.434	0.492	-0.454	1.000		
Economies of scale	0.036	-0.045	0.297	0.139	1.000	
NOC dummy	0.131	0.087	-0.191	0.209	0.183	1.000
Panel C: Small companies [MC < Median(MC)]						
% Ownership	1.000					
% Blockholding	0.792	1.000				
Foreign res density	0.110	0.061	1.000			
ln(Res/MC)	0.252	0.254	-0.105	1.000		
Economies of scale	0.018	0.012	0.208	0.294	1.000	
NOC dummy	-0.123	-0.146	-0.070	-0.019	0.073	1.000

Table 5 presents the pairwise correlations for dependent and explanatory variables for all companies (Panel A), sub-samples of large companies (Panel B) and small companies (Panel C).

4. Regression analysis

4.1. Regression model

We formulate a framework based on ordinary least squares (OLS) procedures to provide industry wide insights into the effect of diversification on asset control. Specifically, we construct two cross-sectional models to investigate the manner in which ownership structures vary across undiversified companies focused on a single region and internationally diversified firms. Using a combination of asset ownership characteristics consistent with prior corporate ownership studies by La Porta et al. [14], we construct two linear regressions of the form:

$$\text{Model 1 : \%Ownership} = \alpha + \sum_{i=1}^4 \beta_i X_i; \tag{1}$$

$$\text{Model 2 : \%Blockholding} = \alpha + \sum_{i=1}^4 \beta_i X_i; \tag{2}$$

where X_1 is the *Foreign reserves density*, X_2 is the $\ln(\text{Res}/\text{MC})$, X_3 is *Economies of scale*, X_4 is *NOC dummy*.

In the regression analysis for dependent variables, consistent with descriptive data analysis, we use the average percentage of ownership in oilfield assets for each company, denoted as *%Ownership*. We also use the number of blockholdings (25%) denoted as *%Blockholding* and defined as the ratio of the number of blockholding stakes to the number of all stakes held by the company. For explanatory variables we employ information (variables) we used and analysed in the descriptive analysis; however, to add more insight into the dataset we use linear combinations of some of the previously stand alone characteristics. For example, for the *Foreign reserves density* we use the percentage of foreign reserves as a fraction of company's total reserves and divide it by the number of regions where those reserves are held. This variable would have a further advantage of being cardinal rather than categorical (like *Number of regions*) or limited to an interval (like *%Foreign Reserves*).⁵

⁵ We acknowledge a valued input made by the suggestion of the anonymous referee to use this linear transformation.

Additionally, to reduce multicollinearity in the data mainly due to high correlation between total reserves and company's market capitalization (and therefore $\ln(\text{MC})$ and $\ln(\text{Res})$ of 72.2%) we use a linear combination of the two measures to control for size, specifically, we control for the size of the company's total reserve holdings relative to its market capitalization by using $\ln(\text{Res}/\text{MC})$. The pairwise correlations for the variables used in the regression analysis are presented in Table 5. The logarithmic transformations of reserve size and market capitalization are used to mitigate the effect of extreme observations in reserve size and market capitalization. *Economies of scale* are defined in consistency with the definition used in our descriptive data analysis (for detailed definitions of all variables see also Table 4). Concerned with the quantitative dominance of *NAII* companies in the dataset, which can potentially bias the findings, we also include a binary dummy variable *NOC dummy*, which tests the sensitivity of the model to the *NOC* companies grouping in the regressed dataset.

Explanatory variables are classified into two main categories to control for diversification and size. Models 1 and 2 are designed to control for the two categories of explanatory variables; diversification and size, where Model 1 models average field ownership and Model 2 explains the blockholding stakes. Table 4 provides detailed description of dependent and explanatory variables. Panel A describes the dependent variables modeling average ownership and blockholdings, Panels B, and C provide definitions for explanatory variables isolating diversification and size, respectively.

We do not subdivide all listed companies into *NOCs*, *large cap majors* and *NAII* because *NOCs* and *large cap majors* company groupings do not provide sufficient numbers of observations to draw statistically meaningful conclusions. We test the robustness of the regression results by taking the sub-sets of large and small companies differentiated by firm market capitalization. Large companies include all firms with above median market capitalization, small firms include remaining companies with market capitalization equal to or below the median. Hence, the correlation parameters in Table 5 and descriptive statistics summarized in Table 6 are grouped according to the company sub-sets categorized according to the company market capitalization. In both Tables 5 and 6, parameters are presented in three different panels A, B, and C

Table 6
Descriptive statistics – dependent and explanatory variables.

	Dependent Variables		Explanatory variables		
	Ownership structure		Diversification	Size	
	%Ownership	%Blockholding	Foreign reserves density	Ln(Res/MC)	Economies of scale
Panel A: All listed companies					
Mean	41%	56%	44%	−9.45	31%
Median	34%	59%	25%	−9.23	25%
Min	0%	0%	0%	−17.13	0%
Max	100%	100%	100%	−2.67	100%
StDev	28%	38%	43%	2.00	33%
N	293	293	293	293	293
Panel B: Large companies [$MC > Median(MC)$]					
Mean	38%	52%	32%	−10.15	0.37
Median	33%	51%	18%	−9.71	0.33
Min	1%	0%	0%	−17.13	0.00
Max	100%	100%	100%	−6.56	1.00
StDev	26%	34%	36%	2.08	0.30
N	146	146	146	146	146
Panel C: Small companies [$MC \leq Median(MC)$]					
Mean	43%	60%	55%	−8.77	0.25
Median	35%	67%	50%	−8.83	0.00
Min	0%	0%	0%	−13.27	0.00
Max	100%	100%	100%	−2.67	1.00
StDev	30%	41%	46%	1.66	0.36
N	147	147	147	147	147

Table 6 reports descriptive statistics of dependent and explanatory variables used in the models for 293 listed oil companies. The table differentiates between dependent and explanatory variables, where explanatory variables are grouped into diversification and size variables. Both dependent variables including %Ownership and %Blockholding reflect ownership data. %Ownership reflects the average percentage participation in oilfield assets by each company. %Blockholding is calculated by the ratio of the number of blockholding stakes to the total number of stakes that the company owns. The company is a blockholder when it owns more than 25% of a field. For Foreign reserves density we use the percentage of foreign reserves as a fraction of total reserves and divide it by the number of regions where those reserves are held. We use a linear combination of the two size measures, total reserves held and market capitalization, specifically, we use Ln(Res/MC). The logarithmic transformations of reserve size and market capitalization are used to mitigate the effect of extreme observations in reserve size and market capitalization. Use of the linear combination of the two measures is due to high correlation between the two measures, which leads to multicollinearity. Economies of scale enable us to isolate ownership in large fields and reflects the number of stakes in large oilfields as a fraction of total number of stakes for each company. We use market capitalization to split the population of listed companies into large and small companies, where large companies are defined to be listed O&G companies with market capitalization above the median for the whole population of companies in the study.

Table 7
Linear regressions analysis - control.

Linear Regression		All Listed companies		Large companies [$MC > Median(MC)$]		Small companies [$MC \leq Median(MC)$]	
OLS Estimates		Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Intercept		0.890*** (11.326)	1.289*** (12.433)	1.004*** (8.778)	1.479*** (10.279)	0.872*** (6.161)	1.205*** (6.282)
% fgn res/regions	X_1	0.082** (2.147)	0.066 (1.312)	0.122* (1.811)	0.123 (1.457)	0.101* (1.839)	0.089 (1.199)
Ln(Res/MC)	X_2	0.053*** (6.721)	0.076*** (7.321)	0.063*** (5.728)	0.092*** (6.652)	0.054*** (3.460)	0.071*** (3.370)
Economies of scale	X_3	−0.059 (−1.207)	−0.108* (−1.686)	−0.085** (−1.158)	−0.189 (−2.041)	−0.079 (−1.077)	−0.096 (−0.964)
NOC dummy	X_4	0.030 (0.474)	−0.025 (−0.295)	0.060 (0.946)	0.025 (0.309)	−0.213 (−1.240)	−0.368 (−1.585)
R Square		0.139	0.158	0.209	0.266	0.101	0.096
Adjusted R Square		0.127	0.146	0.187	0.245	0.076	0.071
Standard Error		0.264	0.348	0.232	0.292	0.292	0.395
Observations		293	293	146	146	147	147

This table reports the estimated coefficients and associated test statistics (in parentheses) of linear regression with OLS estimators of the following form:

$$\text{Model 1 : } \%Ownership = \alpha + \sum_{i=1}^4 \beta_i X_i$$

$$\text{Model 2 : } \%Blockholding = \alpha + \sum_{i=1}^4 \beta_i X_i \tag{3}$$

The explanatory variables include the Foreign res density which is the percentage of foreign reserves as fraction of total reserves divided by the number of regions where these reserves are held. Ln(Res/MC) is the natural logarithm of each company's total reserves divided by the company's market capitalization. This variable isolates the effect of company size and the size of reserve holdings. Economies of scale is the count of stakes in large fields as a proportion of total stakes owned. Binary dummy variable, NOC dummy, tests the sensitivity of the model to NOC company grouping's reserve ownership characteristics. Parameter significance at a 90%, 95% and 99% levels are indicated by *, ** and ***, respectively.

for the whole dataset of listed companies and large and small companies, respectively.

4.2. Regression results

Table 7 presents the results of OLS estimated parameters of models 1 and 2 for all companies in the dataset. Results confirm the findings highlighted in the descriptive data analysis (with reference to previously presented Table 3) and illustrate the link between international diversification and deteriorating ownership. Results of OLS estimation on a subset of large and small companies are included as robustness tests.

Results presented for Model 1, where diversification and size explanatory variables are regressed on %Ownership, we observe a positive significant coefficient for the *Foreign res density*, suggesting that the more densely reserves are held within smaller number of regions, the higher on average is control over assets. This statement is equivalent to saying that greater geographic dispersion of reserves leads to lower control.

From positive significant coefficient on $\ln(\text{Res}/\text{MC})$ we infer that companies with a large reserve base relative to their market capitalization on average have controlling or large ownership stakes in the fields (see Table 7). Consistent with the descriptive data analysis, this result also demonstrates that large companies (with large market capitalization) comprised primarily of oil majors diversify extensively, therefore engaging in an activity that leads to the reduction in percentage of ownership in oilfield assets and hence diminishing control over the oilfield cash-flows. The factor loading for *Economies of scale* shown in the results for Model 1 is negative but insignificant, suggesting that companies' holdings in large fields on average may be smaller, yet this finding is inconclusive for Model 1.

Consistent with the findings, discussed in the descriptive data section, results for Model 2, where %Blockholding is regressed against explanatory variables, demonstrate no significant loading on the reserve density variable. This is largely due to the fact that although diversifying companies see decreasing ownership stakes in the fields, they nevertheless strive to retain blockholdings in the fields. We also observe strong positive significance on the relative reserve size variable $\ln(\text{Res}/\text{MC})$, consistent with that for Model 1. The negative coefficient on the *Economies of scale* gains significance when tested against %Blockholding. This is explained by fierce competition for participation in large fields and protective policies of the states with regard to large strategically important oil and gas reserves, discussed previously and summarized (see Table 2).

For robustness tests to verify our findings for the complete dataset of listed O&G companies we repeat the OLS procedures using the sub-sets of small and large companies sorted by market capitalization. In Table 7 we find that results achieved for the complete dataset of companies are robust for the two sub-sets of data. For Model 1 we find evidence of a positive relationship between the density of foreign reserve holdings and average ownership, supporting our finding of the effect of geographic dispersment of company's reserve holdings on diminishing control over oilfield assets. Relative size variable likewise retains its sign and significance levels. In Model 2 consistent with the results for all companies, we find no significant effect of the density of foreign reserve holdings on the number of blockholdings held by the companies. The results for a subset of small companies are consistent with the findings for all and large companies.

Despite the significance levels of the variable coefficients, we also find and admit high standard error of the regression results

(see Table 7). This in the main is explained by the fact that correlation levels between some of the regressor variables are stronger than between the regressor and dependent variable, as shown in Table 5. Regression results therefore should be treated with caution and read as supplementary to the findings we observe from the data.

5. Conclusion

Widespread international diversification has provided researchers with a puzzling question, why do large listed corporations continue to expand internationally if there is implied cost of diversification – a diminution in control over assets. The results of this study suggest an answer to this question; companies need to undertake reserve replacement, but our results suggest they also need to mitigate against/or price the loss of control over these foreign investments through the retention of control blockholdings. We infer that the limited amount of natural resource opportunities means that the positive benefits associated with geographic expansion are sufficient to offset the loss of control over assets.

Interestingly our findings are supported by the fact that listed companies have more blockholdings *outside* the country of primary listing (compared to blockholdings in domestic oilfield assets). This characteristic occurs despite the demonstrated loss in asset control – most pronounced for large integrated oil companies – for which 44.9% of all ownership stakes are foreign blockholdings – only 10.2% in domestic assets. An exception is the group of listed NOCs, which enjoy privileged position in domestic markets resulting in a majority, 64.9%, of all stakes owned by NOCs being domestic blockholdings with only 14.4% blockholdings in foreign reserves. It is important to recall that companies not publicly listed are excluded from the study for the simple reason that the NOCs, which dominate this category, clearly control their reserves in their own countries – and do not seek (necessarily) to expand control beyond domestic reserves. This feature of our analysis should be borne in mind by readers seeking to understand the international expansion ambitions for unlisted NOCS.

Results document that diversification is directly related to a reduction in ownership for diversified assets. Diversified companies are shown to be the largest listed companies in the oil and gas sector, suggesting a direct link between firm size and level of international diversification. Secondly, we examine the relationship between upper ownership limits of foreign assets from finding above with the minimum blockholding retained by corporates to secure foreign asset ownership. Our study demonstrates that international diversification comes with the important caveat that diversified companies strive to retain a minimum ownership blockholdings in international assets. We suggest that future research that links 'value losses with diversification' will provide rich insights into the value effects of asset control loss.

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Appendix. Regional and country reserve data

Table 8

Reserve ownership and financial ratios: NOCs.

NOC	Reserve holdings	Regions N	%Ownership	% Blockholding	Capitalization
Pakistan oilfields	1580.76	1	37.44%	57.14%	1,033,362
Lion energy	0.31	1	2.50%	0.00%	9582
Pakistan petroleum ^a	18,587.33	1	49.89%	83.33%	2,976,577
PNOOC	172.62	1	10.00%	0.00%	78,519
Hellenic petroleum	613.88	2	41.82%	27.27%	5,027,066
Indian Oil Corporation	22.43	2	18.75%	0.00%	10,736,378
Rosneft	8,382,003.61	2	76.10%	97.73%	101,404,161
GAIL India	338.70	2	17.86%	25.00%	5,675,237
PTTEP	94,931.10	3	45.22%	56.00%	18238664
Petrobras	4,219,644.03	3	81.55%	93.33%	149,719,337
Petronas	23,750.96	3	46.59%	64.71%	1,767,097
CNPC (Hong Kong)	509.17	4	26.15%	33.33%	3,098,802
CNOOC Ltd	545,315.50	4	72.75%	93.90%	75,409,738
JAPEX	2101.70	4	20.88%	20.00%	4,282,103
SINOCHEM	467.89	4	24.87%	50.00%	4,345,474
ONGC	542,246.13	5	49.13%	64.86%	43,205,452
Gazprom	4.00E+07	5	82.51%	98.93%	333,559,400
Sinopec	252,476.54	5	44.50%	79.63%	23,733,799
PetroChina	1,161,067.77	5	44.23%	65.57%	35,212,036
StatoilHydro	2,041,549.00	6	36.32%	60.32%	99,035,341

This table presents the diversification level of 20 NOCs in the study, measured by the number of regions where the company owns oilfield assets. Reserve holdings reflect the amount of remaining physical reserves attributable to each company's field holdings. We use 7 regions to measure the geographic spread of the reserve holdings. Companies are classified into 7 diversification bands. Companies which are not diversified, own assets within a single region. Companies which own assets across all seven geographic regions are included in diversification band 7 respectively. We also include the average ownership percentage for the companies across all field holdings for that company. %Blockholdings is defined as the number of blockholdings as a percentage of all stakes owned by the company. We also list the market capitalization of the NOC in million USD.

^a Pakistan Petroleum does not disclose its financial data, however, we include the company in the analysis as reserve ownership data is commercially available.

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