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Does Ownership Matter? The Performance and Efficiency of State Oil vs. Private Oil (1987-2006)

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Christian Wolf

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JEL Classification C21, G32, L20, L71, M21, Q40

Contact christian.wolf@cantab.net
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CHRISTIAN WOLF

University of Cambridge, Judge Business School

christian.wolf@cantab.net

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OF STATE OIL VS. PRIVATE OIL (1987-2006)

CHRISTIAN WOLF
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Abstract

This paper investigates the existence of ownership effects in the global oil and gas industry, i.e. whether there are systematic performance and efficiency differentials between National Oil Companies (NOCs) and privately-owned International Oil Companies (IOCs). The dataset, which is based on a survey published by *Energy Intelligence* and covers 1,001 firm observation years in the period 1987 to 2006, provides a unique corporate perspective on the industry's development. After summarising the main trends emerging from the data and discussing some key issues of comparing 'State Oil' and 'Private Oil', I find that non-OPEC NOCs underperform their private sector counterparts in terms of labour and capital efficiency, revenue generation and profitability. I also find that much of these differences could be bridged through a change in ownership. OPEC producers show higher efficiency metrics than the private sector, which might be related to exogenous asset quality. All NOCs produce a significantly lower annual percentage of their upstream reserves, but this cannot serve as an indicator of efficiency. This paper complements the time-series analysis of oil privatisations in Wolf and Pollitt (2008) and suggests that a political preference for State Oil usually comes at an economic cost.

Key words
Ownership, performance, efficiency, National Oil Company (NOC), International Oil Company (IOC), OPEC, energy policy

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1 Introduction

In July 1913, as Europe was already sliding towards war, the First Lord of the British Admiralty, a young Winston Churchill, set out the importance of oil to the nation: "If we cannot get oil, we cannot get corn, we cannot get cotton and we cannot get a thousand and one commodities necessary for the preservation of the economic energies of Great Britain".[1] Churchill considered security and diversity of oil supply to be of utmost importance – to achieve them the state could enter into long-term supply contracts as a temporary measure, but ultimately "the Admiralty should become the independent owner and producer of its own supplies of liquid fuel".[2] In 1914, the British government therefore acquired a controlling stake in the Anglo-Persian Oil Company, later renamed BP, setting a precedent for the many other state-owned or 'National Oil Companies' (NOCs) to follow.[3] For there were many governments around the world that deemed energy "too important to be left to the market" (Robinson 1993, p.57).[4]

The UK government of course famously changed its course in the late 1970s and initiated a worldwide move towards private ownership, but direct state involvement in oil and gas remains controversial. High energy prices, the resurgence of economic nationalism and recent asset nationalisations in Russia and Venezuela have re-ignited the debate, which for a long time had been muted when an automatism seemed to exist towards ever greater privatisation and liberalisation.[5] To some, direct state control over resources is an indispensable feature of national sovereignty and political decision-making (Mommer 2002). To others, it remains an article of faith that public ownership results in lower economic efficiency, and that possible market failures should be addressed through regulation instead (Shleifer and Vishny 1998).

In this paper I use a comprehensive dataset of oil and gas companies, covering the largest privately and publicly owned firms over the period 1987 to 2006, to investigate whether ownership matters in economic terms, i.e. whether over the past two decades 'State Oil' or 'Private Oil' have shown superior performance and

[1] Statement to Parliament on 17 July 1913, as quoted in Yergin (1991, p.160).
[2] ibid.
[3] Critics might argue, though, that BP never was a 'proper' NOC, because the state never interfered in commercial operations, restricting its influence to the appointment of two directors to the board.
[4] I will use the terms 'state' and 'government' interchangeably in this paper.
[5] Klein (1999), at the time Chief Economist at Royal Dutch/Shell, predicted that all NOCs would be privatised by the year 2040.

efficiency. If there exists a trade-off between economic outcome and other, socio-political considerations, the result can be used to quantify the economic cost of such trade-off. Direct comparisons of public and private companies can be affected by structural differences between firms, e.g. operational profile, non-commercial objectives, or the underlying geological asset quality, which need to be accounted for. In this paper, a number of observed variables are directly included within the multivariate regression specification. Furthermore, the panel structure of the dataset allows to control for all unobserved time-constant variables, and the comparison of different estimators provides insights as to the existence, importance and direction of such unobserved factors.

The remainder of this paper is structured as follows: Section 2 briefly reviews previous studies on ownership effects; Section 3 sets out the different options available for state participation in the oil and gas sector; Section 4 introduces the data source for the empirical analysis and – using descriptive statistics of the data content – provides a corporate perspective onto the changing structure of the industry over the past two decades; Section 5 has the econometric analysis of ownership effects, including an important discussion on the comparability of results; Section 6 concludes. There are also two Appendices: Appendix A summarises the historical role and key features of NOCs as the most prominent instruments of state control, Appendix B has the detailed descriptive statistical tables of the PIW dataset.

Almost a century after Churchill made his case for a national interest in oil, we are again (still) debating the relative merit of State Oil versus Private Oil. This paper seeks to contribute to this important debate.

2 Cross-sectional studies of ownership effects

In the literature two basic study designs can be found to address the question of whether ownership matters: studies comparing samples of public firms with samples of (different) private firms; and studies looking at privatisation processes over time, whether in the form of a case study, a single-industry or single-country study, or a cross-industry cross-country study. For the purpose of simplicity, I will refer to the first group of studies, which aim to detect static ownership effects, as “cross-sectional” (even though they might well make use of panel data), and to the second group of studies, which aim to trace dynamic privatisation effects, as “time-series”

analyses. Both approaches are closely connected: inherent static superiority of private ownership is a *necessary* condition for the success of privatisation, but not a *sufficient* one, since privatisation processes are dynamic and can include important changes other than ownership, such as political, regulatory and organisational changes (Villalonga 2000). The primary focus of this paper then is cross-sectional, aiming to identify and quantify differences in performance caused by differences in ownership. The rich panel dataset also permits an examination of the impact of ownership change, but has not been specifically collected for this purpose. A more detailed investigation of ownership change within the oil and gas industry is Wolf and Pollitt (2008), a time-series analysis of the performance and efficiency impact of all available privatisations since 1977.[6]

Regarding the previous literature of cross-sectional analyses, Villalonga (2000) provides a concise summary of both original and review studies.[7] Whilst a convincing majority of studies find evidence in favour of private ownership, she argues that many *individual* findings are not fully convincing as the comparisons are impaired by methodological difficulties. The choice of the appropriate measurement variable is one such issue, another is the fact that there are "interacting (non-separable) effects of ownership, competition and regulation" (Vickers and Yarrow 1988, p.39). Furthermore, it is often difficult to find appropriate groups of firms to compare – in many countries or sectors there exist only a small number of truly comparable companies, if any, under either form of ownership. Also, ownership itself might be endogenous i.e. subject to and the result of a system that includes both political and performance goals (Megginson and Netter 2001). In this sense there are often fundamental reasons why certain firms are government-owned, e.g. in the case of perceived market failure, public bail-out of a bankrupt private company or the provision of public goods. The judgement on the severity of these limitations is to

[6] Using a dataset of 60 public share offerings by 28 NOCs, Wolf and Pollitt show that privatisation is associated with comprehensive and sustained improvements in performance and efficiency: over the seven-year period around the initial privatisation offering, return on sales increase by 3.6 percentage points, total output by 40%, capital expenditure by 47%, and employment intensity drops by 35%. Many improvements are realised in anticipation of the privatisation, accrue over time, and level off after the ownership change; they also seem to be largely achievable through partial privatisation alone.

[7] For a literature review of time-series studies of privatisation as well as the underlying theories please see Wolf and Pollitt (2008).

some extent in the eye of the beholder, which is why different reviewers of the literature have come to different conclusions as to general direction of findings.[8]

Amongst the more influential individual studies, Boardman and Vining (1989) examine the economic performance and efficiency of the 500 largest non-U.S. industrial companies in 1983. They find that state-owned and mixed (partly state-owned, partly privately-owned) companies are significantly less profitable and efficient than their private counterparts but that mixed enterprises do not outperform SOEs. In a different study of the same authors (Vining and Boardman 1992), using a sample of Canadian companies, the results of SOEs versus private enterprises are confirmed, but contrary to the first study Vining and Boardman find that mixed enterprises are more profitable than SOEs. Dewenter and Malatesta (2001), following the general approach of Boardman and Vining (1989), test the differences in profitability, labour intensity, and debt levels between private and public companies in the 500 largest international companies, as reported in Fortune for 1975, 1985, and 1995. Controlling for firm size, location, industry, and business-cycle effects, they find convincing evidence that private companies are significantly more profitable, less labour-intensive and exhibit lower levels financial leverage. Contrary to these results, Caves and Christensen (1980) and Martin and Parker (1995) suggest that there is no inherent superiority of private firm performance. Instead, these studies argue that competition in the product market is the key determinant of firm efficiency and that subsequently public and private firms are equally efficient if operating under competitive conditions.

Cross-sectional studies of the oil and gas industry

The fate of the oil and gas sector was of obvious public and political interest in the late 1970s and early 1980s, and a number of important contributions on oil resource ownership date from this period (e.g. Heller 1980; Jaidah 1980; Grayson 1981). Thereafter, however, the industry received limited attention as oil prices were low, supply seemed secure, and the fall of communism opened new opportunities for Western International Oil Companies (IOCs). This changed only with the dramatic increase in commodity prices since 2000, coupled with the entry of India and

[8] To illustrate the degree of subjectivity involved in the interpretation, Villalonga (2000) cites one study (Hirsch 1965) that has been classified as favourable to state ownership, favourable to private ownership, and as neutral by at least one reputable reviewer each.

particularly China into the global oil market and the resurgence of OPEC importance. Valuable contributions on the subject matter have followed suit, e.g. Linde (2000), Stevens (2004), Marcel (2006), and Hartley and Medlock (2007)[9].

But comprehensive empirical analyses are still few in numbers, and this is largely due to a lack of data on NOCs, the operations of which are often characterised by a distinct lack of transparency.[10] Al-Obaidan and Scully (1991) investigate the efficiency differences between 44 international private and state-owned petroleum companies (observed between 1976 and 1982), using Aigner-Chu frontier, stochastic frontier (SFA) and Gamma frontier analysis. Controlling for multinationality and operational integration they find that state-owned enterprises are only 61% to 65% as technically efficient as private firms. Two recent other cross-sectional studies make use of the same data source for industry data (the PIW ranking of the largest global oil and gas companies) as this paper. Eller et al. (2007) use nonparametric Data Envelopment Analysis (DEA) as well as parametric SFA on a sample of 80 firms for the period 2002-04, testing the theoretical predictions developed in Hartley and Medlock (2007).[11] Taking revenues as output and number of employees, oil reserves and gas reserves as inputs, they calculate an average DEA technical efficiency score for NOCs of 0.27, compared to a sample average of 0.40 and an average score for the five biggest private companies of 0.73. The SFA results are not strictly comparable but yield a similar picture. The addition of structural firm variables to the model specification, e.g. the degree of government ownership and domestic fuel subsidies, moves all firms closer to the efficient frontier, but particularly NOCs. Such structural features therefore seem to explain large parts of the inefficiencies of NOCs. It should be noted, however, that part of the observed increase in efficiency is a mere technical consequence of including additional variables in the model. Based on approximately 90 firms observed in the year 2004, Victor (2007) also analyses the relative efficiency of NOCs and private oil companies in converting reserves into production and revenues, but uses a univariate linear regression to do so. She finds that the biggest private oil companies are nearly one-third better than NOCs at converting reserves

[9] The last paper is part of a research programme at Rice University with several interesting contributions on NOCs: http://www.rice.edu/energy/research/nationaloil/index.html.
[10] For an overview of possible data sources for NOCs see Rosser (2000) and Arnott (2004).
[11] Hartley and Medlock argue that NOCs are likely to favour excessive employment, to under-invest in reserves, and to (be forced to) sell oil products in the domestic market at subsidised prices.

into actual output, and tend to generate significantly more revenue per unit of output. Victor concludes that some of the NOCs reserves are effectively "dead oil".

This paper can be seen to build on the analyses of Eller et al. (2007) and Victor (2007), but it investigates a broader range of issues using a significantly more comprehensive dataset (covering the Top 50 oil and gas companies globally over a period of twenty years), which allows for cross-sectional as well as for panel analysis of the data – somewhat surprisingly it is the first multivariate regression analysis of the impact of ownership in the oil and gas industry.

3 State Oil vs. Private Oil

This paper takes as the unit of analysis corporate entities operating within the oil and gas industry and classifies them based on ownership structure, i.e. to what extent shareholders belong to the private or public sector.[12] In this sense the distinction between State Oil and Private Oil is equivalent to the widely used dichotomy between National Oil Companies (NOCs) and International Oil Companies (IOCs), which is historically rooted in the 1970s.[13] NOCs are owned and controlled by governments, with a minimum state interest of between 30% and 50%[14], whereas IOCs are predominantly or exclusively privately-owned (Linde 2000; Stevens 2004). NOCs are certainly the most prominent feature of active state participation in the industry, and the power vested in these companies is a good indication for the degree of state interventionism. It should be pointed out, however, that state involvement can also take forms other than equity ownership of corporatised entities; indeed, there is a wide range of tools and policies available to nation states – a continuum of governance mechanisms (Laffont and Tirole 1993) – to determine the forms and degree of State Oil vs. Private Oil involvement.

For the upstream, the most fundamental decision is between public or private ownership of the subsoil. As of today, the U.S. is the only country to have opted for private ownership – all others chose to retain at least a state veto (Mommer 2002).[15]

[12] For a discussion on the meaning of "ownership" see Learmount and Roberts (2006)
[13] The term 'IOC' can be misleading since an increasing number of NOCs are also operating on an international basis. Also, there are some companies that are neither state-owned nor international.
[14] Both thresholds (30% or 50%) can be found in the literature, reflecting the broader discussion in accounting on effective ownership and consolidation of subsidiaries.
[15] Mommer quotes a speech given by Mirabeau in 1791 to the French National Assembly, outlining his reasons to reject private ownership of subsoil mineral resources. According to Mirabeau, subsoil

Where the subsoil is publicly owned, government has the choice to either grant a monopoly right to one particular party, or to put into place a licensing system for the participation of multiple parties. Allocation mechanism and fiscal terms are prominent features of a licensing regime as they will determine access and "government take" (i.e. total government share in economic profits).[16] States can obviously use the licensing system as a tool to shape industry structure, e.g. by deciding on the frequency and magnitude of any licensing agreements (whether by auction or negotiated deal), by setting particular economic (dis-)incentives, or by imposing conditions such as mandatory involvement of the state.

When the state wishes to participate in the oil sector itself, either as the monopolist or as a license taker, it can do so in the form of a corporate firm or of a public bureau (Horn 1995).[17] State-owned enterprises are certainly more common in the oil sector – as for most products where consumption can be easily measured, marginal costs are non-negligible and price elasticity of demand is sufficiently high (Peltzman 1989) – which opens up the possibility of introducing private shareholders via (part-) privatisation. Even without formal privatisation, NOCs can bring in private sector partners either as service contractors or as joint-venture partners at the operating level.[18] All of the above governance structures, with the exception of subsoil ownership, also apply to downstream markets. Because taxation of both upstream and downstream oil is generally very high and includes sector-specific taxes, it is an important tool of rent distribution and state participation under any system – even in the relations between governments and their NOCs, as taxation to a large extent determines the degree of independence of the NOCs.

Just as State Oil and Private Oil need not be mutually exclusive options, there is no necessary conflict when the two meet. Oil and gas projects are highly capital

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minerals do not lend themselves to partition and often the capital and knowledge required for their exploitation is not in the hands of single surface owners. Subsoil resources should "belong to the nation, but only in the sense that they cannot be worked without her consent" (p.11).

[16] The three generic types of fiscal regimes are royalty/tax systems, production sharing contracts, and service agreements. Total government take around the world varies from around 40% (e.g. in U.S. Deepwater and the UK) to well over 90% (e.g. in Iran's first buyback round and for some blocks in Libya's 2005 auction) (Johnston 2007).

[17] Aharoni (1986) suggests three key characteristics of a state-owned enterprises (SOEs): they are owned (or majority controlled) by the government; they are engaged in the production of goods and services for sale; and their sales revenues should bear some relationship to costs. Public bureaus, on the other hand, are "nonprofit organizations which are financed, at least in part, by periodic appropriation or grant" (Niskanen 1971, p.15).

[18] Where a significant part of the asset base of the NOC is privatised without an official recognition of such policy, this might be referred to as "back-door" privatisation (Al-Mazeedi 1998).

intensive[19], have long lead times and are inherently risky (Stevens 2005). Particularly in the upstream, oil companies are usually partnering each other to diversify risk and financing requirements, and to complement each others skills set.[20] Within a maturing industry, the incentives for risk-sharing might become even stronger. Although there is no danger of running out of hydrocarbons in the foreseeable future (Lynch 2004; Greene et al. 2006; Watkins 2006), the majority of the traditional onshore and shallow-water offshore fields is depleting and new developments, such as deep-water offshore or remote areas with challenging climate and no existing infrastructure links, will become more technically complex and increasingly costly. Relationships between NOCs and IOCs have often been rocky, and some of these issues can undoubtedly be traced back to the nationalisation disputes of the 1970s. In more recent years, even where OPEC NOCs offered to open up upstream projects to foreign participation (e.g. Saudi Gas Initiative), the IOCs have frequently declined on the basis of unsatisfactory returns.[21] Given the challenges ahead, however, an increased degree of cooperation might not just be desirable, but plain necessary (Marcel 2006).

4 The dataset – industry trends, 1987-2006

As the data source for much of this cross-sectional analysis on ownership differentials I use an annual ranking of the world's largest oil and gas companies, which is published annually as a supplement to the 'Petroleum Intelligence Weekly' (PIW). In this section I will briefly introduce this data source and discuss its key advantages vis-à-vis other available rankings. Thereafter, some descriptive statistics will be used for a first characterisation of the data content, yielding a fresh perspective onto the changing structure of the oil and gas industry over the past two decades.

[19] A 2003 estimate of capital expenditure for the 50 largest global oil and gas upstream projects over the coming years was US$210 billion, i.e. in excess of US$4 billion per project (Goldman Sachs 2003), but given recent and very prominent cases of substantial cost overruns (e.g. Kashagan, Snoehvit, Sakhalin, Bonga, etc.) the ultimate costs of these projects are likely to be much higher.

[20] Technical expertise and project control are skills that are usually ascribed to IOCs, but NOCs can add value through local and regional market knowledge, political connections, help in accessing required infrastructure, as well as with making the projects more palatable to the domestic public.

[21] With no suitable reinvestment opportunities at hand, IOCs have increasingly returned excess cash to shareholders, a marked difference to the time before the mid-1980s, when IOCs first introduced shareholder value-based management (Cibin and Grant 1996; Stevens 2005).

4.1 The PIW ranking of oil and gas companies

Each year PIW collects operational and financial data on over 130 oil and gas firms worldwide. The six operational data categories are oil reserves, gas reserves, oil production, gas production, refinery capacity, and oil product sales volumes. Where available there is also information on the firms' revenues, net income, balance sheet assets, number of employees, and the level of state ownership. The final ranking then features the 50 companies that are top in the equal-weighted sum of the six operational rankings.[22] It is usually published in December, based on the disclosed information of the previous calendar year. The first ranking dates from 1988 (based on 1987 data), so that the December 2007 issue represents the 20th edition.

PIW collects its data primarily from company sources and annual reports, but in some cases secondary sources or estimates are used to fill disclosure gaps. In practice, data on the six operational criteria is provided consistently for all companies in the sample, whereas for the more secretive state-owned firms (such as Saudi Aramco or NIOC in Iran) the financial indicators are frequently lacking, owing to the lack of disclosure and the bigger uncertainties of estimation for these metrics. Data on reserves, output and refining capacity are adjusted to exclude equity shares owned by other companies, and revenues, net income, and total balance sheet assets are converted to U.S. Dollars at the average exchange rates of each year.

The key advantage of the PIW dataset over other, more financially oriented rankings is the inclusion of – and focus on – operational data. First, operational data is largely independent of the unavoidable accounting differences between countries.[23] Second, financial results are often impacted by local price premia/discounts (based on transport differentials, different physical qualities of the hydrocarbons, etc.), subsidies and other price distortions, all of which are very difficult to control for. And thirdly, the focus on operational data allows it to include in the sample some of the most important NOCs globally, for which only such data (or estimates) are available. In short, the combination of operational and financial data allows a more comprehensive and meaningful analysis of the global oil and gas sector than would be possible based on financial metrics alone.

[22] The ranking in PIW comprises the Top 50 companies. PIW's publisher, Energy Intelligence Group, also issue a separate publication with an annual ranking of the Top 100 companies in the industry, but this is not available for the full twenty years.

[23] This is certainly true for financial accounting. We will see that there can be serious issues associated with the oil and gas reserves accounting, too.

Whereas most other publications (such as the BP Statistical Review of World Energy) are usually compiled on a country-by country basis, the PIW data provides a corporate perspective on the industry's development over the past two decades. Whilst in a few instances – namely NOCs with monopoly position in the domestic market and no international asset exposure – the two perspectives are identical, more often than not there are differences: the more subtle ones come in the form of NOCs increasingly acquiring international assets, or through the gradual opening of formerly protected markets to outside participation; the more substantial differences are due to the global operating presence of the IOCs, with a majority of assets usually based outside their respective home countries. Any differences between country and company perspective can be very relevant from a policy perspective.

The original PIW data as described above has been checked for internal consistency across different years and, where necessary, adjusted using primary data sources.[24] It has also been supplemented by a number of items. In order to take full advantage of the available information, all companies and their home countries are given unique identifiers over time.[25] The exact percentage of state (voting) ownership has been added where this was not already part of the original dataset, and all entries have been grouped according to four distinct ownership types:

- 'Own-1': fully state-owned NOCs, i.e. public ownership of no less than 100%;
- 'Own-2': majority state-owned companies, i.e. public voting ownership in excess of 50%[26];
- 'Own-3': minority state-owned companies, i.e. state ownership greater than zero but below the 50% mark; and
- 'Own-4': fully private companies with no state ownership whatsoever.

Further additional variables are the IMF's annual Consumer Price Indices; deflated (real-terms) financial indicators, calculated from the nominal PIW values and

[24] Where data was found to be inconsistent but no alternative data source was available, the entries were usually deleted. For employment, data extrapolations for single years were made when data for the periods immediately before and after was available. For Russian companies other than Gazprom, changes were made to early estimates of gas reserves in order to align them with reported data from later years. A full list of changes is available upon request.

[25] In the case of acquisitions (or mergers) only the identifier of the surviving company (or of the higher-ranked company in the year prior to the merger) is carried forward for the combined entity.

[26] Brazil, for example, has reduced its economic ownership in to below 50% in 2000, but retains a voting majority stake. Also, due to the peculiar voting and share transfer stipulations put in place at the privatisation, Gazprom of Russia is considered to have always been under majority state control post 1993, even though the government's share for a number of years had officially dropped to just 38%.

the appropriate CPI deflators; the annual average real-terms crude oil price and global refining margin (average of US Gulf Coast, North-West Europe and Singapore), sourced from the BP Statistical Review of World Energy; a dummy variable for countries with OPEC membership; and finally, annual data on domestic fuel prices (blended value of diesel and super gasoline, in US$ per litre), sourced from the World Bank's World Development Indicators database.[27] The price of transport fuels for the final customer is treated as an inverse proxy for the extent of fuel subsidies (Eller et al. 2007), although this admittedly does not take into account any differences in taxation, which might be just as substantial.

4.2 A corporate view on the industry

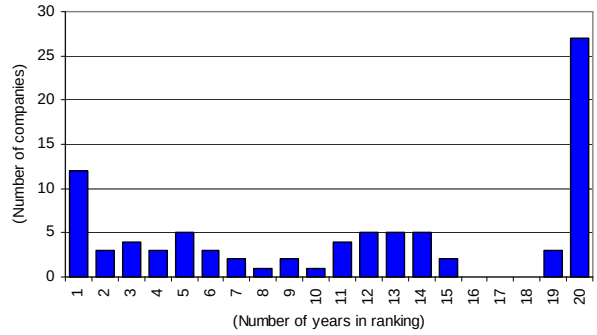
Comparing the aggregate operating output of the 50 oil and gas companies featured in the annual PIW ranking with the total global output as estimated by the BP Statistical Review of World Energy (BP 2007), the coverage of the PIW dataset becomes more comprehensive over time, indicating an ongoing consolidation trend in the industry. Coverage of global oil production increases from 59% in 1987 to 80% in 2006 (73% on average), coverage of global gas production increases from 36% to 69% (58% average), and coverage of global refining capacity increases from 53% to 60% (57% average).

The dataset has a total of 1,001 observations (20 years of 50 observations each, plus in 2003 two firms were tied for the 50th place in the ranking). Of these, 406 observations are of fully state-owned companies, 127 of majority state-owned companies, 67 of minority state-owned companies, and 401 observations are of fully private firms. There is a remarkably stable group of companies that make it into – and frequently to the top of – the rankings year after year. In fact, 27 companies have featured in the Top 50 ranking in every single year over the past two decades.[28] Overall, there are 87 different companies in the dataset, and for 52 of these there are at least 10 years of data, though not necessarily in consecutive years. Comparing the years 1987 and 2006, the number of fully private companies in the Top 50 has remained virtually constant (20 vs. 21), whereas the number of fully state-owned

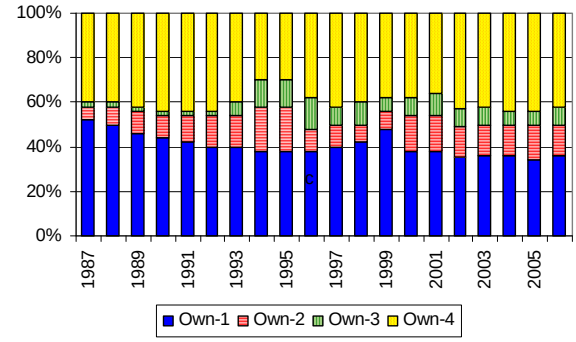
[27] The earliest observations listed in the WDI database are for the year 1991, the last observations date from 2004 (the series were discontinued thereafter). The data is usually reported every two years only, in intermitting years they were assumed to be constant compared to the prior year's observation.
[28] Amongst those 27, there are 15 fully state-owned firms and 8 fully private firms.

companies has dropped from 26 to 18, and the number of 'hybrids' or 'mixed-ownership' companies has increased from 4 to 11.

F-1: Frequency distribution of panel dataset



F-2: Number of companies by ownership type



T-1: Operating statistics of 'typical' companies by ownership type

	O&G reserves		%	O&G production		%	Refining capacity		%
	1987	2006	change	1987	2006	change	1987	2006	change
Own-1:									
- Mean	36,944	76,137	+106%	997	2,602	+161%	489	1,017	+108%
- Median	6,497	36,396	+460%	704	1,827	+160%	456	570	+25%
Own-2:									
- Mean	2,985	24,059	+706%	543	2,519	+364%	648	986	+52%
- Median	3,170	6,819	+115%	589	1,114	+89%	515	325	-37%
Own-3:									
- Mean	1,682	2,794	+66%	404	758	+88%	976	310	-68%
- Median	1,682	1,809	+8%	404	489	+21%	976	265	-73%
Own-4:									
- Mean	3,407	7,187	+111%	910	1,432	+57%	1,172	1,238	+6%
- Median	1,799	4,221	+135%	475	730	+54%	580	347	-40%

Notes:
- Oil and gas reserves are expressed in millions of barrels of oil equivalent, production and refining capacity in thousands of barrels of oil equivalent per day.
- In 1987 there was only one company within the 'Own-3' category.

Of the 87 companies featured in the dataset, 23 have always been under full and exclusive state-control, whereas 35 firms have always belonged to the private sector.[29] 28 firms have seen changes in their ownership structure, i.e. they have been partially or fully privatised.[30] It is also worth pointing out that the large oil and gas companies from the Former Soviet Union (FSU) and China only enter the rankings after they had been properly corporatised. Lukoil is included in the rankings since

[29] Our time horizon for this statement only starts after the wave of asset and corporate nationalisations seen in the 1970s. Clearly some, or even most, of the assets that make up today's largest NOCs once "belonged" to the private, Western oil companies.
[30] Of those 28 privatised companies, 10 are based in the Former Soviet Union, and 3 are based in the P.R. of China. One company in the sample, PDO of Oman, has since its inception been under part-state, part-private ownership, without any substantive changes in recent years.

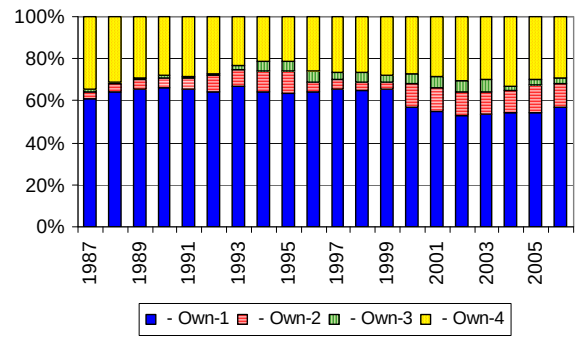
1992, Gazprom and CNPC (the unlisted parent company of PetroChina) since 1993, most other Russian companies since 1994, and Sinopec (again the unlisted parent company) since 1998.

Figures 3 to 5 show the relative contribution of the companies to total oil production, gas production and refining capacity, when grouped according to their ownership status as defined earlier. On the oil side of the industry, the majority of the upstream production remains in fully state-owned hands, whereas refining traditionally has been dominated by the private sector – but this primacy is gradually fading due to asset restructurings by the IOCs and continued efforts to improve downstream integration by some large NOCs. The relative weights in gas production shifted dramatically in 1993 with the inclusion of part-privatised Gazprom in the rankings. All three charts bear witness to the increasing importance of mixed-ownership companies within the industry, even when disregarding Gazprom.

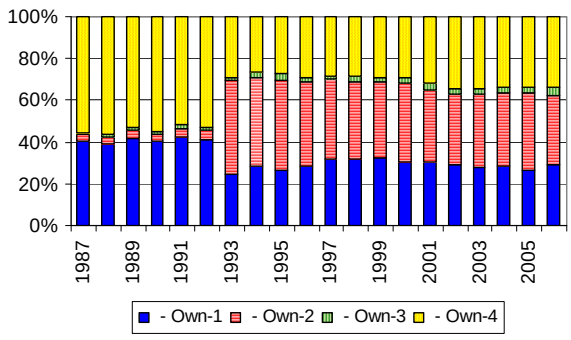
Figure 6 and 7 plot the evolution of state ownership in the upstream and downstream segments, respectively. For each company the exact percentage of state ownership is weighted by that company's relative contribution to the total output in each year, so that an industry-wide indicator of state ownership can be calculated. In 2006, the overall state ownership of oil reserves was 89%, for gas reserves it was 82%, for oil production 64%, for gas production 48%, for refining capacity 43%, and for oil product marketing 36%. A closer inspection of the development over time provides empirical support to some widely held perceptions of the industry's development: since the early 1990s, after the fall of the communism, state ownership in both oil reserves and production was steadily reduced. But these trends have been reversed since 2002, when rising commodity prices, the resurgence of economic nationalism and increased OPEC production all contributed – once again – to a stronger role of the state in the oil markets.

For gas the picture is slightly different: since the mid-1990s (after the part-privatisation of Gazprom) the NOCs' share in gas reserves has risen gradually as these companies now make an increased effort to find and to possibly exploit an increasingly valuable resource. The state ownership of the growing overall gas production has remained quite constant over the same period of time. In line with these observations, for the fully state-owned companies (ownership category 1) the share of oil within their total hydrocarbon reserves and production has been declining, as can be seen in Figure 8.

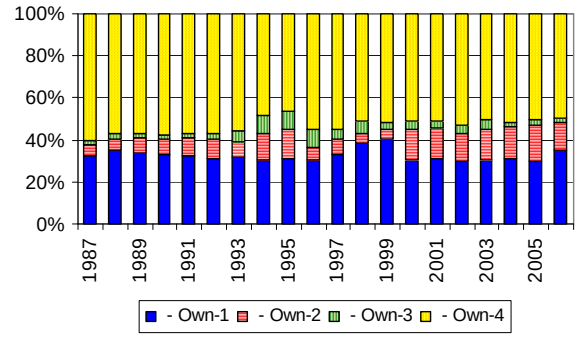
F-3: Oil production by ownership type



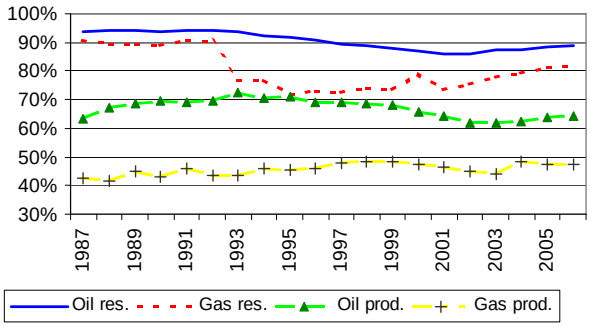
F-4: Gas production by ownership type



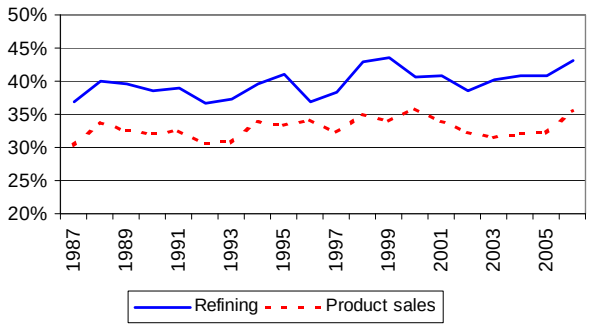
F-5: Refining capacity by ownership type



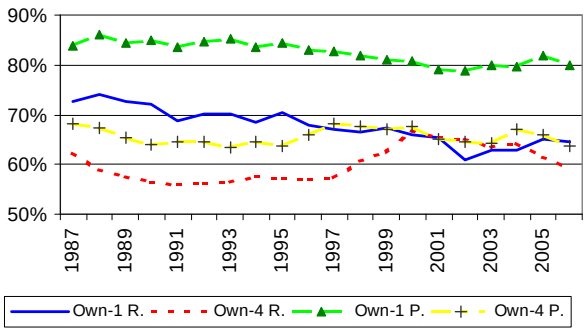
F-6: Weighted state ownership – Upstream



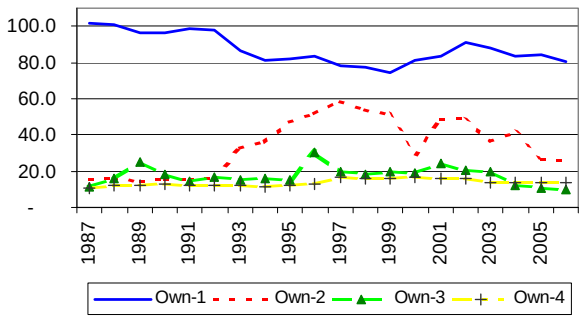
F-7: Weighted state ownership – Downstream



F-8: % Oil in reserves (R.) and production (P.)



F-9: R/P ratio (years) by ownership type



F-10: Upstream (oil prod.-to-refining) and downstream (ref.-to-sales) integration by own.type

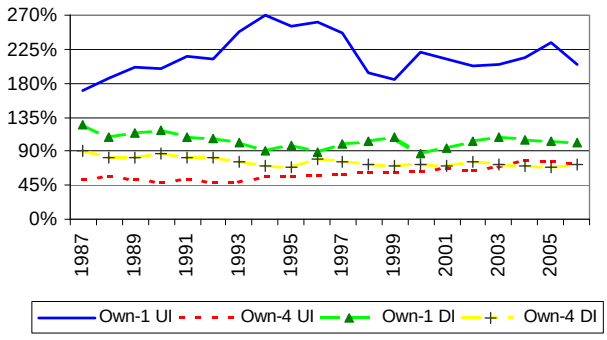


Figure 9 shows the reserves-to-production ('R/P') ratio for each ownership type, indicating the number of years that a company could continue to produce at current pace, even without finding any additional reserves (an alternative interpretation of the R/P ratio is to see it as an indicator of how successful a company is converting its reserve base into commercial production). For most years the ratio for fully state-owned companies is the largest by far, followed by the majority state-owned firms, the minority state-owned firms, and finally the fully private firms exhibiting the lowest R/P ratio for the majority of years.[31] Another interesting result concerns the change of R/P ratios over time. Whilst the trend of declining ratios probably has several causes, for all but the fully state-owned firms this downward trend seems to begin with – or at least be reinforced by – the oil price crash in 1998. In its wake most private companies cut down their capex budgets and introduced severe economic hurdle rates for the development of new reserves, contributing to the shortfall in new supply coming to the market in recent years. The data confirms this to be true for the fully privately-owned firms, but also highlights that all companies listed on public stock markets (whether fully private, minority or majority state-controlled) seem to have been affected in a similar way.

Looking at the operational integration of the business (Figure 10), the upstream integration ratio (oil production to oil refining) of the fully state-owned firms peaks in the year 1994 and declines thereafter. In 2006 these companies nevertheless produced more than double the amount of crude oil that they were able to refine. For fully private firms, the upstream integration ratio has been steadily climbing (from 53% to 74%) due to an increased focus on E&P as well as refinery consolidation, in order to reduce overcapacities in the market. The downstream integration ratio (refining capacity to oil product sales) for the fully state-owned firms currently is very balanced at 101%, although they were slightly long in refining in the first years of the sample. For the fully private companies the ratio stands at approximately 70%, meaning that their wholesale and retail networks sell not only their own refined products, but purchase additional volumes from third party refiners.

[31] The small number of observations in ownership categories 2 and 3 make these results more susceptible to individual outliers. For Own-2, e.g., the enormous gas reserve base of Gazprom is the most important single factor in determining their high R/P ratio.

T-2: Distribution of global output, based on home country of the producing firm

	Oil production		Gas production		Refining	
	1987	2006	1987	2006	1987	2006
- USA and Canada	25%	13%	42%	17%	43%	24%
- Mexico	7%	6%	1%	2%	4%	3%
- Venezuela	5%	4%	3%	1%	3%	6%
- Brazil	2%	3%	1%	1%	4%	4%
- Saudi Arabia	12%	16%	4%	4%	3%	5%
- Iran	7%	7%	2%	5%	2%	3%
- Iraq	6%	3%	1%	0%	2%	1%
- Kuwait	3%	4%	1%	1%	2%	2%
- UAE and Qatar	3%	4%	2%	3%	1%	1%
- Algeria	3%	3%	7%	4%	1%	1%
- UK and NL	9%	7%	12%	10%	17%	13%
- Norway	0%	2%	0%	2%	0%	1%
- Other Europe	3%	5%	7%	7%	9%	10%
- Russia	-	10%	-	32%	-	7%
- China	-	5%	-	3%	-	11%
- Others	15%	10%	17%	9%	10%	8%
Total	100%	100%	100%	100%	100%	100%

As was stated earlier, there can exist significant differences between a country perspective and a company perspective on the global oil and gas sector, largely because of the global operations of the IOCs. Whilst the ultimate control over the subsoil will always rest with the host governments, it is unquestionable that the identity (in terms of cultural, political and other roots) and possibly even the home governments of multinational corporations can influence decision-making in the industry. Table 2 contrasts the geographic distribution of production and refining output for the years 1987 and 2006, whereas the distribution is based on the home countries of the oil and gas firms involved (not on the countries in which the assets are physically located).

The most fundamental change – and the one that makes all other comparisons less straight forward – is the emergence of Russia and China as home countries to large, corporatised firms. It is obviously debatable whether it makes any practical difference whether a portfolio of assets is administered by a ministry (as was the case for both countries in 1987) or state-controlled corporate headquarters, other than adding another layer of decision-making. But one might argue that in both countries corporatisation has in fact strengthened management's confidence, and limited its inhibitions, to openly and aggressively pursue a domestic agenda in its commercial dealings.

The decline in the relative importance of the U.S. is very marked.[32] Also declined over time has the prominence of the two 'traditional' European oil and gas nations, the UK and NL, whereas Norway and the other European states have been strengthened – privatised NOCs such as Eni, Total, Repsol, which today rank as some of the industry's key players, have been instrumental in this. Another key observation is that the Middle Eastern exporters – with the exception of Iraq – have not only defended their positions despite the new entrants, but have even managed to increase their global weighting in absolute and relative terms. Within this group, Saudi Arabia has clearly been focused on oil, whereas Iran has gained a lot of market share in the global gas markets.

5 Performance and efficiency effects of ownership

The literature review showed that the balance of empirical evidence points to better performance and greater efficiency in the private sector, although a number of caveats apply. Our 20-year dataset on the oil industry allows the investigation of several key aspects of performance: upstream production, reserve management, capital and labour efficiency, revenue generation, and profitability. The hypothesis is that "ownership matters" in favour of Private Oil, i.e. higher efficiency, revenue generation and profitability. I will argue, however, that differences in reserve management are not necessarily a good indicator of relative efficiency, as is implied by Eller et al. (2007) and Victor (2007).

I will first discuss the issue of comparability between different oil companies, specifically between state-owned and privately-owned firms. This will be followed by a simple ratio analysis by ownership type, and finally by a multivariate regression analysis, which allows to control for some of the important structural differences between firms.

[32] Canada's contribution to the North American aggregate is very small.

5.1 Apples and apples: addressing issues of comparability

When benchmarking performance and efficiency of firms, one needs to ensure that the objects of comparison are indeed comparable. Whilst this problem applies to any industry and also to private-vs-private benchmarking, the lack of disclosure at many NOCs makes it particularly difficult to control for relevant exogenous factors in a state-vs-private setting. Some of the key issues on which firms might fundamentally differ are:

Non-commercial objectives. Critics argue that the use of standard performance measures, and profitability in particular, yields distorted results, because most SOEs pursue objectives other than profit maximisation (Bozec et al. 2006). For companies operating in competitive markets, however, Boardman and Vining (1989) maintain that if such posited social benefits are *internal* to the firm (e.g. in the form of excess employment), they can only be achieved at a deadweight loss of social welfare; and if the benefits are *external* to the firm (e.g. provision of social infrastructure), then profitability comparisons can at least reveal the shadow prices of these commitments. Because the oil and gas industry is not a natural monopoly and can very easily be run under competitive conditions, the author sides with the latter view. Nevertheless, a number of countries grant monopoly status to their NOCs (often seen as a compensation for non-commercial obligations), which can have material consequences in the form of market power and excess monopoly profits.

Underlying asset quality. Resource endowments are a powerful determinant of performance of any natural resources industry. Availability of hydrocarbons, ease of access, availability of supply/evacuation infrastructure, flow rates and production costs vary greatly between and within individual countries.[33] Many of the most important NOCs are monopoly players blessed with a favourable resource endowment. But even where NOCs and private firms today compete within a country, the state firms have often (historically or by law) preferential access to the most attractive assets, whether upstream fields, refinery plant locations, or retail networks. But not all aspects of asset quality are exogenously prescribed by geology or geography – the impact of investment, technology and management is not to be

[33] CSFB (2002) reports that there are about 500,000 producing wells in the U.S. with an average production of 14 barrels per day, whereas in the Middle East the average production per well is almost 4,000 barrels per day.

underestimated. Distinguishing one from the other is critical in reaching a final judgement on managerial performance.

Oil and gas reserves data. A number of important issues arise in the interpretation of oil and gas reserve estimates.[34] First, there might be differences in the legal framework of reserve entitlement. Private oil companies usually bid for individual licences, covering areas which they intend to explore and develop in the near future. Only reserves associated with these licences can be "booked" as equity oil reserves. NOCs with monopoly powers, on the other hand, sometimes enjoy full entitlement to all reserves within a given country or region. Second, there is no uniform global approach to the estimation and certification of oil and gas reserves. Whilst there are established guidelines available[35], these usually differ in important aspects.[36] Many NOCs do not follow any of these recognised standards (or do not disclose which one they use), and even some of the large private IOCs follow the guidelines but fail to employ outside reserve auditors to verify their internal assessment.[37] Third, due to the lack of a universally enforced standard, reserves data might be manipulated on political or other grounds. As an example, Kuwait experienced a gradual decline in its reserve base from 1980-84, but in 1985 the country reported a 50 percent increase in reserves with no corresponding discovery, which was apparently linked to OPEC's decision to base its production quota system on country reserves (Campbell 1997).[38] Fourth, even where reserves are properly reported, different policies on reserve management can make comparisons difficult. The development of resources into reserves usually requires upfront investment, which a private sector company might not be willing to incur several years before the actual production phase.[39] Given the

[34] By industry convention, *reserves* are quantities which are anticipated to be commercially recoverable from known accumulations, whereas *resources* are quantities estimated to be potentially recoverable but which are either undiscovered or not currently considered to be commercially recoverable.
[35] Most widely used are the SPE (Society of Petroleum Engineers) and the U.S. SEC classifications, but others include e.g. the 'ABC' reserve system of the Former Soviet Union or Canada's NI 51-101.
[36] SPE and SEC are broadly similar, but SEC requires existing prices to determine the commercial viability of reserves (SPE allows an averaging period), does not allow proved reserves below the 'lowest known hydrocarbons' point, etc. Both SPE and SEC differ markedly from the Russian classification, which is only interested in the physical presence of reserves. Furthermore, there are different reserve categories under each system (e.g. proven, probable and possible reserves).
[37] Two examples should emphasise the magnitude of these issues: Mexican NOC Pemex reduced its proven reserve estimate from 60 billion barrels in 1997 to 22 billion in 2002 (-64%), mainly as a result of independent reserve audits according to SEC definition. Royal Dutch/Shell in January 2004 had to reduce its estimate for proven reserves by 20% following an external audit.
[38] For similar reasons, Campbell argues, did significant reserve increases take place in Abu Dubai, Dubai, Iran and Iraq in 1988, and Saudi Arabia in 1990.
[39] A quote from Sibneft (2004, p.6), at the time one of the few private oil companies to have access to a more than sufficient resource base: "Sibneft does not have a policy of maintaining an unnecessarily

pressures from equity analysts and investors, however, private companies often have a strong incentive to show a small but steady reserve growth. For a nation state, on the other hand, maximising the domestic reserve base as a signalling tool or even as a policy instrument might well be an appropriate choice, as would indeed be the option to deliberately *delay* the development of the resource base as a hedge against inflation, a bet for higher commodity prices, or an insurance policy for future generations.

Operational profile. The various sub-segments of the oil and gas industry (upstream production of oil and gas, refining of oil, wholesale and retail of oil products, petrochemicals production, natural gas sales) have very different characteristics in terms of capital and personnel requirements, price volatility, competitive pressures, and ultimately profitability. Between 1996 and 2002, the return on capital employed in the upstream was on average 17.0%, whereas the comparable return for refining and marketing was 10.2% (UBS 2004).

Taxation. It was shown earlier that the total government take from upstream taxation varies between 40% and 90% across the world (Johnston 2007), leading to great differences in the companies' tax exposure. Furthermore, whilst some countries tax their NOCs consistently in line with other industry participants, others apply different and often intransparent sets of rules, and it largely depends on the individual country – and the power balance between government and NOC – whether such 'special' NOC taxation is particularly lenient or particularly harsh.[40] The picture might be further complicated by monetary transfers between NOC and the government to account for social provision, fuel subsidies, etc.

Non-commercial objectives, the underlying asset quality, quality of reserves data, operational profile and taxation are thus important firm-specific features to consider in a direct comparison of oil companies. Unfortunately, reliable and comprehensive data is largely unavailable, except for the vertical integration ratios described earlier to measure the business mix. Three different approaches are taken in this paper to account for these important variables. First, some of the observed variables included in the regression specification can also be interpreted as proxy variables for other,

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long reserve life. We plan to maintain the current level of reserves, but to decrease reserve life to 15 – 20 years by increasing crude oil production."

[40] As an example, over the period 1997-2001, the tax on Mexican NOC Pemex was an astonishing 49% of total revenues (Moody's 2003). Since Pemex is a state monopoly there is no corresponding figure for the private sector in Mexico, but in the international context this is very "taxing" indeed.

unobserved factors: OPEC membership can be seen to indicate the political nature of state involvement, the quality of underlying upstream assets, and possibly the credibility of reserve estimates; retail fuel prices are an indication of fuel subsidies and thus of non-commercial obligations, which can also be suggested by high labour intensity ratios. Second, and more importantly, all of the five factors set out above are firm-specific but rarely change over time. Using a within (fixed-effects) panel estimator allows to control for all such unobserved but time-invariant variables (see Section 5.3), which is a very substantial advantage of this dataset over "simple" cross-sectional analyses. Third, the quantitative regression results from the observed variables can also be used to infer the boundary conditions of the unobserved variables, i.e. to identify the conditions under which the reported results hold true.[41]

5.2 Ratio analysis

Shown below are the long-term average performance and efficiency ratios for capital and labour efficiency, profitability, and revenue and income generation by ownership type of the firm. Upstream production and reserves management (measured by the ratio of production over reserves, i.e. the inverse of the R/P ratio) have been reported earlier in this paper.

Based on the unadjusted ratios fully state-owned NOCs (Group 1) generate more physical output per employee and per US$ of invested capital than private IOCs (Group 4). It is plausible to assume, though, that the operational profile – with an average upstream integration ratio of 217% for NOCs vs. 60% for IOCs – has some leverage on this result. The business mix might also impacts on the ratio of employment to real assets, a measure of labour intensity, and the profitability metrics. As to the latter, the averages mask a remarkable change over time – up to the year 1997, the NOCs outperform the other three groups on both profitability measures, but in the period since the oil price crash 1998 they have actually been the *least* profitable. Possible explanations include the value-based restructuring at IOCs after the 1998 oil price crash, which included a focus on profitability and the rejection or

[41] For example, how much do taxes need to differ for the different groups of companies to be equally profitable? If there is more than one unobserved variable, these results are unlikely to be exact and unbiased, but provide an instructive approximation of the magnitude of the differences.

closure of low-threshold projects[42], the efforts of IOCs to strengthen their upstream portfolio relative to refining and petrochemicals (which is reflected in the business integration ratios over time), and the much improved returns on refining and marketing since 2001.

T-3: Long-term averages (1988-2006) of selected performance ratios

	Capital and labour efficiency				Profitability	
	Output / employee (kboe)	Output / real assets (kboe/US$m)	Employees / real assets (US$m)		Return on sales (%)	Return on assets (%)
Own-1	42.0	84.6	1.95		11.2%	7.3%
Own-2	25.5	61.5	2.47		8.6%	7.3%
Own-3	27.8	58.4	2.04		7.4%	6.2%
Own-4	37.9	58.5	1.29		7.8%	6.3%
5 NOCs	*68.8*	*90.8*	*1.33*		*8.8%*	*6.7%*
5 IOCs	*51.5*	*64.5*	*1.35*		*5.2%*	*4.1%*

	Revenue and income generation					
	Real revenue / employee (US$m)	Real income / employee (US$ '000s)	Real revenue / reserves (US$/boe)	Real income / reserves (US$/boe)	Real revenue / output (US$/boe)	Real income / output (US$/boe)
Own-1	0.44	45.7	1.3	0.10	12.2	1.30
Own-2	0.37	27.0	4.5	0.28	15.9	1.45
Own-3	0.50	40.5	5.9	0.34	19.6	1.41
Own-4	0.80	64.4	7.3	0.30	23.2	1.65
5 NOCs	*0.77*	*67.9*	*0.3*	*0.03*	*10.4*	*1.03*
5 IOCs	*1.36*	*80.3*	*7.5*	*0.44*	*23.9*	*1.41*

Notes:
- Output is defined as the sum of oil and gas production, refining capacity and oil product sales.
- Ratios for Own-2 and Own-3 are based on a small number of observations (6.4 and 3.4 on average) and are thus vulnerable to individual outliers.
- Group of "5 NOCs" includes Saudi Aramco, NIOC, KPC, Sonatrach and PdVSA. Group of "5 IOCs" includes ExxonMobil, BP, RD/Shell, Chevron and ConocoPhillips. Only years with data for 3+ companies of either group are included in calculation

Revenue generation per employee, per unit of output, and per unit of hydrocarbon reserves[43] is significantly larger for the private sector, but this is unsurprising given its relative focus on higher-value downstream products. Moving from revenue generation to profit generation, the lower long-term average profitability of the private sector leads to a narrowing of the gap between NOCs and IOCs.

Table 3 also shows the values for two company sub-samples: five of the largest fully state-owned NOCs (Saudi Aramco, NIOC, KPC, Sonatrach and PdVSA), and five of the largest private players (ExxonMobil, BP, RD/Shell, Chevron and

[42] IOCs aggressively stress-tested project profitability, i.e. investments had to be NPV-positive at very low oil prices. Projects that survived this degree of scrutiny delivered spectacular returns in the high oil price environment post 2000.
[43] The table includes the ratio of revenues to reserves (as analysed in Eller et al. 2007), but for the detailed econometric analysis to follow this relationship will be de-composed into its two constituent parts of reserve management (production/reserves) and revenue generation (revenues/production).

ConocoPhillips). Unfortunately the largest NOCs tend to be amongst the most secretive, and to avoid the risk of unduly influential outliers only years are included in the calculation, for which at least 3 observations from either group are available. For some metrics, this reduces the sub-samples to 3 observation years over two decades, but even this limited data shows that bigger size is not necessarily correlated with higher profitability, or higher revenues or profits per unit of output.

The univariate analysis thus illustrates the differences between ownership categories, but also the differences within ownership categories. Just as the output per employee ratio of the 'top' IOCs is not representative of the overall private sector, so do important differences exist between NOCs. The gulf between OPEC and non-OPEC firms is particularly striking: across the 20-year sample non-OPEC firms on average have a 2.3 times higher labour intensity ratio (employees/assets) than OPEC firms and their output per employee is only at 36% of the OPEC benchmark.

5.3 Regression analysis

Multivariate regression analysis is able to identify the determinants of selected measures of corporate performance and efficiency, and to quantify the impact of ownership whilst controlling for other key variables. Because the dataset has a panel structure, a number of different estimators can be used: the total estimator, the between estimator, the within estimator, and the random-effects estimator. Following Petersen (2004), these different models can be interpreted as "different ways of describing the data, each yielding relevant insight in its own right" (p.334). The following analysis will focus on the total and within estimators. The between estimator makes comparisons between individuals in their average outcomes, but in the PIW dataset the time-distribution and frequency of observations varies between firms, which in a volatile pricing environment can lead to estimation bias. Random-effects models are superior to within estimator in that they can measure both time-variant and time-constant variables[44], and are more efficient in using the available information, but make the strong assumption that the unmeasured time-constant variables are independent of the measured variables (Wooldridge 2002). Hausman tests have been conducted on all of the models described in the following, indicating a violation of this assumption and warranting the fixed-effects specification instead.

[44] Fixed-effects models cannot interpret time-invariant (or very slowly moving) variables.

$$y_{it} = \alpha + \beta' x_{it} + \varepsilon_{it} \quad (1)$$

The specification in (1) is the total estimator (or pooled or ordinary least squares estimator), where x_{it} is a K-dimensional vector of explanatory variables and α is a non-unit-specific intercept. It ignores the grouped nature of the data and therefore roughly corresponds to the estimator obtained in standard cross-sectional analysis, except that individual firms may contribute with more than one observation (Petersen 2004). In the context of this paper the total estimator yields the performance differential between companies of different ownership structure, controlling for a given set of other independent variables. There is no inherent bias in the results *relative to this question* posed, but the estimated effect of ownership might still in part reflect other, unobserved variables.

$$y_{it} = \alpha + \delta_i D_i + \beta' x_{it} + \varepsilon_{it} \quad (2)$$

The within estimator (or fixed effects or least squares dummy variable (LSDV) estimator) as set out in (2) recognises the group structure of the data and includes a firm-specific dummy variable D_i, which changes the intercept for each company to capture all (observed and unobserved) time-invariant variables. It therefore controls for a broader range of variables. Importantly, it estimates the within-individual changes over time, i.e. the effect of a *change* in ownership on performance and efficiency, rather than the total difference between two types of ownership status. In fact, the within estimator *needs* changes in ownership to estimate this variable because ownership otherwise would be an additional time-invariant factor included in the unit-specific intercept. One might therefore consider a trade-off between the total estimator, which uses all cross-sectional information on ownership but cannot account for unobserved variables, and the within estimator, which controls for all time-invariant variables but cannot use observations with no within-individual variation over time, and therefore uses the data much less efficiently (Beck 2001; Wilson and Butler 2007). Each different estimators conveys useful information on its own, but

any arising differences between them can often also be rationalised and thus contribute to a fuller understanding of the subject matter.[45]

Except for upstream production, the performance and efficiency metrics tested in the following are ratios. To estimate the impact of state ownership on these performance ratios, there are two alternative model specifications. First, the ratio itself can be used as the dependent variable, regressed upon a variable for state ownership and a set of control variables – the "direct ratio model". Alternatively, the output variable (the numerator of the ratio) can be regressed on the input variable (the denominator), an interaction variable of state ownership and this input variable, plus a set of control variables as before – the "numerator model". Both specifications are likely to provide *different* results, but ideally they should be *consistent* regarding the impact of state ownership. In addition to state ownership, I also include a dummy variable for OPEC membership and another dummy variable for state majority control, but the latter one did not prove significant over and above the percentage of state ownership.

For the choice of control variables, the industry literature provides some guidance on relevant variables (e.g. firms size, operational profile, oil prices), but not usually on their hypothesised functional form. In some cases interaction variables could be relevant: given the economies of scale available in the industry it is plausible to hypothesise, for example, that efficiency metrics are not only impacted by company size and operational profile respectively, but that any particular operational focus might be more valuable for bigger companies. A range of possible control variables is therefore available. Given the lack of previous multivariate studies on the performance impact of ownership in oil and gas, my main criteria for model selection are goodness of fit and, other things being equal, parsimony. In practice, I start with a deliberately wide choice of plausible control variables (plus state ownership and OPEC) to minimise the risk of omitted variables and then gradually eliminate, separately for each performance metric, any non-significant variables (Baum 2006).[46]

[45] If, for example, the total estimator indicates a performance differential of x between state firms and private firms, but a change in ownership results in within-differences of $2x$, then it is plausible that time-invariant factors unobserved in the cross-sectional model play an important role.

[46] This approach is usually known as general-to-specific modelling (Hendry 1993). The empirical analysis starts with a general statistical model that captures the essential characteristics of the underlying dataset. Then, "that general model is reduced in complexity by eliminating statistically insignificant variables, checking the validity of the reductions at every stage to ensure congruence of the finally selected model" (Campos et al. 2005, p.3).

5.3.1 Upstream production and reserves management

Upstream production is a popular choice for benchmarking analysis due to its economic importance and the (relative) homogeneity of the output product. Closely related to upstream production is the question of reserves management, measured by the production rate of reserves[47], which indicates the relative pace with which companies (and/or nation states) chose to produce their existing reserve bases. This rate is a relevant metric for a number of reasons, but *not necessarily* an indicator of productivity or even efficiency – these could only be measured for reservoirs that are being produced rather than being available for production.

Table 4 shows the impact of ownership on combined oil and gas production, controlling for firm size, operational profile and oil price environment. Hydrocarbon reserves are confirmed as the fundamental driver of upstream production with a coefficient (elasticity) of 0.66 in the pooled OLS model. When estimating oil reserves and gas reserves separately, both are significant, but in line with the greater share of oil production the elasticity for oil reserves is about 50% higher than for gas reserves.[48]

T-4: Regression results for (log of) oil and gas production

	Total estimator		**Within estimator**	
	Coeff.	*t-test*	*Coeff.*	*t-test*
lgResOilGas	0.6638	22.42 ***	0.4087	6.80 ***
State%*lgRes	-0.0370	-7.37 ***	-0.0682	-6.53 ***
OPEC*lgRes	-0.0386	-4.67 ***	-0.1833	-1.28
lgAssets	0.2499	8.20 ***	0.3704	8.55 ***
Up-Int	0.1612	2.10 **	0.5574	2.37 **
lag_lgOil	-0.0983	-1.98 **	-0.0672	-1.49
N	645		645	
F-test	961.5		138.1	
R-sq (total)	0.90			
R-sq (within)			0.76	

Notes:
- Dependent variable is the logarithm of annual oil and gas production (in mmboe). 'lgResOilGas' is the logarithm of oil and gas reserves (in mmboe), 'State%*lgRes' and 'OPEC*lgRes' are interaction variables between state ownership (%) / OPEC membership (DV) and reserves, 'lgAssets' is the logarithm of total assets in real terms, 'Up-Int' is the ratio of upstream production to the sum of upstream production and refining capacity, 'lag_lgOil' is the lagged logarithm of oil price in real terms. Constant regression term not reported.
- Total estimator calculated with robust standard errors (HC3) as suggested in Long and Ervin (2000). Within estimator calculated with cluster-robust standard errors, with individual companies as clusters.
- F-test for within estimator is for joint significance of listed variables, excluding fixed unit effects.
- * / ** / *** : Significant at the 10-percent / 5-percent / 1-percent level, respectively.

[47] The production rate, or reserves-production conversion rate, is the reciprocal value of the R/P-ratio.
[48] All regression results not included in table format within this paper are available upon request.

The impact of state ownership and OPEC membership are best captured through their interaction with oil and gas reserves – both reduce the reserves-elasticity of production by approximately four percentage points, with OPEC membership being incremental to the fact that OPEC NOCs are 100% state-owned. All three control variables are significant in explaining cross-sectional differences in upstream production, although the negative sign of the oil price variable might be surprising.[49]

Table 4 is based on the combined output of oil and gas. In separate regressions to explain the production of oil, oil reserves are significantly positive, but the coefficient of gas reserves is negative at 10% significance. For the production of gas, gas reserves are significantly positive and oil reserves are negative (at 5% significance). State ownership and OPEC membership are significant for both production regressions, but for oil the more important parameter is OPEC membership, whereas for gas it is state ownership – OPEC is an *oil* cartel after all.

Comparing the results of the total and within estimators, the reserves coefficient is noticeably higher in the first model, implying that reserve levels are more important to determine production differences between companies than changes within companies over time. The impact of ownership, on the other hand, is much more "severe" in the fixed effects model, i.e. changes in ownership affect the production rate at almost double the rate implied by cross-sectional ownership differences.[50] Differences in the size ('lgAssets') and composition ('Up-Int') of the asset base also have a greater bearing on changes within companies, suggesting the presence of unobserved variables which cause variations in asset productivity between companies – differences in the underlying asset quality are the most plausible explanation.

The lower production rate of state-owned producers might be caused by a more conservative policy on reserve management[51], by a systematic overstatement of

[49] One possible explanation: high oil prices are an incentive to raise production levels, but technically this is very difficult, and rarely any firm (other than Saudi Aramco) has short-term spare production capacity. Plus certain licensing agreements (e.g. PSCs) stipulate higher royalty oil payments in times of high prices, reducing the production entitlement of firms.

[50] The within estimator of the OPEC variable is non-significant, because OPEC status does not change over time. Furthermore, for most OPEC producers (e.g. Saudi Aramco, NIOC or Adnoc) there is no data available on their total assets, so they are excluded from the full specification regression reported in Table 4. Most of these OPEC companies have actually grown production well beyond the growth in reserves over the past two decades, so their reserve elasticity of production has been greater than one.

[51] Mommer (2002) contrasts the liberal "non-proprietorial" governance approach (where the state merely acts as administer of the natural goods vis-à-vis the producers, and licenses are granted as soon as it is deemed economically viable to explore and produce) with the proprietorial governance of the major exporting countries (where the state acts like a private landlord, weighting off private profits, fiscal revenues and longer-term production strategy).

reserves, or by a combination of both. The above result of a greater impact of ownership change than of absolute ownership differences supports the notion that policies on reserve management are changed when ownership changes, e.g. in the context of a formal privatisation. Assuming that there is *no* overstatement of reserves, the impact of ownership on upstream production is quite substantial. Taking the results from the total estimator, and assuming a real-terms oil price of US$50 per barrel and median sample values for the other variables, a fully private firm is predicted to produce 297 million barrels per year from a reserve base of 4.4 billion barrels (6.8% production rate), whereas a fully state-owned NOC should produce 218 million barrels from the same reserve base (27% less, 5.0% production rate) and an OPEC NOC only 158 million barrels (47% less, 3.6% production rate).[52] Dropping the asset variable from the specification increases the risk of omitted variable bias, but gives an indication of production rates for the full sample including all OPEC producers (997 observations): private producers remain at 6.8% vs. fully state-owned NOCs at 4.1% and OPEC NOCs at 2.4% production rate. The differences implied by the within estimator are more dramatic still.

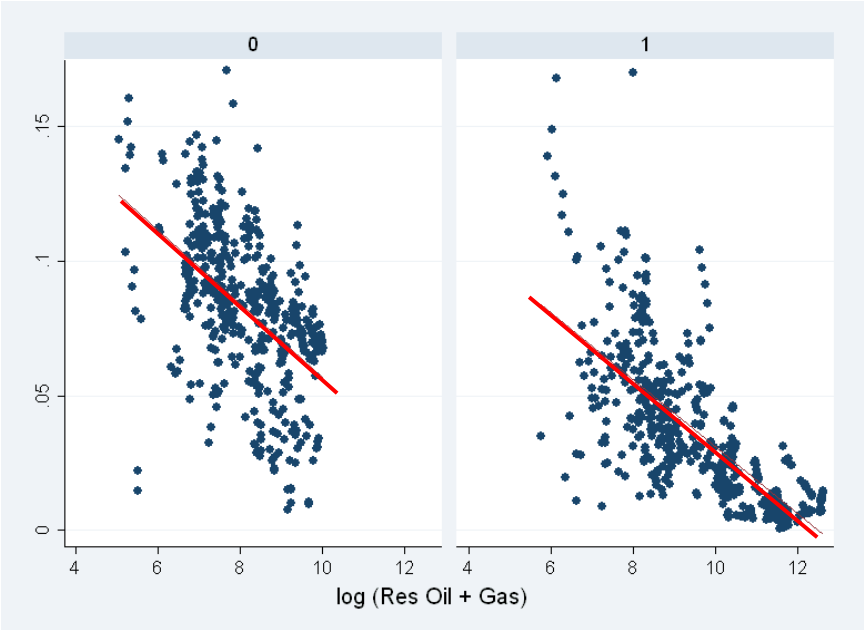
If NOC reserves were systematically overstated, the true NOC production rates would be higher and the differences in reserve management between private and state-owned firms less pronounced. But unless *all* of the differences can be explained by reserves overstatement, NOCs are still managing their reserves more conservatively. This might be based on *rational* reasoning and policies, some of which were briefly touched upon in Section 5.1. The planning horizon for nation states differs from that of private oil companies, which – based on painful experiences – are never fully assured of their long-term property rights, with obvious consequences for the two groups' respective incentives. Considerations of global supply and associated prices have always been explicit target variables for OPEC members. High current oil prices, due in part to the rising cost of production, reward (with hindsight) every producer that restrained the production of "cheap" hydrocarbons in the past. Other than by rational policies, a conservative reserve management can of course also be explained by technical or managerial deficiencies. Lack of capital, infrastructure, trained personnel, project expertise, etc. are factors not unheard of in the context of NOCs (see Appendix A). But because conservative reserve management can be a deliberate

[52] Due to the constant and the logarithmic form this result will differ for other assumed values.

choice, and because the welfare consequences associated with it might well be positive, Victor's (2007) terminology of "dead oil" in the hands of NOCs is somewhat misleading.[53] In light of the climate change discussion, another issue to be considered in this context is the trade-off between accelerated production and environmental impact.

Irrespective of ownership, the production rate is empirically also linked to the level of reserves: private and public companies with larger reserve bases tend to produce a lower proportion of these reserves (see Figure 11).[54] Possible explanations include a greater degree of market power, diseconomies of scale in project management, and again the overstatement of reserve numbers.

F-11: Linear fit of production rate on logarithm of reserve base (by ownership control)



Notes:
Left graph: privately-controlled companies (N=468); right graph: state-controlled companies (N=533).
Both graphs include observations over the period 1987 to 2006.

[53] What obviously should be questioned, even where deferred production is justifiable on welfare grounds, is whether any form of reserve management can be efficiently implemented at the corporate level, or whether this should rather be within a transparent licensing regime.

[54] This relationship holds true for state-controlled firms in 20 out of 20 years, and for privately controlled firms in 19 out of 20 years. I do not report formal regression results on the production rate, because endogeneity tests indicate the need for IV/GMM, but none of the available instruments are orthogonal to the error process.

5.3.2 Capital and labour efficiency

Moving beyond the upstream to a corporate perspective, the ratios of employees over assets (indicating labour intensity), total output over assets (indicating capital efficiency) and total output over employees (indicating labour efficiency) will be discussed next – the third metric being the mathematic product of the first two.

As shown in Tables 5 and 6, controlling for operational business mix, oil prices and reserves, state ownership increases the elasticity of employment to changes in the asset base, i.e. state companies tend to have a greater workforce in order to manage a comparable asset base. For the median sample values and a real terms oil price of US$50 per barrel, the two regressions predict the employee/asset ratio of a non-OPEC fully state-owned firm to be between 23% and 71% above that of a private company. OPEC producers are significantly less labour-intensive then private companies, which shows that not all NOCs are alike, but the OPEC coefficient is based on less than 50 observations, with only 5 member countries contributing more than 5 observations each. The within estimators (not reported here) strongly confirm the significance of ownership for the numerator model, but fail to do so for the direct ratio specification.

T-5 and T-6: Total estimator for employees (left) and employees / real assets (right)

	lgEmploy		
	Coeff.	*t-test*	
lgAssets	0.3163	5.23	***
State%*lgAssets	0.0217	1.96	**
OPEC	-1.4888	-8.83	***
lgResOilGas	0.5620	11.23	***
Up-Int	-1.2812	-4.42	***
Dw-Int	1.2130	2.65	***
lgOil	0.0724	0.64	
N	554		
F-test	129.7		
R-sq (total)	0.62		

	Employ/Assets		
	Coeff.	*t-test*	
State%	6.1119	3.14	***
State%*Up-Int	-9.7587	-2.80	***
OPEC	-3.7666	-5.12	***
lgResOilGas	0.4253	2.94	***
Up-Int	7.7323	5.01	***
Dw-Int	12.5285	4.66	***
lgOil	-1.4762	-2.57	**
N	554		
F-test	15.1		
R-sq (total)	0.27		

Notes:
- Dependent variables are the logarithm of number of employees (Table 5, left) and the ratio of employees over real assets (in US$m) (Table 6, right). 'Dw-Int' is the ratio of refining capacity to the sum of refining capacity and oil product sales, 'lgOil' is the logarithm of the crude oil price in real terms. Constant regression terms not reported.
- Total estimators are calculated with robust standard errors (HC3).
- * / ** / *** : Significant at the 10-percent / 5-percent / 1-percent level, respectively.

As to the metric of total output over real assets (total output defined as the sum of upstream production, refining capacity and oil product sales), the univariate ratio in Section 5.2 showed an apparent advantage for NOCs. But when estimating total output and controlling for business mix, oil prices and employment levels, the impact

of state ownership on the relationship between assets and output is statistically significant in favour of the private sector (see Table 7). Although direct estimation of the ratio is insignificant for the full time period (Table 8), private ownership is favourable for the period after 1991 (at 10% significance level; at 1% significance level for the period after 1996). Based on the full data period and previous assumptions, the two regression predict the output-to-assets ratio of fully state-owned firms to be between 7% and 18% lower than of the private sector, whereas OPEC producers achieve about 70% more. As before, the within estimation strongly supports the findings on the impact of ownership for the numerator model, but not for the direct ratio model where the estimation is generally less successful as evidenced by the significantly smaller F-test and R-squared statistics.

T-7 and T-8: Total estimator for total output (left) and output / real assets (right)

	lgOutput		
	Coeff.	*t-test*	
lgAssets	0.8915	10.88	***
State%*lgAssets	-0.0212	-4.09	***
OPEC	0.7819	13.71	***
lgEmp	0.2700	15.00	***
Up-Int	1.1872	1.28	
Up-Int*lgAssets	-0.1762	-1.75	*
Dw-Int	3.6028	2.85	***
Dw-Int*lgAssets	-0.4486	-3.37	***
lgOil	-0.2183	-5.03	***
N	554		
F-test	541.0		
R-sq (total)	0.88		

	Output/Assets		
	Coeff.	*t-test*	
State%	-0.0032	-0.71	
OPEC	0.0452	6.06	***
lgEmp	-0.0158	-2.74	***
Up-Int	-0.2717	-5.23	***
Up-Int*lgEmp	0.0258	5.18	***
Dw-Int	-0.0682	-0.72	
Dw-Int*lgEmp	0.0085	0.98	
lgOil	-0.0263	-8.29	***
N	554		
F-test	20.8		
R-sq (total)	0.24		

Notes:
- Dependent variables are the logarithm of total output (=sum of upstream production, refining capacity and oil product sales in mmboe) (Table 7, left) and the ratio of output over real assets (Table 8, right). Constant regression terms not reported.
- Total estimators are calculated with robust standard errors (HC3).
- * / ** / *** : Significant at the 10-percent / 5-percent / 1-percent level, respectively.

In line with the above (but not reported separately), the ratio of total output per employee is also affected by ownership. Controlling for asset base, business mix and oil prices, NOCs generate significantly less output from a comparable employment base. The predicted output-to-employee ratio for a typical fully state-owned firm is between 17% and 32% lower than the ratio of its private sector counterpart.

The reported results generally support the hypothesis that NOCs tend to be less efficient than fully private firms, with the evidence being stronger in terms of labour efficiency. The within estimators yield even stronger results for the numerator

models, implying that the efficiency differentials can be effectively unlocked through a change in ownership (or through policies that go hand in hand with ownership change). Three caveats apply: first, the estimate of the *magnitude* of differences is less certain than the *existence* of such differences, largely due to the lesser goodness of fit of the direct ratio regressions. Second, OPEC NOCs strongly defy the general trend, with significantly lower employees per asset, and significantly higher output per asset and per employee than the average of the private sector. As explained earlier, the OPEC estimates unfortunately cannot draw on a full set of asset data[55], and the inclusion of companies such as Saudi Aramco might change (or further accentuate) this picture. Third, in the absence of reliable data on exogenous asset quality, there is room for interpretation as to whether IOCs outperform non-OPEC NOCs *in spite of*, or *due to* differences in asset quality.

5.3.3 Revenue generation

Under the heading of revenue generation, I am looking for systematic differences (1) in the ability to translate physical output (i.e. upstream production, refining and oil product sales) into operating revenues, and/or (2) in the amount of revenue generated per employee.

Based on the total estimator, state ownership negatively impacts the input-output efficiency for both metrics – the higher the state ownership, the lower the revenue generated. Tables 9 and 10 show the results for the conversion from output to revenues, using numerator and direct ratio specification. As before, the first of the two models exhibits a much better overall fit and reports a stronger significance level for the impact of ownership. Assuming a real-terms oil price of US$50 per barrel, the typical fully state-owned firm is predicted to generate between 78% and 92% of the real revenue per unit of output created by a fully private firm, and between 80% and 83% of the real revenue per employee. OPEC producers once again outperform the other NOCs, with revenue generation approximately at par with the private sector.

[55] Asset data (or estimates) is only available for a total of 47 OPEC observations: 16 on PDV (Venezuela), 8 each on KPC (Kuwait) and Pertamina (Indonesia), 7 on Sonatrach (Algeria), 5 on Petroecuador, 2 on NIOC (Iran), and one on Qatar Petroleum. No observations are available for Saudi Arabia, Iraq or the UAE.

T-9 and T-10: Total estimator for real revenues (left) and real revenues / output (right)

	lgRevenues		
	Coeff.	*t-test*	
lgTotOutput	0.4149	6.25	***
State%*lgOutput	-0.0347	-3.90	***
OPEC	0.2590	2.27	**
lgAssets	0.3645	2.89	***
lgEmp	-0.0577	-2.32	***
Up-Int	-0.8849	-6.42	***
Dw-Int	-7.8731	-3.64	***
Dw-Int*lgAssets	0.7474	3.22	***
lgOil	0.2403	4.60	***
FuelPrice	0.1779	5.27	***
N	374		
F-test	451.6		
R-sq (total)	0.93		

	Revenues/Output		
	Coeff.	*t-test*	
State%	-1.6764	-1.72	*
OPEC	0.1506	0.13	
LgEmp	-2.2411	-5.31	***
Up-Int	-7.2413	-3.38	***
Dw-Int	-95.3880	-9.29	***
Dw-Int*lgAssets	7.8418	7.81	***
lgOil	7.2129	6.57	***
lgFuelPrice	12.3907	4.15	***
lgFuel*Dw-Int	-16.0828	-2.57	**
N	374		
F-test	69.0		
R-sq (total)	0.62		

Notes:
- Dependent variables are the logarithm of revenues in real terms (Table 9, left) and the ratio of real revenues over total output (Table 10, right). Constant regression terms not reported.
- Total estimators are calculated with robust standard errors (HC3).
- * / ** / *** : Significant at the 10-percent / 5-percent / 1-percent level, respectively.

The total estimator results for revenues generated per employee are very comparable. State ownership is a significantly negative influence, at 1% significance level for the numerator model and at 5% significance level for the direct ratio model.

For both metrics and both model specifications, however, the within estimator does *not* show significant coefficients for the level of state involvement, implying that – when controlling for independent variables and all time-constant factors – revenue generation fails to improve when state ownership is reduced. For revenue generation per employee, this result is at odds with the earlier finding of a strong within-effect of ownership on the output per employee. A technical explanation could be the smaller sample size (374) for the revenue generation models. Only a minority of these observations have effective changes in ownership, leaving the within estimation potentially short of data to estimate its impact. A different explanation for the revenues generation from output is that changes in this metric can usually only be implemented through changes in the asset base or through policy changes (particularly price regulation) – the former being a long-term process and the latter not always corresponding to changes in ownership.

5.3.4 Profitability

To investigate profitability, the link between revenue and profit generation, I examine two of the most commonly used metrics, return on sales (RoS) and return on assets (RoA). For return on sales, the total estimators at first provide an inconclusive picture of the impact of ownership – the revenue elasticity of income is subject to a negative state influence (Table 11; point estimates yield RoS of 10.8% vs. 8.8% in favour of private firms), whereas the direct estimation of the profitability ratio provides no equivalent evidence over the full data period (Table 12; point estimates: 12.8% vs. 12.3% in favour of private firms). But examining the evolution of profitability over time, the analysis confirms that there is a markedly different picture before and after the oil price crash in 1998. Controlling for company size, employment levels, business mix and oil prices, state ownership pre-1998 is insignificant (numerator model) or even marginally positive (direct ratio model). Post-1998, state ownership is significantly *negative* (at 5%) in both regressions. The likely causes have been discussed in Section 5.2, but the magnitude of the swing is striking.

Furthermore, Tables 11 and 12 also show that the within estimations of state ownership are very significant, even over the full sample period.[56] This means that changing ownership into private hands has a significantly positive bearing on profitability, regardless of the relative standing of the firm prior to privatisation, and is in line with the expectation of a refocusing on commercial objectives. Where NOCs are at least equally profitable prior to privatisation, any further improvement is probably not possible without either fundamentally better assets (and thus lower costs per unit) or retained privileges and market power. OPEC membership was insignificant over and above the variable for state ownership and was therefore excluded from the specification.

[56] In fact, even in the period pre-1998 the within estimator for return on sales is significantly negative for state ownership (at 5% level), even though the total estimator is significantly positive.

T-11: Regression results for real income

	Total estimator			Within estimator		
	Coeff.	*t-test*		*Coeff.*	*t-test*	
lgRevenues	0.4523	2.83	***	0.7792	2.84	***
State%*lgRev	-0.0217	-1.84	*	-0.1153	-2.97	***
lgAssets	0.4975	2.77	***	0.1586	0.61	
lgEmp	0.0730	1.38		-0.2859	-1.43	
Up-Int	1.8079	6.69	***	-0.1718	-0.19	
Dw-Int	0.2726	0.57		-1.1134	-1.79	*
lgOil	1.0657	9.13	***	1.0823	5.92	***
N	502			502		
F-test	119.6			59.6		
R-sq (total/within)	0.64			0.48		

T-12: Regression results for return on sales

	Total estimator			Within estimator		
	Coeff.	*t-test*		*Coeff.*	*t-test*	
State%	-0.0057	-0.50		-0.0773	-3.44	***
lgAssets	-0.0279	-3.66	***	-0.0284	-1.49	
LgEmp	0.0146	2.35	**	-0.0240	-1.68	*
Up-Int	0.2075	10.16	***	0.0168	0.16	
Dw-Int	0.0354	0.60		-0.0653	-1.10	
lgOil	0.0743	7.48	***	0.0817	4.36	***
N	533			533		
F-test	31.6			9.1		
R-sq (total/within)	0.30			0.16		

Notes:
- Dependent variables are the logarithm of net income in real terms (Table 11) and the ratio of return on sales (Table 12).
- Total estimator calculated with robust standard errors (HC3), within estimator calculated with cluster-robust standard errors.
- F-test for within estimator is for joint significance of listed variables, excluding fixed unit effects.
- * / ** / *** : Significant at the 10-percent / 5-percent / 1-percent level, respectively.

The results for the second measure of profitability, return on assets, are essentially comparable, but for the full time period both regressions show a significantly negative influence of state ownership. Using the numerator model, State Oil is predicted at 7.9% RoA vs. Private Oil at 9.9%. Using the direct ratio specification, the point prediction is for 9.3% (State) vs. 11.0% (Private).

When evaluating the higher observed profitability of private companies, potential differences in non-commercial objectives and taxation need to be considered. The impact of different tax rates on profitability depends on the cost structure of the firm. Assuming total costs at 80% of revenues, a difference of two percentage points in return on sales (based on the total estimator in Table 11) could be explained by a difference in effective tax rates of 10 percentage points, whereas only a tax differential of 49 percentage points could explain the profitability gap indicated by the

within estimator.[57] As to non-commercial obligations of NOCs, the differences in profitability can be useful to estimate their shadow price: multiplying the delta in return on assets with the median 2006 asset value of a Top 50-ranked oil company (US$51 billion) yields a range of US$1.0 to 1.4 billion (post-tax), which can be compared to the typical (pre-tax) expenditure of NOCs on non-commercial activities.

6 Conclusion

The past years have seen a re-emergence of a fundamental debate between State Oil and Private Oil, which to some extent reflects broader shifts in global economic balance and policy approaches. To analyse the economic consequences of different ownership structures, this paper has compiled the most comprehensive dataset yet, covering the largest public and private oil firms from 1987 to 2006, based on the annual 'Top 50' ranking published in "Petroleum Intelligence Weekly". The data also provides a corporate perspective on the industry's development over the past two decades. It is shown how a very stable group of companies has remained dominant over time, and the ongoing consolidation in the industry is confirmed: over the full period, fully state-owned NOCs have increased average upstream production by 161%, and fully private firms by 57%. Hybrid forms of ownership have become increasingly established, and some of the biggest industry players today fall into this category. The number of fully state-owned NOCs in the rankings has come down over time, but their aggregate relative contribution has hardly declined. One important factor has been the rebound in state ownership of oil producing assets since the turn of the millennium, driven largely by increasing OPEC output but also by recent asset nationalisations. Other observations in terms of business mix are the greater importance of gas across the board, and the still very pronounced upstream-focus of NOCs despite a gradual build-up in downstream exposure. Slicing the data cake according to the home nations of the companies rather than the host nations in which the assets are based, the three most striking global developments over the 20-year period are the rise of Russia and China as home nations to powerful industry players, the very pronounced decline in relative importance of U.S.-based firms, and the

[57] Assuming costs at 60% of revenues, the required tax rate differentials are 5% and 25%.

continued growth in importance – in both absolute and relative terms – of the Middle East producers.

This paper performs econometric comparisons between NOCs and IOCs on the basis of upstream production, reserves management, capital and labour efficiency, revenue generation and profitability. An important issue in making such comparisons are structural differences between the firms, e.g. in non-commercial objectives and the operational business mix. The multivariate regression framework employed in this analysis allows for direct control of some of these variables and the panel structure of the dataset also allows to control for any unobserved, time-constant variables. Furthermore, the comparison of different estimators provides insights as to the existence, importance and direction of such unobserved factors.

NOCs, and OPEC NOCs in particular, are found to produce a significantly lower annual percentage of their upstream reserves than the private sector. This can be caused by a more conservative reserves management, a systematic overstatement of reserves, or by a combination of the two. Genuinely and deliberately slow production rates might well be justified on national welfare grounds and do not necessarily serve as proof of lower productivity or efficiency at state-controlled firms. Measurements of capital and labour efficiency, however, indicate a statistically and economically significant underperformance of non-OPEC State Oil vs. Private Oil. A typical NOCs employs up to 71% more personnel for a comparable asset base, and generates up to 18% less output from these assets than its private counterpart. Publicly owned firms are also found to generate less revenue per unit of output and per employee, and they tend to be less profitable than their private counterparts. For all metrics other than revenue generation, the within estimators indicate a strongly negative significance of state ownership, i.e. reducing the influence of the state can indeed unlock the performance gaps identified by the total estimators.

The findings are generally supportive of the hypothesis that “ownership matters” in the sense that private ownership encourages better performance and greater efficiency than state ownership does. A number of results nevertheless require further study and critical examination. First, substantial differences exist within each ownership category, such as the OPEC/non-OPEC distinction within NOCs. OPEC producers are not more profitable than other state-owned firms, but are at par with the private sector in terms of revenue generation, and outperform all other firms in terms of capital and labour efficiency. There obviously has been no privatisation initiative in

an OPEC member state yet, so one can only speculate about the impact of ownership change on such companies. Second, the OPEC results highlight the fact that I have not been able to explicitly control for all relevant factors in the pooled OLS regressions, most importantly the geological quality of upstream assets, which impacts on production costs, flow rates, and capital and labour requirements. It is plausible to assume that much of the difference between OPEC producers and other NOCs can be explained by this unobserved variable, but there can be no certainty in the absence of reliable data. Being able to distinguish between exogenous asset quality and management-induced asset quality would be another important step. Third, most performance and efficiency metrics have been estimated using two different specifications, the "nominator" and "direct ratio" models – ideally both should have provided consistent results with regard to ownership effects. However, the goodness of fit and overall quality of the direct ratio estimation has been limited, which probably contributed to some differences on the individual result level. Finally, there might be questions about the longer-term sustainability of the private sector advantage. A large part of the current profitability gap materialised after the oil price crash in 1998, when private firms under-invested in new production capacity. It has also been suggested that in a high energy price environment the resource-holding nations will be at greater liberty to chose like-minded partners, and that therefore Western IOCs might struggle to access new reserves as NOC-NOC cooperation becomes the norm.

These future concerns notwithstanding, the balance of evidence presented in this paper suggests that a (political) preference for State Oil usually comes at a tangible economic cost.

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Appendix A: National Oil Companies

Sectors such as postal services, railways, telecommunications, electricity, gas, water, but also airlines, oil, coal and steel are among those industries that historically were prone to be state-owned. Whereas many of those industries are (or used to be) natural monopolies and/or are subject to market failures, the natural resource industries are typically in state ownership for political reasons, including high possible rents, economic importance and employment generation. With regard to the energy sector, most people including the government found it "too important to be left to the market" (Robinson 1993, p.57).

The emergence of NOCs

The importance of the petroleum industry was widely recognised from the early 20th century. Governments since had a wide range of reasons to justify their invention in one of the 'commanding heights' of the economy. The first NOC is believed to have been created in Austria in 1908 when the private oil producers faced a situation of excess supply of crude. Emperor Franz Joseph at the time approved the building of a topping plant owned and operated by the government, which helped process the crude and further developed end markets for oil products (Heller 1980). European states, particularly the colonial powers, set up or participated in oil companies in order to control the domestic petroleum markets and pursue upstream exploration and production abroad, usually within their respective colonial domains. The creation of Agip in Italy in 1926 was the first instance of a consuming country aiming to counter-balance the influence of outside IOCs in the domestic downstream market. As to developing countries, Latin America was leading the way, with Argentina's YPF being first NOC to be founded in 1922 (Linde 2000).

A major increase in numbers of NOCs occurred in the exporting countries during the 1960s and 1970s (Bentham and Smith 1987), triggered by the worldwide tide of nationalism, the desire for state control over key resources, the apparently ever increasing rents in the oil sector and the successes of OPEC. Finally, the last significant NOCs to be set up outside the communist influence sphere were in producing but net-importing countries (e.g. Canada, UK), sparked by security of supply concerns after the OPEC revolution. By the end of the 1970s, among the net importing countries, the U.S. was the only significant producer without an NOC

(Linde 2000). Overall, the foundation of state-controlled companies had a significant impact on the ownership structure of the oil and gas industry. Heller (1980) reports that from 1963 to 1975, outside the U.S., Canada and the centrally planned economies, public sector control rose from 9% to 62% in production, from 14% to 24% in refining, and from 11% to 21% in marketing and that this trend was continuing into the 1980s.

The rationale for NOCs

The initial role of most NOCs could be described as custodians of the domestic oil and gas sector, either by taking over operations from the IOCs or by working alongside them (Stevens 2004). For a large number of countries in the world, the oil and gas sector is a key industry to determine economic, social and political outcomes, and this is particularly true in the developing world. In exporting countries, the sector accounts for high percentages of GDP, government revenues and foreign exchange earnings. In importing countries, it typically accounts for a large share of foreign exchange expenditures. Furthermore, taxes on oil consumption contribute importantly to fiscal revenues – or, in some cases, the subsidies on oil consumption cause large fiscal deficits (McPherson 2003).

Stevens (2004) summarises the main arguments why governments chose to set up a National Oil Company with significant influence over the sector, rather than opting for more liberal governance regimes. The 'OPEC revolution' and oil nationalisation of the 1970s was carried by a notion that IOCs were backed by foreign, imperialistic governments and opposed to national interests (Grayson 1981; Hartshorn 1993). Many countries with an important oil and gas industry thus demanded state control, but did not deem regulation or legislation to be appropriate alternatives. The spirit of nationalism plus the inherent weakness of the private sector in most developing countries largely ruled out the option of domestic, but privately-owned operators in the sector (Linde 2000). But even in developed countries, the wider political view after WWII suggested that the state could and should actively tackle social and economic issues. State ownership in the upstream ensures that all excess rents accrue to the public, and in the downstream a key attraction is control over the pricing of oil products, an area of great political and social sensitivity (McPherson 2003). The perceived cash-richness of NOCs allowed for the introduction of company objectives other than profit, e.g. employment generation, development of local commercial and

technical capacity, provision of social and other infrastructure, income redistribution through subsidised prices, and assistance in state borrowing (Nore 1980; Grayson 1981; Horn 1995). In many ways was the corporate purpose of the NOCs "tied to the national purpose" (Khan 1987, p.188). In oil importing countries, the creation of NOCs was a tool to address worries about the security of supply and to balance the power of the exporting nations, but also of powerful IOCs and their respective home countries. NOCs also provide governments a "window to the oil industry" (Grayson 1981, p.10), which helps to overcome information asymmetries between the sovereign and private industry participants – such asymmetries could otherwise impair the state's ability to conduct effective oversight and implement appropriate regulation.

It is very conceivable that policy makers are aware of the potential economic issues associated with NOCs (see below), but that these shortcomings are judged to be outweighed by broader social and political benefits, if the interests of the private sector participants and the public welfare are not fully aligned.

Key issues of NOCs

Despite the apparent rationale in favour of NOCs, their performance and commercial efficiency is often believed to be lacking. Although much anecdotal "evidence" exists, it is rare for precise numbers to make their way into the public sphere. One exception was in 1998, when the IMF commissioned an independent audit of three state-owned companies in Indonesia, among them the NOC Pertamina. The audit report, which was leaked to the press, calculated losses of US$6.1 billion due to corruption and inefficiencies over two years time, which for each year was in excess of 10% of the national budget (Linde 2000). The auditors found excessive mark-ups on contracts, sales of natural gas below market price, questionable fees to trading companies partially owned by the President's family, etc. In terms of operational efficiency, the upstream production cost per barrel was calculated at US$5.50 for Pertamina compared to an industry average of US$1.20 at the time. Another audit of Nigerian state oil company NNPC in 1999 for the World Bank estimated annual losses of between US$800 million and US$1 billion (McPherson 2003). Many authors blame the operational inefficiencies at NOCs on a lack of technical and managerial capabilities (Jaidah 1980; Al-Mazeedi 1992; Gochenour 1992). They argue that IOCs used the shelter of high energy prices between the early 1970s and 1985 to restructure and improve efficiency levels through R&D, whereas

the NOCs failed to invest in upgrading facilities or new technologies. In terms of human resources, NOCs are accused to be overstaffed and pay above-average wages (Waelde 1995), but also to tend to recruit according to family, tribal or religious considerations rather than according to qualification and performance (Al-Mazeedi 1992). As additional issues, McPherson (2003) points out the frequent lack of competition for NOCs, a lack of corporate governance mechanisms[58], the distorting nature of fuel subsidies[59], and conflicts of interest embedded within the domestic industry structure - in many countries the NOC devises, implements and supervises sector policy[60] whilst also being the most important industry actor.

NOCs and their governments

NOCs, although originally set up as mere instruments of the state, have become over time – probably inevitably – "major actors on their own, interposed between the government per se and, mostly foreign, oil companies" (Waelde 1995). NOCs and their governments are thus separate actors, who can share a common agenda and objectives, but in reality often have quite divergent views. The principal trade-off which has been evidenced in many different countries is between the level of government control imposed on the NOC and the ability of the NOC to efficiently pursue its business interests. In the view of some, this trade-off has become a no-win dichotomy: "Either the NOC exerted its will and pursued its own goals which were likely to lead to takeover of the state, or the state exerted its will and effectively inhibited the NOC from operating effectively" (Stevens 2004, p.14).

Liberalisation, privatisation, and resurgence of the state

Certainly not all NOCs are overburdened with non-commercial objectives or sheltered from effective competition, and in other countries governments have taken steps to address such issues. Liberalisation (or deregulation), understood as the opening up to competitive forces, and privatisation, the transfer of ownership from

[58] Neither the NOC managers nor the politicians in government have strong incentives to enforce governance standards. Managers strive to maximise their scope of discretionary decision-making, whilst the government often has an interest to obscure the exact uses of cash for political purposes.
[59] In 1999, 13 out of the 15 major oil exporting countries in the world were subsidising domestic petroleum prices. The subsidies in these countries on average accounted for 3.8% of GDP and 18.8% of all government expenditure (IMF 2002). In 2005, Indonesia alone is estimated to have spent US$13.8 billion on fuel subsidies (Bloomberg 2005).
[60] Even in countries where a ministry is formally in charge, the NOC often contributes substantially to the decision-making process due to its superior resources and industrial expertise.

public to private hands, are two logically distinct concepts, as "[p]ublic ownership does not imply state monopoly and private ownership does not entail competition" (Vickers and Yarrow 1988, p.45). Both are nevertheless frequently intertwined in practice. The historical context of many NOCs – the desire for complete state control – does not sit well with the idea of competition. Furthermore, there are powerful interest groups within a public enterprise – including management, employees and unions – that have an incentive to oppose the introduction of competitive forces. On the other hand, groups with an explicit interest in such competitive pressure – e.g. potential market entrants and the wider consuming public – often are not as effective in arguing their case. Commercialisation, a company-internal process of increasing the focus on efficiency and profitability, can be targeted and achieved independently of liberalisation and privatisation, but there are also important practical interconnections. First, market liberalisation is most often employed as a policy tool when either there is an abuse of market power or a lack of efficiency due to a lack of competition. In the latter case the goal of liberalisation then is a greater degree of commercialisation within the industry (Vickers and Yarrow 1988). And secondly, the announcement of privatisation often acts as a catalyst for commercialisation of the company to be privatised. In many cases a higher degree of commercialisation is actually a pre-requisite to make the privatisation palatable for private investors. A greater focus on commercialisation implies restrictions on non-commercial objectives and activities of the firm, but attempts to impose such restrictions without changing ownership have often been difficult (Horn 1995). Kikeri, Nellis and Shirley (1992) note that since the 1970s nearly all developing countries have tried to reform state-owned enterprises[61] without changing ownership. Although there has been some improvement, the overall implementation has been difficult, the entire reform was seldom enacted and "most importantly, performance improvements have proved difficult to sustain once the crisis that instigated the reform dissipated" (Kikeri et al. 1992, p.4).

Wolf and Pollitt (2008) show that *partial* privatisation can act as a catalyst for important performance improvements in NOCs. Examples exist where governments have undertaken partial privatisations whilst enacting supplementary measures to

[61] These reforms include: increasing competition, reducing privileges, instituting hard budget constraint, reducing political intervention in management, reducing importance of non-commercial objectives, increasing accountability of management for financial performance, etc.

strengthen competition for the NOCs and perpetuate these efficiency gains. In Norway, the state traditionally held part of its interests through the two oil companies Statoil and Norsk Hydro, but a significant part was also held directly (the so-called 'State Direct Financial Interest' – SDFI), but managed by Statoil on behalf of the state. When Statoil was partly privatised in 2001, the state sold some of its SDFI assets to the company in order to make it more competitive on a global level. However, to safeguard effective competition in the Norwegian oil and gas sector, the government also auctioned another part of the SDFI to parties other than Statoil in early 2003.[62] China, on the other hand, has opted to introduce a degree of competition between its different, part-privatised NOCs.[63] PetroChina, Sinopec and CNOOC (and their unlisted parent companies) compete with each other in large parts of the oil, gas and petrochemicals businesses, although the companies in principle have a different focus of operations.[64]

The first privatisations of NOCs within the oil and gas sector occurred in the UK (BP in 1977, followed by two other NOCs in the early 1980s), and then – up until the mid 1990s – in net consuming countries such as France, Austria, Spain or Italy, as the security of supply became an international concern at the level of OECD and IEA rather than the nation state (Linde 2000). Net oil-exporting states took longer to be convinced of the possible benefits of liberalisation and privatisation. After all, oil producing assets in the Middle East had only been nationalised in the 1970s and other producing regions in Latin America and Africa were no strangers to foreign domination and imperialism either (Waelde 1995). As far as OPEC member states were concerned, they emphasised OPEC policies over national policies (Linde 2000). Non-OPEC producing countries took the lead in the late 1980s, although many of them were led down this path by external pressures of international creditors such as the World Bank and the IMF, who were keen to implement "Washington Consensus"-inspired stabilisation programmes. Argentina was first to sell 60% of its NOC Yacimientos Petroliferos Fiscales (YPF) on the stock market for US$4.2 billion (Grosse and Yanes 1998). The transformation of YPF into a commercial entity was generally considered a great success and other Latin American countries followed to

[62] In 2007, the Norwegian state allowed a merger between Statoil and the oil business of Norsk Hydro, which reduced competition in the domestic oil and gas sector, but this was judged necessary to have the combined company compete on a global level with much larger private and state-owned competitors.
[63] The competition could also be between different subsidiaries of one NOC (McPherson 2003).
[64] CNOOC retains the monopoly on offshore E&P, PetroChina's activities are biased towards onshore E&P, while Sinopec is strongest in R&M.

liberalise (Venezuela, Bolivia, Ecuador) or even privatise (Brazil) their respective oil sectors and NOCs.

A major boost for the privatisation agenda was the collapse of the centrally planned economies, although the framework for voucher privatisation in these transition economies is unique relative to other market economies (Boycko et al. 1994). Since 2000 countries such as China, India, Pakistan, Norway and Japan have chosen to (part-)privatise their NOCs, but there is also a powerful counter-movement towards greater state participation once again. Some of the key producing and reserve holding countries still do not allow foreign participation in the upstream at all (e.g. Saudi Arabia, Mexico) or on very restrictive policies only (e.g. Kuwait, Iran, UAE) and sustained levels of high energy prices are likely to relieve budgetary pressures for any kind of reform. Russia, Venezuela and Bolivia have seen the re-nationalisation of strategic assets or companies, and more countries might follow suit – or at the very least increase the government take through taxation, as even “liberal” countries/states such as the UK and Alaska recently did.

Appendix B: Descriptive statistics of the PIW dataset

	Unit	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Sample distribution by ownership type and sample coverage																					
Total companies in PIW sample	#	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	51	50	50	50	50
- fully state-owned ('Own-1')	#	26	25	23	22	21	20	20	19	19	19	20	21	24	19	19	18	18	18	17	18
- majority state-owned ('Own-2')	#	3	4	5	5	6	7	7	10	10	5	5	4	4	8	8	7	7	7	8	7
- minority state-owned ('Own-3')	#	1	1	1	1	1	1	3	6	6	7	4	5	3	4	5	4	4	3	3	4
- privately owned ('Own-4')	#	20	20	21	22	22	22	20	15	15	19	21	20	19	19	18	22	21	22	22	21
Total oil reserves (PIW sample)	mmboe	748,346	841,140	853,896	856,960	864,212	873,458	878,905	903,060	934,254	952,082	952,304	950,035	927,842	954,590	979,025	986,077	993,802	995,070	1,018,555	1,025,325
World proven oil reserves (BP est.)	mmboe	909,135	996,390	1,003,766	1,000,995	1,005,660	1,011,406	1,012,354	1,014,062	1,027,192	1,049,005	1,058,785	1,063,852	1,083,000	1,108,216	1,135,356	1,173,451	1,188,933	1,197,349	1,209,547	1,208,242
PIW sample / BP world estimate	%	82%	84%	85%	86%	86%	86%	87%	89%	91%	91%	90%	89%	86%	86%	86%	84%	84%	83%	84%	85%
Total gas reserves (PIW sample)	mmboe	290,975	312,629	339,301	347,914	408,758	386,126	531,884	560,113	585,721	647,445	679,315	658,365	641,207	582,789	716,787	804,926	714,410	742,189	673,820	675,656
World proven gas reserves (BP est.)	mmboe	643,458	667,548	752,242	772,650	808,612	827,705	839,714	844,918	848,421	867,623	881,903	900,175	900,860	954,304	1,032,758	1,042,707	1,055,615	1,050,176	1,057,167	1,064,556
PIW sample / BP world estimate	%	45%	47%	45%	45%	51%	47%	63%	66%	69%	75%	77%	73%	71%	61%	69%	77%	68%	71%	64%	63%
Total oil production (PIW sample)	kboe/d	35,687	38,636	39,971	40,321	41,389	42,466	46,901	51,618	51,386	52,757	54,838	55,282	55,126	57,524	57,933	58,759	61,225	63,357	65,944	65,527
World oil production (BP est.)	kboe/d	60,784	63,157	64,049	65,470	65,287	65,795	66,051	67,122	68,125	69,931	72,251	73,626	72,439	75,033	74,932	74,496	77,056	80,244	81,250	81,663
PIW sample / BP world estimate	%	59%	61%	62%	62%	63%	65%	71%	77%	75%	75%	76%	75%	76%	77%	77%	79%	79%	79%	81%	80%
Total gas production (PIW sample)	kboe/d	10,468	10,268	11,647	11,656	12,512	11,886	21,906	22,722	22,851	24,011	23,797	25,012	25,939	25,639	27,715	28,687	29,774	30,447	30,122	32,046
World gas production (BP est.)	kboe/d	29,006	30,272	31,337	32,119	32,634	32,758	33,430	33,761	34,422	35,828	35,984	36,759	37,794	39,000	40,026	40,711	42,157	43,469	44,826	46,204
PIW sample / BP world estimate	%	36%	34%	37%	36%	38%	36%	66%	67%	66%	67%	66%	68%	69%	66%	69%	70%	71%	70%	67%	69%
Total refining capcity (PIW sample)	kboe/d	39,084	37,657	38,714	40,599	39,039	41,560	40,012	40,338	41,113	42,711	44,383	47,882	48,591	48,441	48,658	52,125	52,193	52,232	51,617	52,444
World refining capacity (BP est.)	kboe/d	73,208	73,186	73,756	74,526	74,238	73,494	74,202	75,430	76,186	77,029	78,939	79,796	81,927	82,265	83,107	83,650	83,956	85,349	85,929	87,238
PIW sample / BP world estimate	%	53%	51%	52%	54%	53%	57%	54%	53%	54%	55%	56%	60%	59%	59%	59%	62%	62%	61%	60%	60%
Operating contribution by ownership type																					
Total oil reserves	mmboe	748,346	841,140	853,896	856,960	864,212	873,458	878,905	903,060	934,254	952,082	952,304	950,035	927,842	954,590	979,025	986,077	993,802	995,070	1,018,555	1,025,325
- Own-1	%	93%	93%	93%	93%	93%	93%	93%	89%	88%	88%	88%	87%	87%	84%	82%	83%	84%	85%	85%	86%
- Own-2	%	1%	1%	1%	1%	1%	2%	2%	5%	6%	3%	2%	2%	2%	4%	5%	5%	5%	5%	5%	5%
- Own-3	%	0%	0%	0%	0%	0%	0%	0%	2%	1%	3%	1%	2%	2%	2%	3%	2%	2%	1%	1%	1%
- Own-4	%	6%	6%	5%	6%	5%	5%	5%	5%	5%	7%	9%	9%	9%	10%	10%	11%	9%	10%	9%	9%
Total gas reserves	mmboe	290,975	312,629	339,301	347,914	408,758	386,126	531,884	560,113	585,721	647,445	679,315	658,365	641,207	582,789	716,787	804,926	714,410	742,189	673,820	675,656
- Own-1	%	90%	88%	89%	88%	90%	90%	66%	66%	58%	61%	60%	62%	63%	69%	60%	62%	66%	64%	69%	72%
- Own-2	%	1%	1%	1%	1%	1%	1%	28%	28%	36%	31%	33%	31%	30%	22%	33%	30%	25%	28%	21%	18%
- Own-3	%	0%	0%	0%	0%	0%	0%	1%	1%	1%	2%	0%	1%	0%	1%	1%	1%	1%	1%	1%	1%
- Own-4	%	9%	10%	10%	10%	9%	9%	6%	5%	5%	5%	7%	6%	7%	8%	7%	7%	7%	8%	9%	9%
Total oil production	kboe/d	35,687	38,636	39,971	40,321	41,389	42,466	46,901	51,618	51,386	52,757	54,838	55,282	55,126	57,524	57,933	58,759	61,225	63,357	65,944	65,527
- Own-1	%	61%	64%	66%	66%	66%	65%	67%	64%	64%	64%	66%	65%	65%	57%	55%	53%	53%	54%	54%	57%
- Own-2	%	4%	4%	4%	4%	5%	7%	8%	10%	11%	4%	5%	4%	3%	11%	11%	11%	11%	10%	14%	11%
- Own-3	%	1%	1%	1%	1%	1%	1%	2%	5%	5%	6%	3%	5%	3%	5%	5%	5%	5%	2%	3%	3%
- Own-4	%	35%	31%	29%	28%	28%	27%	23%	21%	21%	26%	26%	27%	28%	27%	29%	31%	30%	33%	30%	29%
Total gas production	kboe/d	10,468	10,268	11,647	11,656	12,512	11,886	21,906	22,722	22,851	24,011	23,797	25,012	25,939	25,639	27,715	28,687	29,774	30,447	30,122	32,046
- Own-1	%	40%	39%	42%	40%	43%	41%	25%	28%	27%	29%	32%	32%	33%	30%	31%	29%	28%	29%	26%	29%
- Own-2	%	3%	3%	4%	3%	4%	4%	45%	43%	43%	40%	38%	37%	36%	38%	35%	33%	35%	35%	37%	33%
- Own-3	%	1%	1%	1%	1%	2%	1%	2%	3%	3%	2%	2%	3%	2%	3%	3%	3%	3%	3%	3%	4%
- Own-4	%	55%	56%	53%	55%	51%	53%	29%	26%	27%	29%	28%	28%	29%	29%	32%	34%	34%	34%	34%	34%
Total refining capacity	kboe/d	39,084	37,657	38,714	40,599	39,039	41,560	40,012	40,338	41,113	42,711	44,383	47,882	48,591	48,441	48,658	52,125	52,193	52,232	51,617	52,444
- Own-1	%	33%	35%	34%	33%	32%	31%	32%	30%	31%	30%	33%	39%	40%	31%	31%	30%	31%	31%	30%	35%
- Own-2	%	5%	5%	7%	7%	8%	10%	8%	13%	14%	6%	7%	4%	5%	15%	15%	14%	14%	15%	18%	13%
- Own-3	%	2%	3%	3%	2%	2%	2%	5%	9%	8%	9%	4%	6%	4%	4%	3%	4%	4%	2%	2%	2%
- Own-4	%	60%	57%	57%	58%	57%	57%	56%	48%	47%	55%	55%	51%	52%	51%	51%	53%	51%	52%	50%	50%
Total oil product sales	kboe/d	38,430	41,078	41,732	42,032	43,472	46,185	47,325	48,152	48,852	49,578	51,548	56,543	57,689	59,348	60,035	59,668	59,951	62,310	61,929	62,593
- Own-1	%	26%	30%	28%	27%	27%	26%	26%	28%	27%	29%	29%	32%	31%	29%	27%	25%	25%	25%	24%	29%
- Own-2	%	4%	4%	6%	6%	7%	8%	6%	8%	9%	6%	6%	4%	4%	10%	10%	11%	11%	12%	13%	11%
- Own-3	%	3%	3%	3%	3%	3%	3%	5%	7%	7%	5%	3%	5%	3%	4%	5%	4%	4%	2%	2%	2%
- Own-4	%	67%	63%	64%	64%	63%	63%	63%	56%	57%	60%	63%	60%	62%	57%	58%	60%	61%	62%	61%	58%

Appendix B (cont'd)

	Unit	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Percentage of state ownership, weighted by operating contribution																					
Oil reserves-weighted state own.	%	94%	94%	94%	94%	94%	94%	94%	92%	92%	91%	89%	89%	88%	87%	86%	86%	87%	88%	89%	89%
Gas reserves-weighted state own.	%	91%	89%	89%	89%	91%	90%	77%	78%	73%	75%	73%	75%	75%	79%	73%	75%	77%	79%	81%	82%
Oil production-weighted state own.	%	64%	67%	69%	70%	69%	69%	72%	71%	71%	69%	69%	68%	68%	66%	64%	62%	62%	62%	64%	64%
Gas production-weighted state own.	%	43%	42%	45%	43%	46%	44%	43%	46%	46%	46%	48%	48%	48%	47%	46%	45%	44%	49%	47%	48%
Refining-weighted state own.	%	37%	40%	40%	39%	39%	37%	37%	40%	41%	37%	38%	43%	44%	41%	41%	39%	40%	41%	41%	43%
Product sales-weighted state own.	%	30%	34%	33%	32%	33%	31%	31%	34%	33%	34%	32%	35%	34%	36%	34%	32%	31%	32%	32%	36%
Other operating statistics																					
Oil as % of total reserves																					
- Own-1	%	73%	74%	73%	72%	69%	70%	70%	68%	71%	68%	67%	67%	67%	66%	65%	62%	64%	64%	65%	64%
- Own-2	%	70%	68%	70%	70%	69%	80%	9%	22%	20%	11%	9%	9%	8%	25%	18%	17%	20%	18%	26%	28%
- Own-3	%	63%	74%	82%	74%	75%	73%	61%	80%	72%	68%	83%	77%	83%	82%	86%	71%	71%	55%	54%	55%
- Own-4	%	62%	59%	58%	56%	56%	56%	56%	58%	57%	64%	63%	67%	67%	67%	65%	65%	64%	64%	62%	59%
Sample average	%	72%	73%	72%	71%	68%	69%	62%	62%	61%	60%	58%	59%	59%	62%	58%	55%	58%	57%	60%	60%
Oil as % of total production																					
- Own-1	%	84%	86%	84%	85%	84%	85%	85%	84%	84%	83%	83%	82%	81%	81%	79%	79%	80%	80%	82%	80%
- Own-2	%	78%	81%	79%	82%	80%	86%	27%	35%	36%	20%	21%	18%	17%	40%	40%	40%	39%	38%	45%	40%
- Own-3	%	71%	73%	73%	75%	65%	74%	70%	79%	76%	86%	82%	76%	77%	79%	79%	78%	78%	66%	65%	62%
- Own-4	%	68%	67%	65%	64%	64%	64%	63%	64%	64%	66%	68%	68%	67%	68%	65%	65%	64%	67%	66%	64%
Sample average	%	77%	79%	77%	78%	77%	78%	68%	69%	69%	69%	70%	69%	68%	69%	68%	67%	67%	68%	69%	67%
Oil Reserves/Production ('R/P') ratio																					
- Own-1	Years	88.1	86.4	83.2	81.7	81.0	80.9	71.1	66.5	69.1	68.0	63.5	63.3	61.4	66.8	68.9	71.2	70.1	66.9	66.7	64.6
- Own-2	Years	13.5	13.4	12.8	12.7	13.3	15.0	10.6	22.7	26.5	27.7	23.6	26.1	25.2	18.6	21.3	20.4	18.7	19.7	15.8	18.1
- Own-3	Years	10.2	16.5	27.9	17.8	16.3	16.6	13.1	16.0	14.3	23.6	19.8	17.9	21.7	19.3	26.8	18.6	18.1	10.3	8.8	8.9
- Own-4	Years	9.4	10.7	10.8	11.4	10.8	10.6	11.1	10.4	10.8	12.6	15.4	15.6	15.6	16.4	16.0	15.8	13.3	13.3	13.0	12.8
Sample average	Years	57.5	59.6	58.5	58.2	57.2	56.4	51.3	47.9	49.8	49.4	47.6	47.1	46.1	45.5	46.3	46.0	44.5	43.0	42.3	42.9
Gas Reserves/Production ('R/P') ratio																					
- Own-1	Years	170.8	187.8	169.3	178.4	188.7	193.3	177.1	158.6	153.1	157.4	147.4	140.9	129.6	142.2	138.5	163.1	158.0	147.9	162.3	142.8
- Own-2	Years	20.7	27.1	20.1	24.8	23.5	23.4	41.0	43.8	58.0	57.9	67.5	60.1	56.4	36.7	66.6	68.4	47.6	53.6	35.3	31.5
- Own-3	Years	14.4	15.6	16.9	18.9	10.3	18.1	19.2	15.6	18.0	69.8	18.1	17.7	14.7	15.9	16.6	28.0	26.2	16.7	13.6	12.0
- Own-4	Years	12.1	15.4	15.1	15.6	15.4	14.9	14.8	13.9	14.2	13.9	19.1	16.1	16.0	16.9	15.7	15.3	13.7	15.1	15.7	15.4
Sample average	Years	76.2	83.4	79.8	81.8	89.5	89.0	66.5	67.5	70.2	73.9	78.2	72.1	67.7	62.3	70.9	76.9	65.7	66.8	61.3	57.8
Total Reserves/Production ('R/P') ratio																					
- Own-1	Years	101.5	100.5	96.7	96.2	98.6	98.0	86.7	81.5	82.3	83.1	78.0	77.4	74.4	81.2	83.4	90.8	87.7	83.3	84.0	80.2
- Own-2	Years	15.1	16.0	14.4	14.9	15.3	16.2	32.8	36.4	46.8	51.9	58.1	54.0	51.1	29.5	48.4	49.1	36.2	40.7	26.7	26.2
- Own-3	Years	11.4	16.2	24.9	18.1	14.2	17.0	14.9	15.9	15.2	30.1	19.5	17.9	20.1	18.6	24.6	20.6	19.8	12.5	10.5	10.1
- Own-4	Years	10.3	12.2	12.3	12.9	12.4	12.1	12.4	11.6	12.1	13.0	16.5	15.8	15.7	16.5	15.9	15.6	13.4	13.9	13.9	13.7
Sample average	Years	61.7	64.6	63.3	63.5	64.7	63.5	56.2	53.9	56.1	57.1	56.8	54.9	53.0	50.6	54.2	56.1	51.4	50.7	48.3	47.8
Integration ratio: Oil Production-to-Refining																					
- Own-1	%	171%	187%	201%	199%	215%	212%	249%	271%	255%	262%	247%	194%	185%	221%	212%	203%	204%	214%	233%	205%
- Own-2	%	66%	73%	64%	63%	60%	79%	120%	101%	96%	94%	75%	93%	83%	89%	89%	90%	90%	82%	99%	102%
- Own-3	%	29%	34%	38%	47%	52%	51%	44%	67%	69%	82%	88%	88%	112%	156%	184%	143%	152%	126%	137%	151%
- Own-4	%	53%	56%	53%	48%	53%	48%	49%	56%	56%	57%	59%	61%	61%	63%	67%	65%	70%	77%	75%	74%
Sample average	%	91%	103%	103%	99%	106%	102%	117%	128%	125%	124%	124%	115%	113%	119%	119%	113%	117%	121%	128%	125%
Integration ratio: Refining-to-Product Sales																					
- Own-1	%	126%	109%	113%	118%	109%	107%	101%	90%	98%	90%	99%	104%	108%	87%	94%	103%	109%	105%	104%	101%
- Own-2	%	113%	117%	113%	111%	106%	109%	103%	136%	126%	85%	116%	101%	108%	116%	119%	112%	119%	110%	109%	101%
- Own-3	%	101%	93%	88%	74%	68%	69%	92%	99%	105%	161%	124%	105%	97%	74%	56%	91%	87%	86%	90%	86%
- Own-4	%	91%	82%	82%	87%	81%	81%	75%	71%	69%	79%	76%	72%	70%	73%	71%	76%	73%	70%	69%	72%
Sample average	%	102%	92%	93%	97%	90%	90%	85%	84%	84%	86%	86%	85%	84%	82%	81%	87%	87%	84%	83%	84%

Appendix B (cont'd)

	Unit	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Operating contribution by home country of companies																					
Oil reserves by home country of company																					
- Saudi Arabia	%	22%	30%	30%	30%	30%	30%	30%	29%	28%	27%	27%	28%	28%	27%	27%	27%	26%	26%	26%	26%
- Iran	%	12%	11%	11%	11%	11%	11%	11%	10%	10%	10%	10%	9%	9%	9%	9%	10%	13%	13%	13%	13%
- Iraq	%	13%	12%	12%	12%	12%	11%	11%	11%	11%	12%	12%	12%	12%	12%	11%	11%	12%	12%	11%	11%
- Kuwait	%	13%	11%	11%	11%	11%	11%	11%	11%	10%	10%	10%	10%	10%	10%	10%	10%	10%	9%	10%	10%
- UAE and Qatar	%	8%	8%	8%	8%	8%	8%	8%	6%	7%	7%	6%	6%	6%	7%	7%	7%	7%	6%	7%	7%
- USA and Canada	%	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	3%	4%	4%
- Mexico	%	6%	6%	6%	6%	6%	6%	6%	6%	5%	5%	5%	5%	3%	3%	3%	2%	2%	1%	1%	1%
- Venezuela	%	8%	7%	7%	7%	7%	7%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
- Brazil	%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- UK and Netherlands	%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
- Other Europe (ex. Norway, Russia)	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- Russia	%							0%	5%	5%	5%	6%	6%	6%	7%	8%	7%	6%	6%	5%	5%
- Norway	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
- Algeria	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- China	%							2%	2%	2%	2%	3%	2%	2%	1%	1%	1%	1%	1%	1%	2%
- Others	%	9%	7%	7%	7%	7%	8%	7%	6%	7%	6%	6%	6%	6%	6%	7%	8%	7%	8%	8%	8%
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Gas reserves by home country of company																					
- Saudi Arabia	%	8%	9%	9%	9%	8%	8%	6%	6%	6%	5%	5%	6%	6%	6%	5%	5%	5%	5%	6%	6%
- Iran	%	28%	27%	29%	29%	32%	31%	23%	22%	19%	21%	20%	21%	21%	23%	19%	17%	22%	22%	23%	24%
- Iraq	%	2%	5%	5%	5%	5%	5%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%	3%	3%	3%	3%
- Kuwait	%	2%	3%	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	2%	1%	1%	1%	1%	1%	2%
- UAE and Qatar	%	16%	16%	14%	14%	14%	17%	12%	15%	10%	13%	12%	13%	13%	17%	17%	23%	18%	17%	19%	19%
- USA and Canada	%	7%	7%	7%	7%	6%	6%	4%	4%	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%
- Mexico	%	4%	4%	4%	3%	3%	3%	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%	0%	0%
- Venezuela	%	6%	5%	5%	6%	6%	6%	4%	4%	4%	4%	4%	4%	4%	4%	3%	3%	3%	3%	4%	4%
- Brazil	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
- UK and Netherlands	%	2%	3%	3%	4%	3%	3%	2%	2%	2%	1%	2%	2%	2%	3%	2%	2%	2%	2%	2%	2%
- Other Europe (ex. Norway, Russia)	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- Russia	%							27%	27%	35%	32%	34%	31%	31%	21%	31%	29%	24%	27%	20%	18%
- Norway	%	0%	0%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%	1%
- Algeria	%	6%	6%	6%	6%	6%	5%	4%	4%	3%	3%	3%	4%	4%	4%	4%	3%	3%	3%	4%	4%
- China	%							0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%
- Others	%	17%	13%	13%	13%	12%	13%	9%	8%	8%	8%	9%	9%	10%	9%	8%	9%	10%	9%	9%	9%
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Oil production by home country of company																					
- Saudi Arabia	%	12%	14%	13%	16%	21%	19%	17%	17%	17%	17%	17%	16%	15%	15%	14%	14%	15%	16%	17%	16%
- Iran	%	7%	6%	7%	8%	8%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	6%	6%	6%	6%	7%
- Iraq	%	6%	7%	7%	5%	1%	1%	1%	1%	1%	1%	2%	4%	5%	5%	4%	3%	2%	3%	3%	3%
- Kuwait	%	3%	4%	4%	3%	0%	2%	4%	4%	4%	4%	4%	3%	4%	3%	3%	3%	4%	4%	4%	4%
- UAE and Qatar	%	3%	3%	4%	4%	4%	4%	3%	3%	3%	3%	4%	4%	3%	4%	4%	4%	3%	3%	4%	4%
- USA and Canada	%	25%	21%	19%	19%	19%	18%	16%	14%	14%	13%	13%	12%	11%	11%	12%	13%	13%	12%	12%	13%
- Mexico	%	7%	6%	7%	7%	8%	7%	7%	6%	5%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
- Venezuela	%	5%	5%	5%	5%	6%	6%	5%	5%	6%	6%	6%	6%	5%	6%	5%	5%	4%	4%	4%	4%
- Brazil	%	2%	2%	2%	2%	2%	2%	1%	1%	1%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%
- UK and Netherlands	%	9%	9%	8%	8%	9%	8%	7%	7%	7%	7%	7%	8%	8%	7%	7%	8%	7%	8%	7%	7%
- Other Europe (ex. Norway, Russia)	%	3%	4%	4%	4%	5%	5%	4%	4%	4%	4%	4%	4%	5%	5%	5%	5%	5%	5%	5%	5%
- Russia	%							3%	9%	8%	8%	8%	8%	8%	9%	9%	10%	10%	11%	10%	10%
- Norway	%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%	2%	2%
- Algeria	%	3%	3%	3%	3%	3%	3%	2%	2%	2%	3%	2%	2%	3%	2%	2%	2%	3%	3%	3%	3%
- China	%							6%	5%	5%	5%	5%	5%	6%	5%	5%	5%	5%	5%	5%	5%
- Others	%	15%	15%	16%	15%	14%	16%	14%	12%	13%	13%	13%	13%	12%	12%	12%	12%	12%	10%	9%	10%
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Appendix B (cont'd)

	Unit	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gas production by home country of company																					
- Saudi Arabia	%	4%	5%	4%	4%	5%	5%	3%	3%	3%	3%	3%	3%	2%	3%	3%	3%	4%	3%	4%	4%
- Iran	%	2%	3%	3%	3%	4%	3%	2%	3%	3%	3%	3%	3%	3%	4%	4%	3%	4%	5%	5%	5%
- Iraq	%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
- Kuwait	%	1%	1%	1%	1%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	0%	1%	1%	1%	1%
- UAE and Qatar	%	2%	2%	3%	2%	3%	4%	2%	2%	2%	3%	4%	4%	3%	4%	5%	6%	4%	3%	3%	3%
- USA and Canada	%	42%	43%	40%	40%	38%	40%	21%	20%	20%	20%	18%	16%	16%	14%	17%	18%	18%	17%	17%	17%
- Mexico	%	1%	1%	4%	4%	4%	4%	2%	3%	3%	3%	3%	3%	3%	3%	3%	2%	2%	2%	2%	2%
- Venezuela	%	3%	3%	3%	3%	4%	3%	3%	2%	2%	3%	2%	3%	3%	3%	2%	2%	2%	2%	2%	1%
- Brazil	%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- UK and Netherlands	%	12%	12%	12%	13%	12%	12%	7%	6%	6%	6%	7%	9%	9%	10%	11%	11%	11%	11%	10%	10%
- Other Europe (ex. Norway, Russia)	%	7%	7%	7%	7%	7%	7%	4%	4%	4%	4%	4%	4%	4%	6%	6%	6%	6%	7%	7%	7%
- Russia	%							42%	42%	41%	39%	38%	37%	37%	35%	32%	30%	31%	31%	32%	32%
- Norway	%	0%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	2%	2%	2%
- Algeria	%	7%	7%	7%	7%	8%	7%	4%	4%	4%	5%	5%	5%	5%	6%	4%	4%	4%	4%	5%	4%
- China	%							1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	3%
- Others	%	17%	14%	14%	13%	13%	13%	7%	10%	8%	9%	10%	10%	11%	9%	10%	9%	8%	10%	8%	9%
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Refining capacity by home country of company																					
- Saudi Arabia	%	3%	4%	4%	5%	4%	4%	4%	4%	5%	5%	4%	4%	4%	4%	4%	4%	4%	4%	5%	5%
- Iran	%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
- Iraq	%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- Kuwait	%	2%	2%	2%	2%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
- UAE and Qatar	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	1%	1%
- USA and Canada	%	43%	40%	40%	37%	39%	39%	38%	34%	32%	33%	31%	27%	27%	23%	26%	25%	25%	24%	24%	24%
- Mexico	%	4%	4%	4%	4%	4%	4%	4%	3%	4%	4%	5%	3%	3%	3%	3%	3%	3%	3%	3%	3%
- Venezuela	%	3%	4%	5%	6%	6%	6%	5%	5%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
- Brazil	%	4%	4%	4%	4%	4%	4%	3%	4%	4%	3%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
- UK and Netherlands	%	17%	15%	16%	19%	16%	15%	15%	13%	14%	13%	13%	14%	12%	13%	13%	15%	15%	14%	13%	13%
- Other Europe (ex. Norway, Russia)	%	9%	10%	9%	9%	10%	10%	10%	9%	8%	10%	10%	9%	9%	10%	9%	9%	9%	10%	10%	10%
- Russia	%							1%	11%	10%	10%	8%	7%	7%	7%	6%	8%	7%	7%	7%	7%
- Norway	%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- Algeria	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- China	%							1%	1%	1%	1%	2%	10%	9%	9%	9%	9%	9%	10%	10%	11%
- Others	%	10%	12%	10%	8%	9%	11%	10%	6%	8%	8%	8%	7%	9%	12%	8%	8%	8%	8%	8%	8%
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Oil product sales by home country of company																					
- Saudi Arabia	%	3%	4%	4%	4%	4%	4%	4%	4%	5%	6%	5%	5%	5%	5%	5%	5%	4%	4%	4%	5%
- Iran	%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	2%	2%	2%	2%	3%	3%	2%	3%
- Iraq	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- Kuwait	%	2%	2%	2%	2%	1%	1%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	1%	2%	2%
- UAE and Qatar	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	1%	1%	1%	1%
- USA and Canada	%	46%	43%	44%	44%	42%	41%	41%	37%	37%	36%	36%	32%	34%	27%	30%	27%	28%	28%	28%	26%
- Mexico	%	3%	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%	3%	2%	3%	3%
- Venezuela	%	2%	4%	4%	4%	4%	4%	4%	6%	5%	6%	5%	5%	4%	5%	5%	4%	4%	4%	5%	5%
- Brazil	%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	4%	4%	4%	4%
- UK and Netherlands	%	20%	19%	19%	19%	19%	18%	18%	18%	19%	17%	19%	20%	20%	19%	20%	23%	24%	22%	21%	20%
- Other Europe (ex. Norway, Russia)	%	8%	9%	9%	10%	11%	11%	10%	10%	9%	10%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%
- Russia	s							1%	5%	5%	5%	4%	3%	3%	5%	5%	5%	5%	5%	6%	6%
- Norway	%	0%	0%	1%	1%	1%	1%	1%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- Algeria	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
- China	%							0%	0%	1%	1%	1%	4%	4%	4%	4%	5%	5%	6%	7%	6%
- Others	%	9%	8%	7%	7%	7%	10%	9%	6%	6%	6%	6%	6%	7%	11%	9%	7%	6%	7%	6%	7%
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Appendix B (cont'd)

	Unit	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Financial and employment data by ownership type																					
Own-1: Fully state-owned																					
Number of companies in sample	#	26	25	23	22	21	20	20	19	19	19	20	21	24	19	19	18	18	18	17	18
- for which revenue data	#	-	25	11	10	10	11	4	7	10	10	10	9	13	5	5	9	17	18	15	16
- for which net income data	#	-	13	11	9	9	11	4	7	7	10	10	9	13	6	5	7	4	7	5	9
- for which financial assets data	#	-	14	11	9	8	11	4	7	9	10	10	9	13	8	5	9	9	6	3	6
- for which employment data	#	-	16	6	11	14	15	15	17	16	16	16	17	20	15	15	15	16	16	15	16
Revenues - minimum value	US$m		1,350	229	1,396	607	1,829	11,579	921	676	1,109	1,350	3,513	1,139	9,250	2,322	4,332	3,500	4,000	6,682	7,250
Revenues - maximum value	US$m		25,438	29,270	41,760	40,961	33,840	34,760	31,288	26,041	31,659	36,994	34,080	41,891	57,203	46,250	47,032	93,100	122,000	180,000	215,000
Revenues - mean value	US$m		8,487	8,784	11,666	12,427	12,268	23,575	15,592	12,736	13,684	15,842	18,291	16,098	29,466	22,164	24,665	25,203	28,092	43,992	57,258
Revenues - median value	US$m		7,500	4,333	4,696	9,129	12,781	23,981	12,864	12,349	13,057	13,596	16,353	13,564	23,108	19,305	26,976	22,357	16,725	30,650	42,150
Net income - minimum value	US$m		- 47	27	157	224	- 554	- 156	75	1	58	152	- 1,108	- 2,303	- 2,059	- 3,729	- 2,957	- 3,617	- 2,263	- 7,078	148
Net income - maximum value	US$m		1,533	2,204	2,143	3,273	1,289	1,089	2,013	3,103	4,495	4,772	1,735	3,318	7,216	4,339	4,291	6,227	9,358	11,566	14,446
Net income - mean value	US$m		561	736	914	895	393	594	971	1,548	1,475	1,721	305	1,007	2,426	1,129	1,328	887	2,508	1,528	6,029
Net income - median value	US$m		433	722	505	659	293	722	680	1,454	696	916	194	520	2,395	561	694	470	837	1,160	5,452
Assets - minimum value	US$m		250	258	270	2,624	2,977	13,677	1,611	3,665	2,029	3,450	7,609	1,982	2,400	4,300	5,193	6,797	9,426	14,300	18,877
Assets - maximum value	US$m		45,957	45,554	45,079	64,412	69,243	56,081	54,829	40,502	45,402	47,874	61,297	53,880	59,316	60,913	67,625	75,247	84,114	96,733	178,843
Assets - mean value	US$m		11,926	14,308	15,703	22,684	20,641	37,962	24,812	20,778	19,733	23,247	30,805	23,740	26,382	34,058	33,434	32,023	38,048	61,373	87,642
Assets - median value	US$m		9,187	9,448	9,443	12,232	10,741	41,045	12,608	17,922	16,388	17,865	25,345	15,536	17,326	36,954	34,497	28,000	30,912	73,086	82,865
Employees - minimum value	#		700		766	766	4,100	4,000	4,000	4,000	4,443	5,500	5,500	917	4,102	2,167	5,500	6,298	6,027	5,856	5,856
Employees - maximum value	#		170,700		167,952	154,321	150,000	350,000	350,000	400,000	400,000	518,000	1,190,000	1,190,000	132,954	134,852	137,134	138,215	137,772	139,171	1,589,000
Employees - mean value	#		37,357		44,969	43,159	41,180	59,900	66,265	64,821	64,112	76,874	149,572	122,435	49,500	53,872	53,497	50,692	51,125	49,029	144,941
Employees - median value	#		19,258		13,222	35,000	34,600	43,000	47,000	40,963	40,500	44,000	45,000	39,208	41,320	50,061	49,522	42,500	41,800	35,000	37,626
Own-2: Majority state-owned																					
Number of companies in sample	#	3	4	5	5	6	7	7	10	10	5	5	4	4	8	8	7	7	7	8	7
- for which revenue data	#	-	3	4	4	5	5	3	3	3	2	3	2	2	5	6	6	7	7	8	7
- for which net income data	#	-	2	4	4	5	5	4	3	2	2	3	2	3	6	5	6	6	6	7	6
- for which financial assets data	#	-	2	4	4	5	5	3	3	2	2	3	1	2	6	6	6	6	6	7	6
- for which employment data	#	-	2	2	4	6	5	5	5	9	4	5	4	3	8	8	7	7	7	8	7
Revenues - minimum value	US$m		2,500	1,762	1,861	1,981	2,041	3,596	3,356	15,811	26,759	23,599	12,200	12,555	19,240	4,841	7,263	5,700	6,840	9,900	11,000
Revenues - maximum value	US$m		22,556	25,881	37,072	35,572	38,324	39,916	17,357	37,972	37,973	34,323	25,307	22,546	39,009	38,515	43,000	53,533	74,888	101,652	135,090
Revenues - mean value	US$m		13,845	13,400	17,466	15,028	16,165	20,514	10,513	24,743	32,366	28,622	18,754	17,551	30,283	24,015	24,426	29,161	37,112	50,251	59,258
Revenues - median value	US$m		16,480	12,978	15,466	16,275	16,602	18,029	10,826	20,447	32,366	27,944	18,754	17,551	29,232	25,842	22,517	35,348	40,244	60,151	66,616
Net income - minimum value	US$m		265	128	511	- 520	2	162	186	586	643	1,353	- 7,100	436	1,098	1,291	921	2,013	2,960	3,247	3,453
Net income - maximum value	US$m		1,370	1,247	2,083	1,737	1,118	686	1,432	2,824	2,930	6,585	1,149	2,141	10,197	5,655	5,665	8,402	12,421	16,284	22,655
Net income - mean value	US$m		818	583	947	408	436	364	862	1,705	1,787	3,610	- 2,976	1,186	4,577	2,857	2,553	4,521	6,132	8,223	9,266
Net income - median value	US$m		818	478	598	383	425	305	967	1,705	1,787	2,893	- 2,976	982	3,819	1,936	2,226	3,903	5,269	4,996	6,565
Assets - minimum value	US$m		13,690	2,501	4,040	4,431	3,459	4,391	4,195	18,837	33,736	34,221	33,175	31,667	8,520	7,455	9,156	13,195	16,877	17,355	18,442
Assets - maximum value	US$m		28,517	33,181	42,559	46,718	45,129	48,044	41,993	54,668	59,305	75,073	33,175	45,710	67,199	55,681	77,667	94,466	115,441	161,816	201,661
Assets - mean value	US$m		21,104	15,166	17,727	17,515	16,885	24,418	21,681	36,753	46,521	52,725	33,175	38,689	38,792	35,982	42,004	51,138	61,216	70,476	82,394
Assets - median value	US$m		21,104	12,491	12,155	13,126	11,713	20,818	18,855	36,753	46,521	48,880	33,175	38,689	40,593	40,584	38,688	50,991	60,178	66,555	64,395
Employees - minimum value	#		41,862		46,024	49,365	51,100	10,000	10,000	5,646	5,679	5,749	4,620	4,417	4,024	4,700	4,470	4,514	57,480	49,919	1,700
Employees - maximum value	#		41,862		46,024	49,365	51,100	51,000	92,000	85,500	106,000	94,200	94,200	100,000	120,000	130,000	150,000	72,405	71,497	72,258	73,572
Employees - mean value	#		41,862		46,024	49,365	51,100	27,000	42,750	37,300	31,526	32,847	42,198	58,813	64,664	73,912	78,375	39,306	64,489	61,089	38,755
Employees - median value	#		41,862		46,024	49,365	51,100	20,000	34,500	34,750	16,500	15,720	23,762	72,023	69,969	80,474	80,655	41,000	64,489	61,089	40,993

Appendix B (cont'd)

	Unit	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Own-3: Majority privately-owned																					
Number of companies in sample	#	1	1	1	1	1	1	3	6	6	7	4	5	3	4	5	4	4	3	3	4
- for which revenue data	#	-	1	1	1	1	1	3	4	4	3	4	5	3	3	3	3	3	2	2	3
- for which net income data	#	-	1	1	1	1	1	3	4	4	3	4	5	3	3	3	3	3	2	2	3
- for which financial assets data	#	-	1	1	1	1	1	3	5	4	3	4	5	3	3	3	3	3	2	2	3
- for which employment data	#	-	1	1	1	1	1	3	4	6	5	4	5	3	3	4	3	3	2	2	3
Revenues - minimum value	US$m		13,982	18,641	23,612	27,530	24,716	3,958	4,192	3,530	4,123	4,267	3,264	4,137	8,812	5,648	7,119	8,833	12,725	19,850	8,218
Revenues - maximum value	US$m		13,982	18,641	23,612	27,530	24,716	24,112	38,890	42,450	21,344	21,057	31,606	32,184	56,886	47,944	47,218	60,556	75,466	92,471	109,688
Revenues - mean value	US$m		13,982	18,641	23,612	27,530	24,716	14,638	21,668	19,670	10,468	10,566	13,892	15,495	26,236	22,385	24,279	30,563	44,096	56,161	47,394
Revenues - median value	US$m		13,982	18,641	23,612	27,530	24,716	15,845	21,794	16,351	5,937	8,471	8,393	10,163	13,010	13,562	18,500	22,299	44,096	56,161	24,277
Net income - minimum value	US$m		328	381	747	1,118	515	529	- 1,017	144	182	214	62	157	604	588	621	1,203	797	1,555	1,399
Net income - maximum value	US$m		328	381	747	1,118	515	706	735	1,026	918	877	2,596	2,877	5,376	6,927	4,360	6,364	9,061	10,878	11,632
Net income - mean value	US$m		328	381	747	1,118	515	603	222	680	639	556	881	1,423	3,082	3,208	2,275	3,756	4,929	6,217	4,925
Net income - median value	US$m		328	381	747	1,118	515	575	586	775	817	566	512	1,236	3,265	2,109	1,843	3,701	4,929	6,217	1,745
Assets - minimum value	US$m		14,764	15,276	20,401	21,955	20,916	7,198	5,304	4,752	5,671	5,872	5,465	5,829	6,601	6,221	8,522	11,270	17,664	18,298	13,628
Assets - maximum value	US$m		14,764	15,276	20,401	21,955	20,916	23,879	46,709	49,360	16,622	17,525	46,100	46,520	49,304	56,162	68,973	84,520	94,082	99,300	116,510
Assets - mean value	US$m		14,764	15,276	20,401	21,955	20,916	13,903	17,222	20,236	11,447	12,578	17,590	20,492	24,338	27,442	33,165	40,788	55,873	58,799	51,209
Assets - median value	US$m		14,764	15,276	20,401	21,955	20,916	10,633	12,198	13,415	12,048	13,457	13,146	9,126	17,109	19,942	22,001	26,574	55,873	58,799	23,489
Employees - minimum value	#		41,862		46,024	49,365	51,100	10,000	10,000	5,646	5,679	5,749	4,620	4,417	4,024	4,700	4,470	4,514	57,480	49,919	1,700
Employees - maximum value	#		41,862		46,024	49,365	51,100	51,000	92,000	85,500	106,000	94,200	94,200	100,000	120,000	130,000	150,000	72,405	71,497	72,258	73,572
Employees - mean value	#		41,862		46,024	49,365	51,100	27,000	42,750	37,300	31,526	32,847	42,198	58,813	64,664	73,912	78,375	39,306	64,489	61,089	38,755
Employees - median value	#		41,862		46,024	49,365	51,100	20,000	34,500	34,750	16,500	15,720	23,762	72,023	69,969	80,474	80,655	41,000	64,489	61,089	40,993
Own-4: Privately owned																					
Number of companies in sample	#	20	20	21	22	22	22	20	15	15	19	21	20	19	19	18	22	21	22	22	21
- for which revenue data	#	-	19	21	22	21	21	20	14	15	16	17	19	16	15	16	21	21	21	21	20
- for which net income data	#	-	19	21	21	21	21	20	14	15	16	17	19	18	16	16	20	21	21	21	20
- for which financial assets data	#	-	19	21	22	21	21	20	14	14	16	15	18	17	16	16	21	21	21	21	20
- for which employment data	#	-	17	14	22	21	21	20	15	14	16	21	20	19	17	18	22	21	21	21	20
Revenues - minimum value	US$m		1,286	1,211	1,960	1,598	1,400	3,297	6,699	3,260	8,272	2,675	1,390	1,750	2,398	2,682	3,860	4,199	5,333	7,100	1,803
Revenues - maximum value	US$m		88,563	99,924	132,414	131,529	128,420	125,814	129,109	150,690	171,796	172,832	138,903	185,527	228,439	191,201	182,616	235,899	286,836	338,992	345,683
Revenues - mean value	US$m		24,803	25,652	29,745	30,243	30,689	29,989	39,151	40,902	48,180	44,604	33,236	35,032	64,349	57,032	45,707	56,025	71,093	83,119	92,253
Revenues - median value	US$m		13,611	12,817	16,457	15,851	17,286	16,067	23,781	19,126	35,058	31,747	22,075	19,090	38,737	21,112	15,449	10,379	11,923	23,171	32,076
Net income - minimum value	US$m		- 305	98	- 1,695	- 387	- 624	- 288	74	- 394	36	8	- 861	315	242	- 188	- 1,467	611	929	867	520
Net income - maximum value	US$m		5,260	7,574	6,533	5,600	5,369	5,300	6,267	6,919	8,885	8,460	6,370	8,584	17,720	15,320	11,460	21,510	25,330	36,130	39,500
Net income - mean value	US$m		1,296	1,335	1,369	1,060	735	1,032	1,581	1,593	2,394	2,344	683	2,039	4,435	3,665	2,218	4,285	5,910	8,209	9,448
Net income - median value	US$m		571	538	779	477	286	327	915	655	1,503	1,264	350	907	2,122	1,480	907	2,278	2,176	3,426	5,043
Assets - minimum value	US$m		3,422	3,651	2,319	4,405	3,700	5,500	6,615	7,756	7,784	3,443	4,652	4,280	4,573	5,713	7,548	8,150	9,122	17,714	3,203
Assets - maximum value	US$m		85,280	107,979	106,431	105,533	100,819	99,380	107,852	117,602	124,140	114,065	110,068	144,521	149,000	143,174	159,125	174,278	195,256	219,516	235,276
Assets - mean value	US$m		24,317	25,913	26,098	26,657	25,413	26,340	31,674	34,137	36,667	36,750	32,116	34,324	46,721	46,732	46,470	50,351	57,381	66,165	78,378
Assets - median value	US$m		11,968	11,529	13,479	12,326	17,877	20,267	25,034	24,468	28,713	29,600	20,637	15,705	25,688	17,887	17,812	19,482	23,423	28,498	35,085
Employees - minimum value	#		2,170		2,700	2,500	1,600	3,000	3,000	8,200	9,085	2,652	7,880	1,536	3,500	1,353	2,003	2,111	2,214	1,700	3,150
Employees - maximum value	#		134,000		137,000	133,000	127,000	127,000	106,000	104,000	101,000	105,000	102,000	125,000	123,303	122,025	121,469	119,000	150,000	150,000	148,600
Employees - mean value	#		41,768		41,008	40,602	38,138	40,050	37,133	31,811	40,091	45,682	47,334	46,980	51,152	53,499	47,031	46,144	47,453	44,993	45,666
Employees - median value	#		23,772		25,000	24,700	22,800	23,500	23,000	21,508	34,889	43,451	40,346	32,103	37,387	52,050	30,801	31,121	33,337	27,756	32,563