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The five offshore drilling rig markets

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ABSTRACT

The offshore drilling industry is composed of five markets engaged in the trade of a unique service or good. Mobile offshore drilling units are owned and operated in the contract drilling services market, supplied by the newbuild and secondhand markets, maintained and enhanced in the upgrade market, and complete their lifecycle in the storage and scrap market. The purpose of this review is to characterize the players, pricing, size and revenue of each market. The contract drilling and newbuild markets are the largest and most transparent of the sectors and the majority of activity is concentrated in a small number of players. In 2010, drilling services generated approximately $45 billion in worldwide revenue and the newbuild market supplied $18 billion in jackups, semisubmersibles and drillships. The secondhand market is an important secondary market where rigs are sold between contractors. Maintenance and upgrade activities are performed by a number of shipyards throughout the world, but because of the sporadic mature of the activities and limited record keeping, the market is the least transparent. In 2010, the secondhand market realized approximately $7 billion in market exchanges and about $2 billion was spent on rig upgrades. The scrap market is the smallest of the five markets and valued at less than $50 million.

1. Introduction

Mobile offshore drilling units (MODUs or rigs) are marine vessels used to explore, develop and workover wellbores. Offshore exploration and production (E&P) started in the U.S. Gulf of Mexico (GOM) in 1947, and expanded rapidly to the North Sea, Brazil, West Africa, the Persian Gulf and Southeast Asia. China and India are important emerging markets and the first offshore well was spud in the Arctic Ocean in 2012. Today, of the 145 countries with a coastline, 51 had at least 1 operating rig over 2010–2012.

Since 1950, over 120,000 wells have been drilled offshore, with about half in the U.S. Gulf of Mexico [1,2]. Over the past decade, about 3500 offshore wells were drilled each year [3], and the majority of these wells were drilled using MODUs. Currently, offshore oil is produced in 30 countries and represents approximately one-third of global production.

The offshore drilling rig industry is composed of five markets. MODUs are owned and operated in the contract drilling services market, constructed in the newbuild market, exchanged in the secondhand market, maintained and enhanced in the upgrade market, and complete their lifecycle in the scrap market. Cash enters the contract drilling market when E&P firms lease rigs from contractors (Fig. 1). Drilling contractors use this cash to operate their units, acquire new rigs for their fleet, and upgrade and maintain existing rigs. The newbuild and upgrade markets are the primary mechanisms by which capital expenditures leave the service market. Most transactions in the secondhand market occur between players in the contract drilling market.

In the contract drilling market, rigs are owned and operated by drilling contractors and leased to E&P firms to drill or service wells. Rigs are hired on a dayrate basis. The dayrate is the daily price to lease a rig and includes the use of the rig and its crew but does not include most of the other costs associated with drilling a well. The contract drilling market is the largest and most closely followed of the five markets and drives the activities of investors in the other markets. Since rig hire represents between 30 to 50% of the costs to drill an offshore well [4], the market dynamics of contract drilling are important indicators of well construction costs.

The newbuild market uses shipyard labor and capital to convert steel and third party equipment into rigs. Drilling contractors enter into turnkey contracts with shipyards for the delivery of one or more rigs, or yards may build on speculation. The newbuild market is primarily Asian with major shipyards in Singapore, South Korea, and China. The newbuild market represents the primary endpoint for capital expenditure for drilling contractors.

Regular maintenance is required for safe and efficient operations, and as a rig ages, its technology becomes obsolete and upgrades are required to sustain competitiveness and market value. The upgrade market is a ship repair market which both upgrades and maintains rigs for contractors. Upgrades improve and modernize the technology on a rig and represent significant capital expenditures. Maintenance is conducted more frequently and is accounted for as an operating expense.

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In the secondhand market, rigs are sold among drilling contractors and between contractors and other market participants. Rigs may be sold for use in the service market, may be converted to another use by the buyer, or sold into the scrap market. Typical conversions are for accommodation units and early production systems. Transactions include corporate mergers where all the assets of the firm are purchased, liquidations during bankruptcy, or conventional sales of one or more units.

In the scrap market, shipbreaking firms buy rigs on the secondhand market, either directly from drilling contractors or from brokers. Equipment is removed and reused or sold as market conditions and demand permit. Following sale, the rig is transported to a specialized shipbreaking facility and the rig is dismantled with the steel recovered and sold for scrap to mini-steel mills. Rigs may be stored in yards for months to years until the scrap price of steel is adequate to make dismantling economic. The financial value of individual sales in the scrap market is low, and companies do not frequently report income from scrap sales. As a result, the scrap market is the least transparent of the five markets.

The purpose of this paper is to describe the activity levels, prices, and cash flows in the five offshore rig markets. We begin with background information on rig types and the activity states through which a rig transitions over its lifetime. For each market, empirical data is used to characterize the primary system measures, players, prices, market size, and market value. Players are the major firms engaged in selling products and services and prices represent the average cost of transactions. Market size and market value are the annual number of transactions and their cumulative cost, respectively.

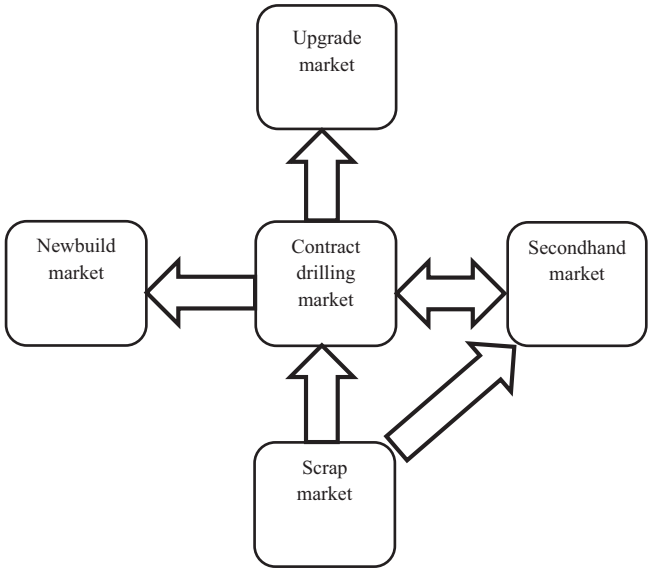

Fig. 1. Direction of cash flow through offshore rig markets.

2. Rig types

MODUs are classified as bottom supported and floating rigs. In bottom-supported units, the rig is in contact with the seafloor during drilling, while a floating rig floats over the site while it drills, held in position by anchors or equipped with thrusters using dynamic positioning.

Bottom-supported units include barges, submersibles and jackups. Barges and submersibles are used for protected and inland regions while jakups are used for exposed and offshore locations. Jakups are the most common bottom-supported rig and consist of a barge-type hull with legs that can be adjusted to suit a given location (Fig. 2). Once in position, the legs are lowered, hoisting the drilling platform above the water. Jackups are capable of drilling on a wide variety of tracks in water depths up to 500 ft [5].

Floating units include semisubmersibles and drillships and are used for deepwater drilling. The semisubmersible (semi) consists of a deck supported by submerged pontoons connected by several large columns. By varying the amount of ballast in the pontoons, the unit can be raised or lowered. The lower the pontoons lie beneath the surface, the less they are affected by wave and current action. Semisubmersibles are very stable in harsh environments [6], and most deepwater, harsh environment rigs are semisubmersibles.

A drillship is a self-propelled ship-shaped vessel. The rig derrick is usually mounted in the middle of the vessel and drilling is conducted through a large aperture known as a "moon pool." Drillships are the most advanced and expensive sector of the rig market and many water depth records are held by drillships. New drillships are capable of drilling in 12,000 ft of water with wells up to 40,000 ft deep.

3. Activity states

Rigs transition through several distinct stages over their lifecycle which determine the size and dynamics of the individual markets (Fig. 3).

Fig. 2. Clockwise from upper left: the semisubmersible West Aquarius, the drillship West Gemini, and the jackup West Triton.
Source: Seadrill.

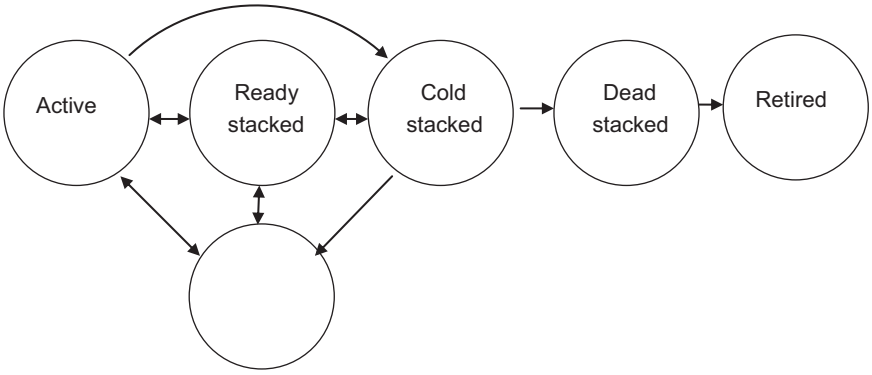

Fig. 3. Transitions among rig activity states.

Active rigs are working under contract and are the only state in which a rig receives income. Active rigs may be drilling, waiting on location, in transit, or in a mobilization/demobilization status [7]. Newbuild markets supply the contract market and newbuild units begin their lives in an active state.

Active rigs become inactive when their drilling contract (work obligation) expires. If a rig is to be idled for a short period of time, the rig is typically maintained in a prepared or "ready-stacked" (warm) state. Ready-stacked rigs are idle but available for immediate use with minor preparation. In a ready-stacked state, normal maintenance operations similar to those performed when the rig is active are continued so that the rig remains work ready. Ready-stacked rigs are actively marketed and considered part of marketable supply [8].

If operators do not expect a rig to be utilized in the near term, the rig is "cold-stacked" to reduce operating cost and support fleet dayrates. Cold-stacked rigs are frequently inactive for a period of several months to one or more years. Cold-stacked rigs are generally not considered part of the marketable supply and are usually not counted in supply and utilization statistics. Cold-stacked units are stored in a wet dock and require capital and time to return to working condition [9,10]. The upgrade and maintenance market is responsible for reactivating cold-stacked units. Cold-stacked units are frequently sold into the secondhand market.

A rig will transition between inactive states many times throughout its life, and as a rig ages, it will spend an increasing portion of its time cold-stacked. After being cold-stacked for several years, reactivation costs become prohibitive and a rig is labeled "dead-stacked." Dead-stacked rigs are highly unlikely to find commercial work and are mostly used for parts before being retired. Units may remain dead-stacked for many years before being dismantled.

A rig is removed from the fleet when it is converted to another use, sold for scrap, or lost due to a catastrophic event. Conversion to a mobile offshore production unit or an accommodation unit are the most common alternative uses and involve sale in the secondhand market. Sale for scrap also involves sale in the secondhand market, but because the scrap market is small and not of interest to investors, sales are rarely documented. Rigs destroyed by hurricanes are scrapped or may be cleaned and towed to an approved reef site.

4. Contract drilling market

4.1. System measures

The contract drilling market is described by dayrates, utilization and fleet size. Dayrates behave according to demand and supply conditions, and as rig demand approaches available supply, dayrates generally rise. Demand for contract drilling is driven by the capital spending patterns of E&P companies, which in turn, is based on producer's expectations of future prices and risk and the availability of acreage [11,12]. Dayrates are an indicator of market conditions and the same drivers that impact dayrates tend to influence the rest of the offshore service and support industry.

Utilization is a system measure defined by the proportion of rigs working to the total fleet. Utilization is a measure of the spare capacity in the market and can be computed at various levels of aggregation. Industry capacity is not a fixed resource because companies can add rigs through newbuilding and redistribute existing fleets to respond to higher demand and stack rigs when demand declines. While adding capacity takes several years, drilling rigs have very long lives (25+ years), and when demand weakens, overcapacity in the market may lead to prolonged declines in utilization [13]. Stacking units removes capacity from the market and can be performed relatively quickly to help support prices, but stacking, like newbuilding decisions, are firm specific and are not performed in unison [8]. High utilization rates cause dayrates to rise and provide a signal to operators that additional capacity can be absorbed in the market. Regionally elevated utilization rates lead drilling contractors to reposition fleets while globally high utilization rates encourage newbuilding investment.

Fleet size describes the total number of rigs of a given water depth or class. Fleet size is described by firm, and when reported regionally, is an indicator of the total capacity in the drilling market. The scale and quality of a contractor's asset base is correlated with its revenue base. A large asset base implies a platform for sustainable earnings and cash flows and is related to a company's market position, its ability to compete in terms of cost structure, and the ability to obtain financing for capital projects [14].

4.2. Players

The major players by rig count (including cold-stacked units and rigs under construction) are shown in Table 1. In 2011, the fleet size was 868 rigs. Fleet sizes change over time with changing market conditions, but the changes are often slow. The market is dominated by a small number of firms including Transocean, Noble Drilling, ENSCO, Diamond Offshore and Seadrill. In total, there are approximately 100 rig operators, but the top four firms own 36% of the rigs and the top eight firms own over half of the rig fleet. Contractors not listed in the table own, on average, three rigs each.

Eleven of the sixteen firms listed in Table 1 are publicly traded, including the six largest firms. Maersk is a subsidiary of the A.P. Moller-Maersk group. COSL, ONGC, National Drilling and Petrobras are backed by state governments, and all but National Drilling are listed on stock exchanges and have access to capital markets.

Table 1
Distribution of rigs by class and operator including cold-stacked rigs and rigs under construction in the 1Q 2011.
Source: Data from [27].

Company	Jackup	Drillship	Semi	Total	Ownership
Transocean	68	23	50	141	Public
Noble Drilling	45	13	14	72	Public
ENSCO	49	7	20	76	Public
Diamond Offshore	13	3	32	48	Public
Seadrill	21	6	12	39	Public
Hercules Offshore	53	0	0	53	Public
COSL	27	0	6	33	State
Rowan	31	0	0	31	Public
Maersk Drilling	14	0	6	20	Subsidiary
Aban Offshore	15	3	0	18	Public
Saipem	7	2	7	16	Public
Nabors Offshore	16	0	0	16	Public
Atwood Oceanics	6	1	6	13	Public
National Drilling	13	0	0	13	State
ONGC	8	2	0	10	State
Petrobras	6	0	4	10	State
All others (87 firms)	147	46	66	259	
Top 4 firms	205	46	116	367	
Top 8 firms	337	52	134	523	
Total	539	106	223	868	

Table 2
Geographic distribution of active rigs by nation in 2011.
Source: Data from [27].

Region	Jackups	Semis	Drillships	Total
US GOM	51	20	10	81
Persian Gulf	85	0	0	85
Brazil	3	52	15	70
North Sea	32	36	2	57
Southeast Asia	42	9	2	53
West Africa	17	13	9	39
India	34	2	9	45
China	28	4	0	32
Mexico	24	3	0	27
Egypt	20	2	2	24
Australia	1	7	1	9
Ghana	0	3	2	5
Azerbaijan	2	3	0	5
Venezuela	3	0	2	5
All others	49	20	8	77
Top 4	171	108	27	306
Top 8	292	136	47	475
Total	394	175	57	626

The demand for drilling varies by region and time. In 2011 the service market was active in the U.S. GOM, Brazil, Persian Gulf, Southeast Asia, India, China, the North Sea, and Mexican GOM (Table 2). These eight regions contain approximately 85% of the active fleet. Smaller markets include the Mediterranean, the Red Sea, Black Sea, Caspian Sea, Eastern Canada, the Caribbean and Western Australia. Frontier regions include the Arctic Ocean, East Africa, Ghana, and the Philippines and typically contain less than five rigs [15].

4.3. Prices

Dayrates are the primary contract specification during the bidding process. Dayrates are often announced by drilling contractors and are monitored by industry observers and assembled by commercial data providers (such as RigLogix, ODS-Petrodata, RigStar and RigData). Contract durations are often less than a year so there is a steady stream of new contracts that provide a transparent and reliable indicator of the industry.

In Fig. 4, the six month moving average[1] of jackup and floater dayrates in the major markets are depicted. Prices were relatively stable from 2000 to 2005 before increasing sharply from 2005 to 2007 as oil prices rose. Prices stabilized throughout 2007 and 2008, but following the 2008 recession, prices fell, especially in the more volatile jackup market. Regional prices tend to move together, but not all markets respond in the same manner. Interregional dayrate correlations range from 0.53 to 0.76 in the jackup markets and 0.78 to 0.85 in the floater markets.

In the jackup market, there are significant price differences between regions. In the 2009 to 2011 period, jackup dayrates ranged from 50,000 to 100,000 $/day in the U.S. GOM compared with 100,000–175,000 $/day in the North Sea. Differences are due to oversupply in the U.S. GOM, the large number of low specification rigs in the Persian Gulf and U.S. GOM, and the high cost of premium, harsh environment jackups in the North Sea.

In the floater market, there is less variation between regions due to patterns of supply and demand, technical requirements, and the general similarity of deepwater rig capacity. In the 2009–2011 period, floater dayrates ranged between 300,000 to 500,000 $/day with slightly lower dayrates in Southeast Asia than in the Atlantic basins.

4.4. Market size

Since 1994 the number of offshore wells drilled has ranged between 2500 and 3700 per year (Fig. 5). Development wells are drilled from either MODUs or platforms, but all exploratory wells are drilled using MODUs. Deepwater (>400 m) drilling activity has grown over the past 15 years while the number of shallow water wells has fluctuated. While many market participants are focused on the more lucrative deepwater segment, approximately 80% of drilling still occurs in shallow water. Asia accounted for nearly half of drilling activity in 2011 while North and South America, West Africa and the North Sea accounted for remaining activity (Fig. 6). North American activity is dominated by drilling in the U.S. GOM, but due to the Macondo blowout on April 20, 2010, and subsequent drilling moratorium, activity levels are depressed relative to historic levels.

4.5. Market value

The market value of the offshore drilling market in 2010 is estimated in Table 3. The number of rigs of each class active in each month and region were counted and multiplied by the average regional dayrates. E&P firms paid approximately $43 billion to drilling contractors in 2010. Despite the fact that deepwater drilling makes up a relatively small proportion (about 20%) of the number of offshore wells drilled, the deepwater market accounts for approximately two-thirds of market revenue. Over the past decade, the contract drilling market has varied from $25 to $50 billion (Fig. 7).

Market valuation estimates are uncertain. Large markets with a high degree of involvement by E&P firms and publicly-traded drilling contractors are transparent and may be estimated with a degree of confidence. However, for small markets or those dominated by NOCs and state-owned drilling contractors, it is more difficult to reliably estimate market size. The Chinese market, for example, is particularly difficult to estimate due to the large number of state-owned rigs.

[1] Moving averages were computed to smooth the month-to-month variation and help differentiate the regions.

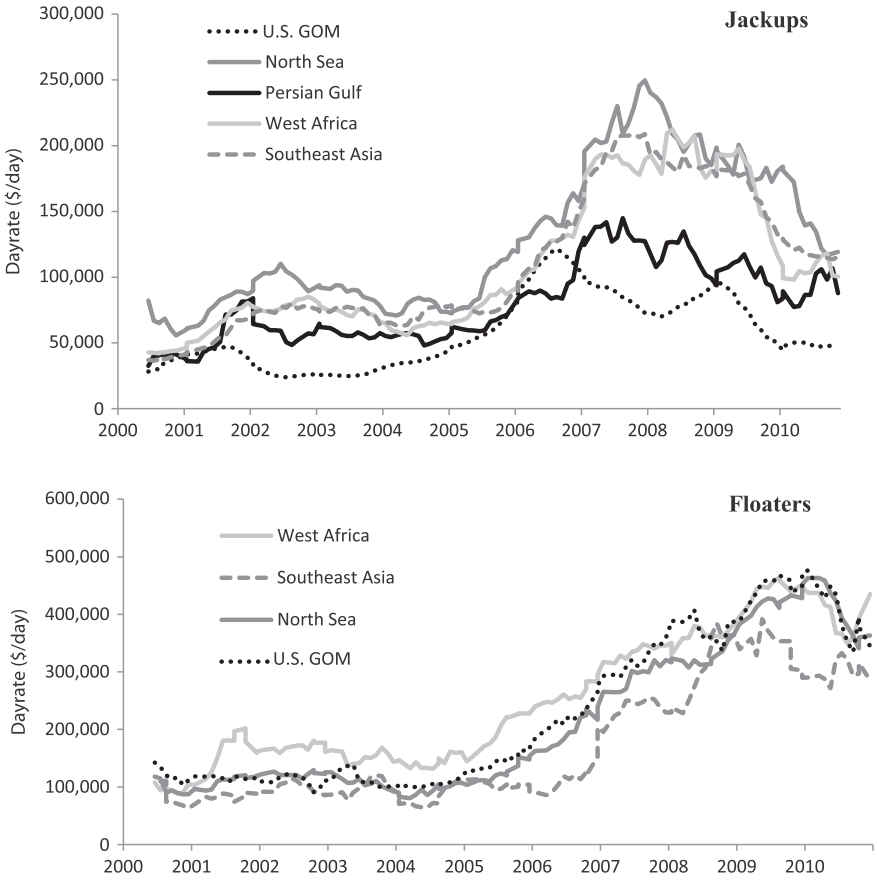

Fig. 4. Regional jackup and floater dayrates, 2000–2011. Dayrates computed as a six month moving average.
Source: Data from [27].

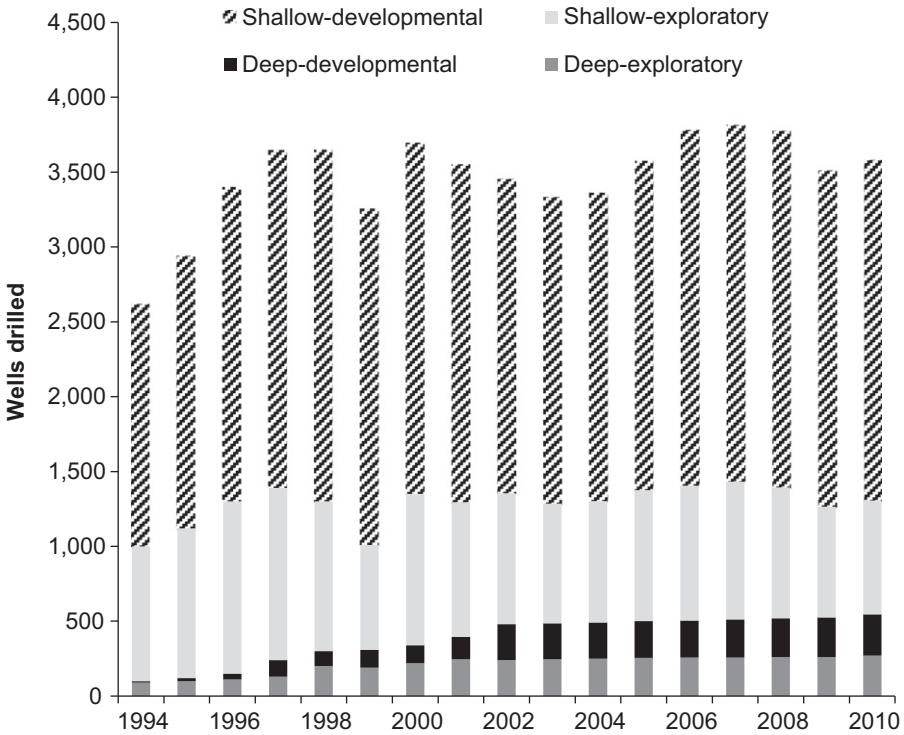

Fig. 5. Number of wells drilled per year, 1994–2010. Deepwater defined as greater than 400 m.
Source: Data from [3].

Drilling market valuations are performed by a number of consulting firms (IHS, ODS-Petrodata, Rystad Energy), and are subject to the experience of the analyst and their assumption set. Table 4 compares our market valuations to the firm Rystad Energy [16]. Our results are lower than INTSOK's across most regions and our total market value is also lower. The difference is due to the methods of analysis and the definition of the market. For example, Rystad Energy estimates also include well management and platform rig costs.

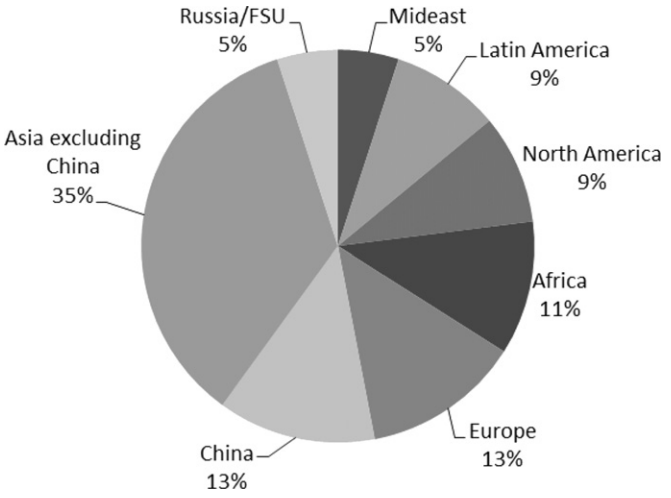

Fig. 6. Geographic distribution of the number of offshore wells drilled in 2011. *Source*: Data from [36].

5. Newbuild market

5.1. System measures

The newbuild market is specified by the number of deliveries and their prices. The market is highly transparent because newbuilding is a significant capital expenditure for contractors and a significant source of revenue for rig-building shipyards. Prices are widely reported for investment purposes and tracked by the same firms that survey dayrates.

Drilling contractors order rigs when the expected rate of return from operating a new rig exceeds internal investment criteria [17]. The benefit of investment depends on dayrates and utilization over the life of the rig [18], and since these are unknown, company management employ their own expectations relative to their business strategy and risk-reward profile. Since the newbuild market depends on conditions in the service market, the cyclical nature of contract drilling causes similar cycles in the newbuild market.

Table 3
Contract drilling service market size in 2010.
Source: Data from [27]; Authors calculations.

	Jackups (million $)	Floaters (million $)	Total (million $)
Persian Gulf	3,253		3,253
Southeast Asia	1,931	2,092	4,023
North Sea	1,865	6,436	8,302
India	1,263	1,369	2,632
Mexico GOM	1,075	256	1,331
West Africa	994	4,314	5,307
US GOM	983	3,781	4,765
Red Sea	511		511
Mediterranean	509	1,291	1,799
China	1,377	526	1,903
Venezuela and Caribbean	296	292	588
Brazil	72	7,615	7,688
Australia	57	1,022	1,079
Total	14,187	28,588	42,775

Table 4
E&P firm investment in contract drilling services by region in 2010.
Source: [16].

Region	INTSOK estimate (billion $)	Author's estimate (billion $)
Brazil	9.2	7.7
Asia	8.5	8.5
North America	8.6	6.1
West Africa	8.8	5.3
North Africa and Mideast	5.2	5.5
Russia and FSU	1.8	
Australia	3.3	1.0
North Sea	3.4*	8.3
Total	48.8	42.7

* Does not include Norway.

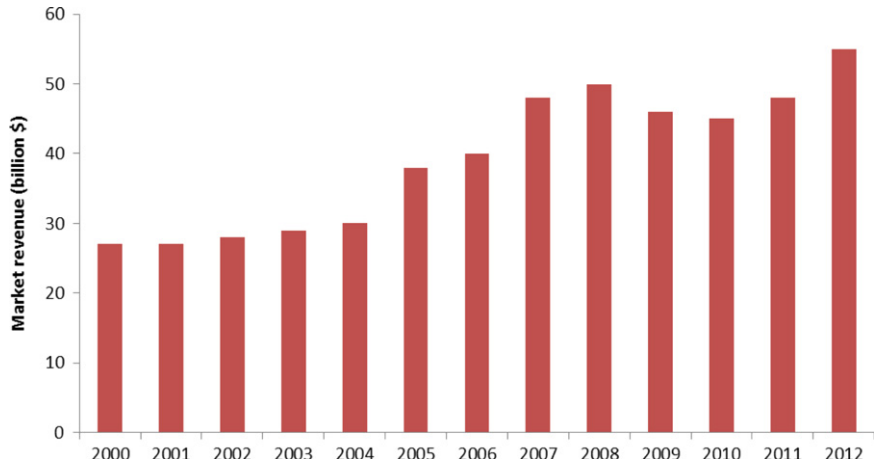

Fig. 7. Annual revenue of the offshore contract drilling market, 2000–2012.
Source: Data from [37].

Prices in the newbuild market are a function of demand and labor prices at shipyards, equipment costs and steel costs. As demand at shipyards increases, backlogs develop and shipyards are able to demand higher prices. In addition, demand at rig-building shipyards is generally associated with demand across the drilling supply chain. Therefore, demand and prices for drilling equipment typically increase along with demand at shipyards, and this leads to further price increases.

5.2. Players

The jackup market in 2011 was dominated by Keppel and its subsidiaries, while the drillship market was dominated by Daewoo and Samsung (Table 5). Keppel has shipyards located throughout the world, while the Daewoo and Samsung yards are located in Korea. The semi market is distributed across five Asian shipyards. There were 130 rigs under construction circa 2011 worth an estimated $56 billion (Table 6). Measured by capital flows, the rig building industry in South Korea is approximately twice as large as the Singaporean industry, however, this is due to the current boom in drillship construction and may not continue after the current round of drillships are delivered. Singapore is a major supplier of jackups to the world market while the U.S. plays a niche role in jackup supply to the U.S. GOM market.

Table 5
Number of newbuild rigs on order by shipyard in 2011.
Source: Data from [27].

Shipyard	Drillship	Jackup	Semisub
Daewoo	11		3
Samsung	16		2
Keppel FELS	1	17	4
Jurong*		5	3
PPL*		6	
Dalian		4	
ABG		4	
Hyundai	6		
Lamprell		4	
COSCO	1		3

* Part of Sembcorp Marine.

Table 6
Worldwide distribution of MODU construction in 2011.
Source: Data from [27]; Authors calculations.

Country	Drillship	Semi	Jackup	Capital expenditures (million $)	Percentage (%)
South Korea	38	5	0	27,125	47.8
Singapore	2	7	33	13,402	23.6
China	3	6	9	6,979	12.3
Brazil	7	0	2	5,088	9.0
UAE	0	1	6	1,585	2.8
India	0	0	5	1,048	1.8
Vietnam	0	0	1	180	0.3
US	0	0	2	375	0.7
Russia	0	0	1	100	0.2
Malaysia	0	0	1	227	0.4
Norway	0	1	0	614	1.1
Total	50	20	60	56,723	

5.3. Prices

The average cost of jackup rigs increased from approximately $100 million for deliveries in 2004–2005 to approximately $200 million for rigs delivered in 2012–2013 (Fig. 8). The price difference between high-spec (>350 ft) and standard (<350 ft) jackups varied only slightly over most of the cycle except in 2010-2011 when several expensive harsh environment high-spec jackups were delivered. Both ends of the jackup newbuild market respond to the same market stimuli due to similarities in the rigs and the firms engaged in construction.

Semis and floaters are about two to three times more expensive than jackups and usually command dayrate premiums of similar magnitude. Drillships are more expensive than semisubmersibles with average premiums ranging from $69 million to $275 million. Newbuild prices for semis peaked in 2011 while prices for drillships peaked in 2012 and average prices for 2013 deliveries are lower than 2012 levels for both rig classes.

5.4. Market size

Newbuild deliveries have exhibited several cycles over the last four decades (Fig. 9). Data for 2012–2014 are estimated based on current contract schedules. The industry began in the U.S. in the late 1950s and spread to Europe and Asia through the mid-1970s as exploration worldwide increased [19,20]. Prior to 1974, a total of 22 jackups and 18 floating units had been delivered. In the late 1970s and early 1980s, oil prices rose and the market grew rapidly, peaking in 1982 with 70 jackup and 11 floater deliveries.

Oil prices declined in the early 1980s and demand collapsed, and between 1986 and 1997, a total of 37 rigs were delivered. By the late 1990s, drilling technology had advanced to allow exploration in ultra-deepwaters, but few rigs were capable of drilling in water depths greater than 1500 ft. Contractors responded by upgrading existing rigs and ordering a limited number of floaters, the first of which were delivered in 1998. Jackup orders also began in this period, due to concerns about the age of the fleet and interest in more challenging reservoirs and harsh environments.

During the 2000–2005 period, approximately five jackups and five floaters were delivered each year. In 2005, the number of jackup orders increased dramatically followed by an increase in floater orders, due in large part to increasing oil and gas prices and contractors expectations of sustained prices in the future. Jackup deliveries peaked in 2009 when 38 rigs were delivered, and floater deliveries peaked in 2011 with the delivery of 52 units. In every year since 2000, high-spec jackup deliveries have outnumbered standard jackups, and in 2011 only three standard jackups were delivered compared to 33 high-spec rigs.

5.5. Market value

The value of the newbuild market is shown in Fig. 10 by delivery year. Values are computed by summing the prices of rigs delivered per year, and because cost information is not available for a small number of rigs built by state-owned shipyards for a state-owned drilling contractors, the values slightly underestimate the market size. The value of the newbuild market peaked in 2010 at approximately $18 billion. In most years, floaters made up the majority of the market value while jackups make up the majority of deliveries. Market revenue peaked in 2009–2011 due to the high demand in the 2007–2009 period. Orders declined in 2009 and 2010 due to the recession, and as a result, market revenue in 2012 is expected to be low.

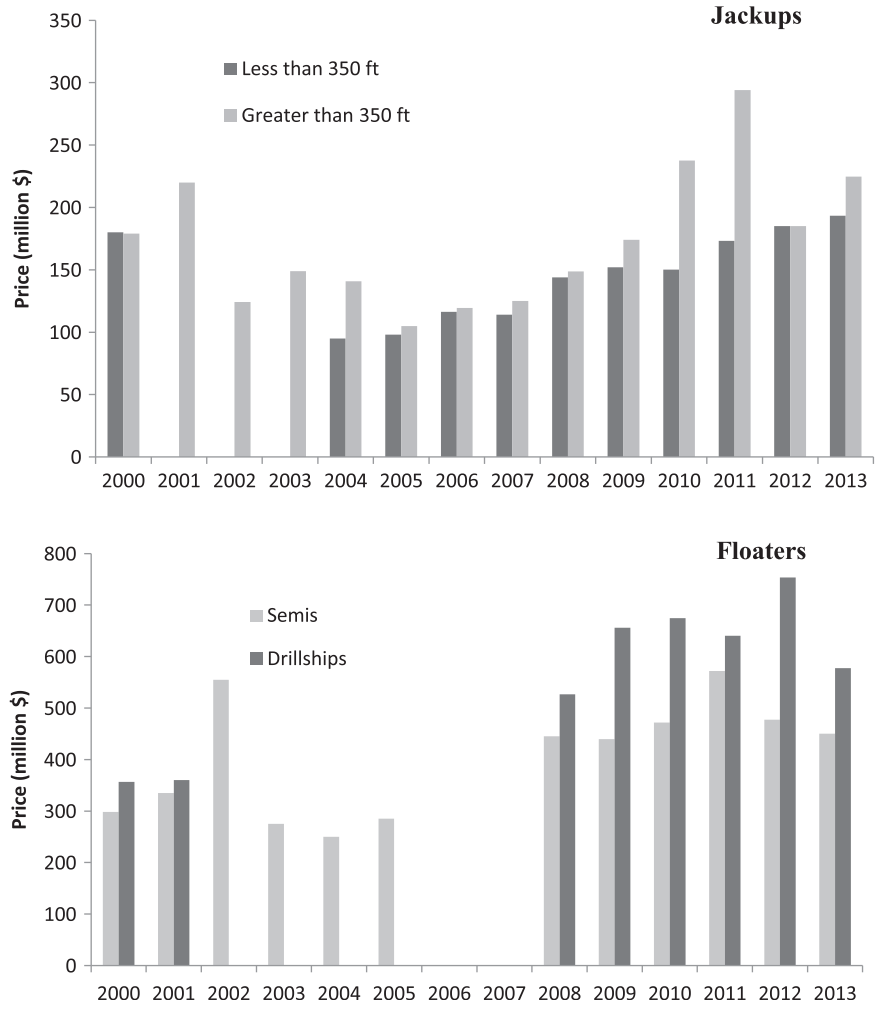

Fig. 8. Average cost of jackup and floater deliveries, 2000–2013.
Source: Data from [27].

6. Upgrade market

6.1. System measures

Rigs require routine maintenance and periodically undergo upgrades. Periodic maintenance occurs over a 3–10 year period and typically consists of painting, replacing corroded or worn components, upgrading living quarters, and changing out machinery and equipment. Maintenance is performed to repair defects, accommodate customer demands, and maintain the useful life and value of the rig. Maintenance does not increase the value of a rig and usually requires between several days and several months to perform.

In addition to periodic maintenance, rigs are generally upgraded at least once over the course of their lifetime to improve technology and maintain competitiveness. Rig upgrades involve significant capital expenditures and often involve structural changes to the rig, including adding dynamic positioning, increasing leg length, adding cantilever capability and increasing variable load [21,22]. Installation of new drilling equipment is also common. Upgrades increase the value of the rig and its replacement cost and require at least several months to perform [23].

There are three categories of upgrade and refurbishment costs [24]. In some cases, E&P companies require modifications to a rig before commencement of a contract. These typically do not significantly alter rig specifications and are charged to the E&P company, either as a lump sum payment or amortized over the duration of the contract. Contractors spend money to maintain the rig in an acceptable state, and these costs are considered operating expenditures. Costs incurred to upgrade the specifications of the rig or extend its life are considered capital costs.

6.2. Players

For most repairs and maintenance, work can be performed at local ports without shipbuilding or drydocking facilities [25]. More intensive upgrades are conducted at specialized facilities. Shipyards conducting major upgrades in 2009 and 2010 are shown in Table 7. Lamprell and Keppel are the dominant players and no other shipyard upgraded more than one rig during this time. Other firms active in the upgrade market include Signal International in the U.S., Gulf Cooper in the U.S., Drydocks World in the U.A.E., Larsen and Toubro in Oman, Malaysia Marine and Heavy Engineering in Malaysia, Maua Shipyard in Brazil, PD&MS in the U.K., Rijeka Shipyard in Croatia, and Remontowa in Poland.

6.3. Prices

The scale of upgrades varies widely, and only by reviewing the scope of work can the variation in cost be understood (Tables 8–10). Recent jackup upgrades have ranged between $10 and $30 million

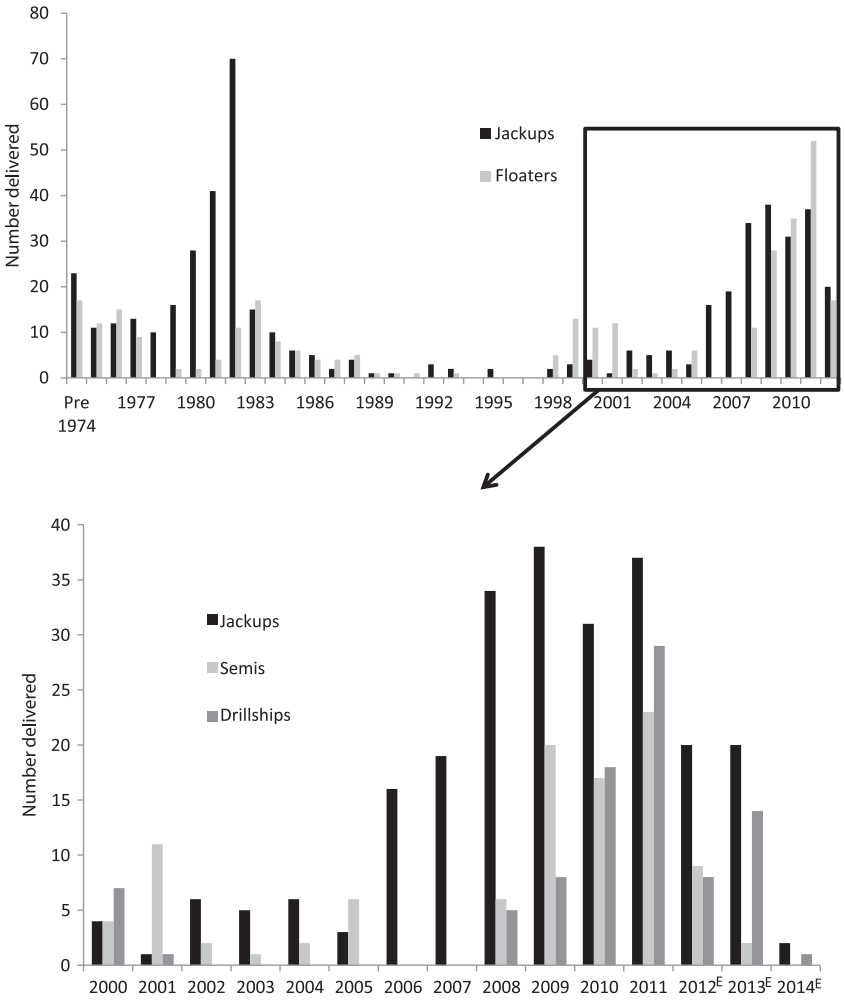

Fig. 9. Deliveries of newbuild rigs by class, 1974–2014.
Source: Data from [27].

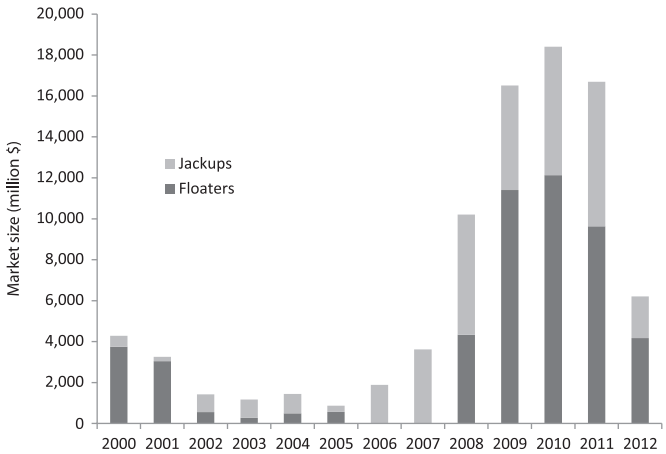

Fig. 10. Newbuild market size by delivery year, 2000–2012.
Source: Data from [27].

and include painting, drilling equipment change-outs, new accommodations, piping and electrical system replacement, and repair work to legs and spudcans. Upgrade costs can exceed $50 million but at higher prices many firms choose to newbuild rather than upgrade [26].

Floater upgrades vary significantly in price depending on the type of upgrade. Complete rebuilds using the existing hull cost $300–$350 million and replace nearly all other components. For $10–$50 million, upgrades may include helideck addition, quarters replacement, piping installation, and minor structural modification. At the mid-range, $75–$150 million will increase the variable load, replace accommodations and may change out equipment. The $152 million upgrades of Noble's drillships *Roger Eason* and *Leo Segerius* are representative. These upgrades added a new stern block, including 85% of the ships' marine operating systems, refurbished the derrick, replaced the top drive, replaced cranes, and increased the power of the dynamic positioning system.

6.4. Market size

The number of major upgraded rigs delivered between 2000 and 2010 is shown in Table 11. Major upgrades require several months to perform and are considered capital expenditures. On average, 17 jackups, and 13 floaters were upgraded each year, and there were notable peaks in 2004 and 2007 approximately coinciding with the timing of newbuilding orders and suggesting that firms invest in upgrading under roughly the same conditions in which they invest in newbuilding. Upgrade activity depends on factors such as the age of the fleet, the capital budgets of firms, and market demand. In total, 287 rigs were upgraded between 2000 and 2010, representing approximately half of the active fleet.

6.5. Market value

Estimating market revenue is complicated by the wide range of costs associated with upgrades and the definition of what constitutes an upgrade. Shipyards generally do not breakout rig upgrade cost in their financial reports, and for private shipyards, no financial data is reported at all, therefore, a range of market values is provided by assuming a minimum and maximum expected upgrade cost per rig. Jackup upgrades are estimated to cost at least $10 million and each floater upgrade costs at least $75 million; at a maximum, jackup and floater upgrade costs are estimated as $25 and $250 million. Upgrade costs for individual rigs may fall outside of this range, and these estimates are rough but are based on the public data available for analysis. Under these assumptions, the upgrade market is estimated to have an average value between $1 and $3.4 billion per year.

Table 7
Major rig upgrades by shipyard, 2009–2010.
Source: [35].

Shipyard	Nation	2009	2010
Aker	Norway		1
Keppel	Singapore	2	2
Keppel	Netherlands	1	2
Hindustan	India		1
Keppel	Philippines		1
Lamprel	UAE	3	8
L&T	Oman		1
Keppel	Brazil	3	
Sembawang	Singapore	1	
Others		3	
Total		13	16

7. Secondhand market

7.1. System measures

The secondhand market is measured by the number, value and type of transactions that occur. Rigs sold on the secondhand market may be part of the legacy fleet or newbuilds; units may be sold through mergers, liquidations, or private transactions; rigs may be sold with or without an existing contract backlog, and buyers may continue to use the vessel as a rig or may convert it to another use.

Transactions are conducted for a wide variety of reasons and reflect a diversity of types. In some cases, firms sell rigs due to bankruptcy. For example, Hercules purchased 20 rigs from Seahawk in 2011 for $105 million. Another example is Seadrill's purchase of a Petroprod rig from Sembcorp in 2010. In this case, a new market entrant (Petroprod) ordered a rig from Sembcorp, but entered bankruptcy before construction was finished. Sembcorp completed construction and sold the rig to Seadrill. In other cases, firms sell rigs to eliminate non-core assets. Frequently, this involves a large drilling contractor selling older rigs to a low-spec specialist. For example, in September 2012, Transocean

Table 8
Examples of jackup rig upgrade contracts.
Source: Industry press.

Customer	Shipyard	Year	Cost (million $)	Scope
ENSCO	Lamprell	2008	14.8	Steel renewal, leg repairs, accommodation upgrade, piping renewal, painting
Aban Offshore	ABG	2011	13.2	Painting, steel renewal, replacement of equipment
Gulf Drilling	Keppel-Qatar	2011	16.2	Major upgrade
National Drilling	Drydocks World	2010	20	Life extension
Millennium Offshore	Lamprell	2011	27.5	Conversion to accommodation unit
GSP	Lamprell	2010	12	Upgrade electrical, drilling equipment, accommodation refurbishment
Japan Drilling	Lamprell	2010	11.8	Three month refurbishment

Table 9
Examples of semisubmersible rig upgrade contracts.
Source: Industry press.

Customer	Shipyard	Year	Cost (million $)	Scope
Transocean	Semco	2011	20	Piping installation
Diamond Offshore	Keppel AmFELS	2012	300	Complete rebuild
Noble	Signal	2010	15	Addition of helideck, quarters upgrade, structural modifications
Awilco	Remontowa	2010	75	Increase variable load, new accommodations, power supply
Diamond	Keppel	2008	310	Complete rebuild
Fred Olsen	Keppel	2010	160	Survey, renewal and upgrade
Awilco	Remontowa	2010	15	Survey

Table 10
Examples of drillship upgrade contracts.
Source: Industry press.

Customer	Shipyard	Year	Cost (million $)	Scope
Transocean	Signal	2010	32.4	Living quarters upgrade, equipment replacement, painting, hull and tank repair
Noble	Keppel Brazil	2010	152	Replacement of accommodations and heliport, modifications to stern
Neptune Marine	Sembawang	2009	340	Increase water depth capacity, add dynamic positioning, upgrade drilling equipment

Table 11
Number of major upgrades and estimated market value, 2001–2010.
Source: [35].

	Jackups	Floaters	Total	Market value ($ billion)
2001	8	7	15	0.6–1.9
2002	32	10	42	1.0–3.3
2003	15	12	27	1.0–3.3
2004	22	15	37	1.3–4.3
2005	9		9	0.1–0.2
2006	13	20	33	1.6–5.3
2007	36	29	65	2.5–8.1
2008	18	18	36	1.5–4.9
2009	9	4	13	0.4–1.2
2010	11	5	16	0.5–1.5
Total	172	115	287	10.1–34.3

agreed to sell 38 shallow water drilling rigs to Shelf International for $1.05 billion.

Rigs may be purchased through the takeover of one firm by a larger firm; examples include Seadrill's purchase of Scorpion in 2010, Transocean's purchase of Aker Drilling in 2011, and Noble's purchase of Frontier in 2010. However, there is ambiguity in the distinction between a secondhand transaction and a merger. For example, ENSCOs purchase of Pride in 2010 and Transocean's purchase of Global Santé Fe in 2007 are typically considered mergers by market tracking services and are not included in secondhand market data [27]. In general, mergers of similarly sized companies are not considered secondhand transactions, while mergers between a larger and smaller firm are considered secondhand transactions.

7.2. Players

The number of transactions by major players between 2005 and 2010 is shown in Table 12. Note that each transaction may include multiple rigs. Hercules and Seadrill have been the most frequent buyers in the secondhand market, while Transocean has been the most frequent seller. Seadrill has targeted newbuild and high-spec rig purchases, while Hercules has focused on less-expensive, low spec units as an alternative to newbuilding. Transocean has been active in divesting older rigs, particularly jackups.

The newbuild market allows firms to add capacity, but the secondhand market is critical in allowing firms to build a fleet that matches business strategies. For firms focused on the high specification market, the secondhand market provides a means to profitably divest older assets. For firms focused on lower specification rigs, the secondhand market is the only way to increase fleet size and gain market share.

7.3. Prices

The range in secondhand prices is large and due to the variance in rig age and factors related to the buyer and seller and market conditions (Table 13). The minimum value of a rig on the secondhand market is $5 million which is approximately equal to the scrap value of a jackup or floater. Low-priced transactions are frequently scrap sales or conversion to another use.

Prices on the secondhand market are determined by market conditions and the net asset value (NAV) of the rig. NAV is an estimate of the net revenue generation potential of a rig over its remaining life. Factors that influence NAV include design class, operational water depth, drilling depth and equipment specifications, age, condition, contract status, location, utilization and dayrates in the global and regional market, and participants expectations of future market conditions.

Table 12
Number of transactions in the secondhand market by firm, 2005–2010.
Source: Data from [27].

Firm	Buyer	Seller
Hercules	7	4
Seadrill	8	3
Transocean		10
Songa	4	4
Noble	6	
ENSCO	1	4
Rowan	3	2
Diamond Offshore	1	4
Maersk	2	3
Aban	3	1
Saipem	4	

Table 13
Secondhand market transaction summary, 2005–2010.
Source: [27].

Year	Jackups ($ million)	Floaters ($ million)
2005	42 (22–60)[a]	37 (13–60)
2006	67 (17–210)	102 (14–270)
2007	148 (26–212)	321 (211–675)
2008	106 (9–200)	294 (5–676)
2009	84 (5–199)	475 (460–490)
2010	188 (26–356)	288 (102–560)

[a] Average price is depicted. Price range shown in parentheses.

Table 14
Rigs sold and market valuation in the secondhand market, 2005–2010.
Source: Data from [27]; Authors calculations.

Year	Jackups	Drillships	Semis	Total	Market value ($ billion)
2005	9	1	5	15	0.5
2006	20	1	10	31	2.1
2007	13	3	6	22	3.7
2008	10	1	3	14	2.2
2009	10	0	3	13	2.0
2010	20	7	4	31	6.8
Total	82	13	31	126	17.3

In the absence of market constraints the secondhand price should approximate the NAV, however, imperfect information, supply–demand imbalances, a limited number of players, and financial pressure (e.g., bankruptcy) will cause NAV and secondhand market prices to differ. For example, when Seahawk declared bankruptcy in 2011, it owned a fleet of 20 low specification jackup rigs valued at $397 million. Hercules was the only interested buyer and paid $105 million to acquire the fleet.

The maximum price for secondhand marine vessels can, in theory, exceed the price of a newbuild [28]. Secondhand rigs may be sold with an existing contract backlog, and this is particularly common in company acquisitions. Sale with a contract backlog will increase the NAV. Secondhand rigs may also be more valuable because they are available immediately while rigs under construction may only be delivered after a multi-year delay. In recent years, secondhand prices for recently built rigs have been approximately equal to the newbuild price.

7.4. Market size

On average, from 2005–2010 about 20 rigs were sold each year with the majority being jackups (Table 14). From 2005 to 2010,

jackups transacted the most (82), followed by semis (31) and drillships (13). Relative to the world fleet, approximately 2–5% of the fleet is transferred each year.

7.5. Market value

The secondhand market is valued on the order of $2 to $4 billion per year (Table 14). When cost data for a particular transaction was not available, the value of the transactions was estimated based on the age of the rig, its water depth capability, and the average cost of similar transactions in that year. A conservative approach was used and as a result the value of the secondhand market is likely to be underestimated. High market value in 2010 was due to three transactions: the purchase of Skeie Drilling by Rowan, the purchase of Scorpion by Seadrill, and the purchase of Frontier by Noble. Each of these transactions exceeded $1 billion.

8. Scrap market

8.1. System measures

In the scrap market, cold- or dead-stacked rigs (Fig. 11) are sold to specialized shipbreaking firms for dismantling and recycling [29]. Rigs may be scrapped after being damaged in hurricanes if repairs are uneconomic. When rigs are scrapped following damage, a marine salvage firm (i.e., Smit) is contracted to remove the rig from its offshore location, and the rig is typically transported to the nearest shipyard. The market is specified by the annual number of transactions and their prices.

8.2. Players

Rig scrapping is a small part of the larger ship breaking industry concentrated in India, Pakistan, China, Turkey and Bangladesh [30]. Ship breaking also occurs in the U.S. and Europe, but is hazardous and labor intensive and firms in developed countries cannot generally offer competitive prices to ship owners [31]. As a result, most scrapping occurs in Asia. However, dead-stacked rigs are often in poor condition and transport costs can be high, and as a result, shipbreaking firms in the U.S. and Europe may be able to successfully compete for work [32].

Shipbreaking that occurs in the U.S. is primarily driven by disposal of U.S. Navy ships and other federal vessels and very little rig hull deconstruction occurs domestically. Between 2005 and 2010, only one rig (the jackup *Zeus*) was dismantled in the U.S. without first receiving storm damage [33]. The firms most likely to process scrapped rigs in the U.S. are ESCO Marine, International Shipbreaking, Marine Metals and All-Star Metals, all of which are located along the Brownsville, TX ship channel.

8.3. Prices

Most of the value in an obsolete rig lies in the drilling equipment which is removed and sold before the rig is scrapped. Vessels are sold to ship breaking firms directly or via brokers on a per ton basis and the value of a vessel will principally depend on its weight, the scrap metal price at the time of sale, the labor required to dismantle the unit, and the transport cost from the rigs present location to the scrapyard [34].

In 2010 and 2011, Hercules sold five jackups for scrap ranging between $1 and $5 million with an average price of $2.5 million. This is consistent with prices in the range of $300 to $550 per ton, and is similar to scrap prices for other vessel classes.

It is possible that scrapping will result in a net cost for contractors. In 2008, the Texas General Land Office contracted Cleveland Wrecking Company to deconstruct the jackup rig *Zeus* which was in danger of blocking the Freeport Ship Channel. The Cleveland Wrecking Company was paid $1.75 million in addition to the value of the scrap steel. This suggests that in at least one case, the costs of dismantling the rig exceeded the revenues from the sale of the scrap steel.

8.4. Market size

Rigs are removed from the fleet in one of three ways: they may be converted to another use, they may be lost due to accidents or catastrophic events, or they may be sold into the scrap market. Conversion to another use is almost always more profitable than scrapping, and is preferred if available. In addition, because storage costs are low, there is little incentive for contractors to

Fig. 11. The dead-stacked jackup rig *Zeus*, being dismantled in the Freeport Ship Channel.
Source: Texas General Land Office.

Table 15
Market value summary in the five offshore rig markets, 2005–2012.

Market	System measures	Market value (billion $)
Contract drilling	Dayrates, utilization, fleet size	40–50
Newbuild	Deliveries, prices	10–20
Secondhand	Number of rigs exchanged, prices	2–7
Upgrade	Number of upgrades, prices	1–5
Scrap	Number of rigs scrapped	<0.05

retire rigs from the fleet and a large number of dead stacked rigs are in storage awaiting final disposition. As a result, rigs are rarely scrapped unless they have sustained damage from storms, blow-outs or other accidents. Between 2005 and 2011, just seven rigs were sold for scrap [27].

8.4. Market value

Given the small number of rigs scrapped each year and their low value, the size of the scrap market is negligible relative to the other rig markets. In many years, no rigs are scrapped, and when rigs are scraped the value of individual transactions are based on the rig weight and scrap metal price at the time of sale, rarely exceeding $5 million per unit. The average size of the market is estimated to be less than $50 million annually.

As the legacy fleet continues to age, scrapping activity could increase and the market may grow; since many aging rigs are in the GOM, some of these rigs are likely to be processed by U.S. ship recyclers. While costs at GOM ship recyclers are likely to be high, they may be justified by the high costs to transport a rig from the GOM to Asia [32].

9. Conclusions

Cash flows in five offshore drilling markets in 2005–2012 and their primary system measures are summarized in Table 15. In 2010, the contract drilling market generated approximately $45 billion in revenue, and approximately $18 billion flowed to the newbuild market which was associated with a peak in newbuild deliveries. Between $1 to $2 billion in capital expenditures was spent on rig upgrades and the secondhand market realized approximately $7 billion in market exchanges. The scrap market is very small relative to the other markets and is usually valued at less than $50 million per year.

The contract drilling and newbuild markets are large and transparent and market activity and valuations are known with a high degree of confidence. The upgrade market is well documented, but a large amount of routine maintenance occurs and these costs are not reported. Transactions in the secondhand market typically occur between drilling contractors, and are reported by commercial data services, but the demarcation between a secondhand purchase and a merger is not always clear. The scrap market is small, poorly documented, and opaque.

The offshore oil and gas industry supplies approximately one-third of global oil production, and with restricted access to much of the world's conventional onshore resources, the importance of offshore hydrocarbon development is expected to increase. Offshore developments are long-lived capital intensive projects which are less sensitive to the short-term price cycles in the industry. As offshore capital budgets increase, cash flows into the drilling service market will increase with related impacts on the newbuild, secondhand, upgrade and scrap markets.

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