

**Final Examination**  
Summer, 2008

Please check that you have 16 pages in your copy of this exam. Answer each question in the space provided. If you need more space, please use the back of each page (but be clear to the grader where the answer is). You may consult two sides of a single page of notes. Calculators are permitted.

There are 90 points to be gained in this examination. Since the examination will last 100 minutes, you should use the points allocated to each question as a rough indication of how much time to spend answering it.

If you need more paper then let me know. Put your name on every piece of paper you want to be graded on (don't trust the staple...)

I understand that the honor code applies: *I will not lie, cheat, or steal to gain an academic advantage, or tolerate those who do.*

\_\_\_\_\_  
(Name and Signature)

---

---

## 1 The Game Theory Question [30 points]

[This question is based on the first major oil discovery in Texas in 1901 – called Spindletop. For the short period it was active Spindletop had 214 independent drillers simultaneously extracting oil from an area about twice the size of Soho. This led to a significant, short-lived, speculative boom and subsequent bust: As one driller was moved to quip: “The cow was milked too hard. Moreover, she was not milked intelligently”]

An oil deposit is discovered in Mexas, a fictional country with no property rights system covering the extraction of oil from under the ground. That is, if you own land, you can stick a drill in it and start sucking out any oil that lies underneath it.

The deposit can produce 100 barrels per day at most. Oil exists underground in a large ‘lake’ that sits underneath **two** properties upon which it is possible to mount an oil drill. The pressure in this underground lake is critical to maintain to achieve maximum oil extraction. Pressure needs to be carefully managed, and extraction that is too fast can cause it to drop sharply. As a consequence, if the owners of both properties were to drill for oil the total amount that the deposit could generate would go down by 20%.

If two drillers are extracting oil from the deposit they both extract half the total available oil each. The price of crude oil is \$120 per barrel.

Each potential driller has to decide whether to drill or not. Each has to make this decision without observing what the other potential driller does. The cost of drilling is \$20 per barrel. If they don’t drill, they get a payoff of zero.

- a. Set up this game: show the players, their strategies, and payoffs in an appropriate way. [8 points]
- b. Define a dominant strategy [2 points]
- c. Does either player have a dominant strategy? If so, what is it? [2 points]
- d. What is the Nash equilibrium of this game. [2 points]

Imagine that one driller could move before the other and this action could be observed by the second driller.

- e. Portray this new game in an appropriate way. [4 points]
- f. What is the SPNE of this game? [4 points]
- g. Has the outcome changed from part d? [1 point]
- h. How much would the first oil driller be willing to pay for an exclusive lease of the second driller’s property (in terms of \$/day)? (An exclusive lease would mean that the first driller could exclude the second driller from drilling.) Explain your answer. [5 points]

## 2 The Market Data Question [30 points]

Figure 1: Used VLCC Transactions: # of Deals Completed and Price in USD/DWT  
(DWT = tons of deadweight)

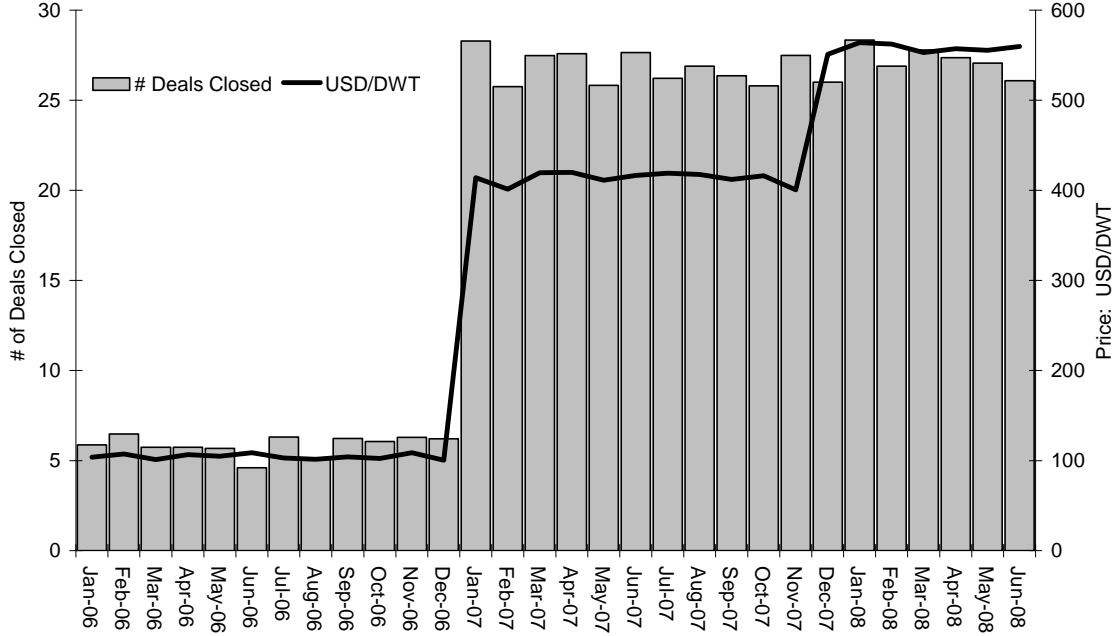
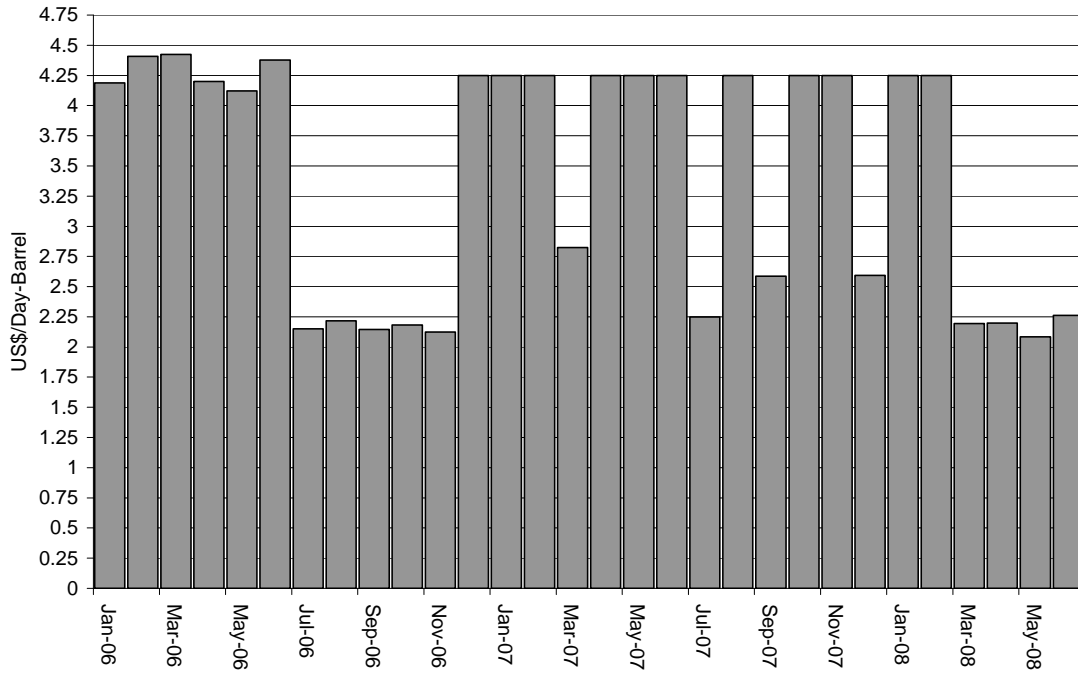


Figure 2: VLCC Charter Rates: Yenbo-LOOP, US\$ per Day per Barrel



---

You have been assigned to a deal that requires understanding the market for transportation of crude oil. Most of the world's crude is transported from net producing countries to net consuming countries in massive oil tankers, known in the industry as Very Large Crude Carriers (VLCC's).

There is an active market for buying and selling used VLCC's. Price and Quantity data from this market is shown in Figure 1.

You uncover the following facts about the used VLCC market:

- On Jan 1<sup>st</sup> '07 Lloyds' of London, the leader in maritime shipping insurance and brokerage services, released its full archival records on every ship in the world's tanker fleet to subscribers for a small fee. To get insured by Lloyds' a ship must undergo annual structural surveys covering metallurgy, corrosion and systems checks, among other things. Previous to this date buyers of used VLCC's were only able to inspect ships they were thinking of buying via a physical walk-through and were unable to engage in intensive structural audits.
- Many shipping firms are active in the used VLCC market. No firm has market power in this market.
- At the end of Dec '07 the Chinese government opens four new VLCC unloading terminals and allows all major global petroleum retailers to build gas stations in the country. This coincides with the release of a report forecasting Chinese demand for oil products to expand by 300% in the next 5 years.

Using the information in the Figures and the facts provided, answer the following questions:

- a. What model that we have studied in class accurately describes the used VLCC market prior to Jan '07? [One sentence only] [5 Points]
- b. Describe the why a dramatic change in the used VLCC market coincided with the release of archival data by Lloyds'. [5 Points]
- c. Account for major movements in the used VLCC market between Jun '07 and Jun '08. Use a diagram if you think it appropriate. [5 Points]

### **[Now think about a different market]**

During your research you also examine a specific charter market for shipping services:

About 25% of Saudi Oil is loaded onto VLCC's at the Yenbo port on the Red Sea. Much of this oil is transported to the USA and offloaded at the Louisiana Offshore Oil Port (LOOP). The LOOP consists of a series of deepwater platforms in the Gulf of Mexico near the town of Port Fourchon. Most tankers offloading at LOOP are too large for U.S. inland ports. LOOP handles 13 percent of the nation's foreign oil, about 1.2 million barrels a day, and connects by pipeline to 35 percent of the U.S. refining capability.

---

VLCC charter rates for the Yenbo-LOOP route (in US\$ per barrel per day on route) are shown in Figure 2.

During your industry research you uncover the following facts:

- Until the end of June '06, the only tankers allowed to dock at the Yenbo tanker facility were owned by Picard Shipping Lines.
- On July 1<sup>st</sup>, Enterprise Shipping was given permission to dock at Yenbo by the Saudi government. Picard and Enterprise operate the same type of ships on the same schedules with the same marginal costs.

Using the information in the Figures and the facts provided, answer the following questions:

- d. How would you describe the market for VLCC charters on the Yenbo-LOOP route prior to Jul 1<sup>st</sup> '06? [One sentence only] [2 Points]
- e. How would you describe competition in the market for VLCC charters on the Yenbo-LOOP route between to Jul 1<sup>st</sup> '06 and Nov '06? [One sentence only] [3 Points]
- f. Provide an estimate of the elasticity of demand corresponding to a typical price charged on the Yenbo-LOOP route in the period prior to Jul 1<sup>st</sup> '06. Show your working and be clear as to your approach. [5 Points]
- g. Account for price movements on the Yenbo-LOOP route in the period following Nov '06. Be as precise as possible, given the data, as to what is going on. [5 Points]

---

### 3 The Other Question [30 points]

West Texas Intermediate (WTI) is a type of crude oil that is refined by the ExxonMobile facility in Baytown Texas. One of the products that Baytown refinery produces from WTI, and then sells, is gasoline. The refinery sells gasoline to 'jobbers' who transport the gasoline from the refinery to the gas stations. There are three types of jobbers: large, medium and small (according to the jobber's customer base). Due to prohibitive monitoring costs, ExxonMobile cannot ascertain the type of a jobber when the jobber's trucks arrive to load gasoline.

It costs ExxonMobile \$1000 to load each jobber's truck with a tank of gasoline.

The willingness to pay for a truckload of gasoline for each type of jobber (and the number of jobbers of each type) is:

	WTP	#
Large	\$2500	10
Medium	\$1500	10
Small	\$500	10

- a. If the refinery just offers one type of service, providing gasoline, what is the best price to offer gasoline at? What is profit at this price? Show working. [10 points]

Now, imagine the refinery can offer high priority service and low priority service. High priority means that you can jump to the head of the queue to fill your truck. The cost of loading a truck under either service type is still \$1000 per truckload. Since a truck can't enjoy low and high priority at the same time bundling is impossible. The willingness to pay for a truckload of gasoline under each service type is:

	WTP (low priority)	WTP (high priority)
Large	\$1900	\$3000
Medium	\$1500	\$1600
Small	\$400	\$800

- b. Should the refinery serve the small jobbers? Explain briefly. [2 points]
- c. If the price scheme for low and high priority service were \$1500 and \$3000 (resp.), what would you expect revenue to be? Explain. [5 points]
- d. Building on question c, what needs to change to induce the Large jobbers to choose high priority service? [5 points]
- e. Setting aside the scenario in parts (c) and (d): What would the optimal profit be if the refinery excluded the medium and small jobbers and only served the large jobbers? Show your working [3 Points]
- f. If ExxonMobile can set any prices they like, what is the profit maximizing price scheme to offer? What is ExxonMobile's profit at this price? (Explain, to the extent that you need to beyond what you wrote in d. and e.) [5 points]