

The Oil Market

Consider a model of competitive market equilibrium for oil, a depleting resource.

The initial stock is S .

Demand gradually depletes the stock, until no oil remains.

Asset-Market Equilibrium

An owner of oil decides when to sell, to maximize profit.

Let P denote the logarithm of the price.

Since the capital gain is the only return from holding oil, in asset-market equilibrium the rate of capital gain must equal the market interest rate:

$$P(t) = P(0) + Rt. \quad (1)$$

The price $P(t)$ at time t increases above the initial price $P(0)$ by R each year. For example, if $R = .10$, then P rises by .10 each year, which means that the price rises by 10% per year.

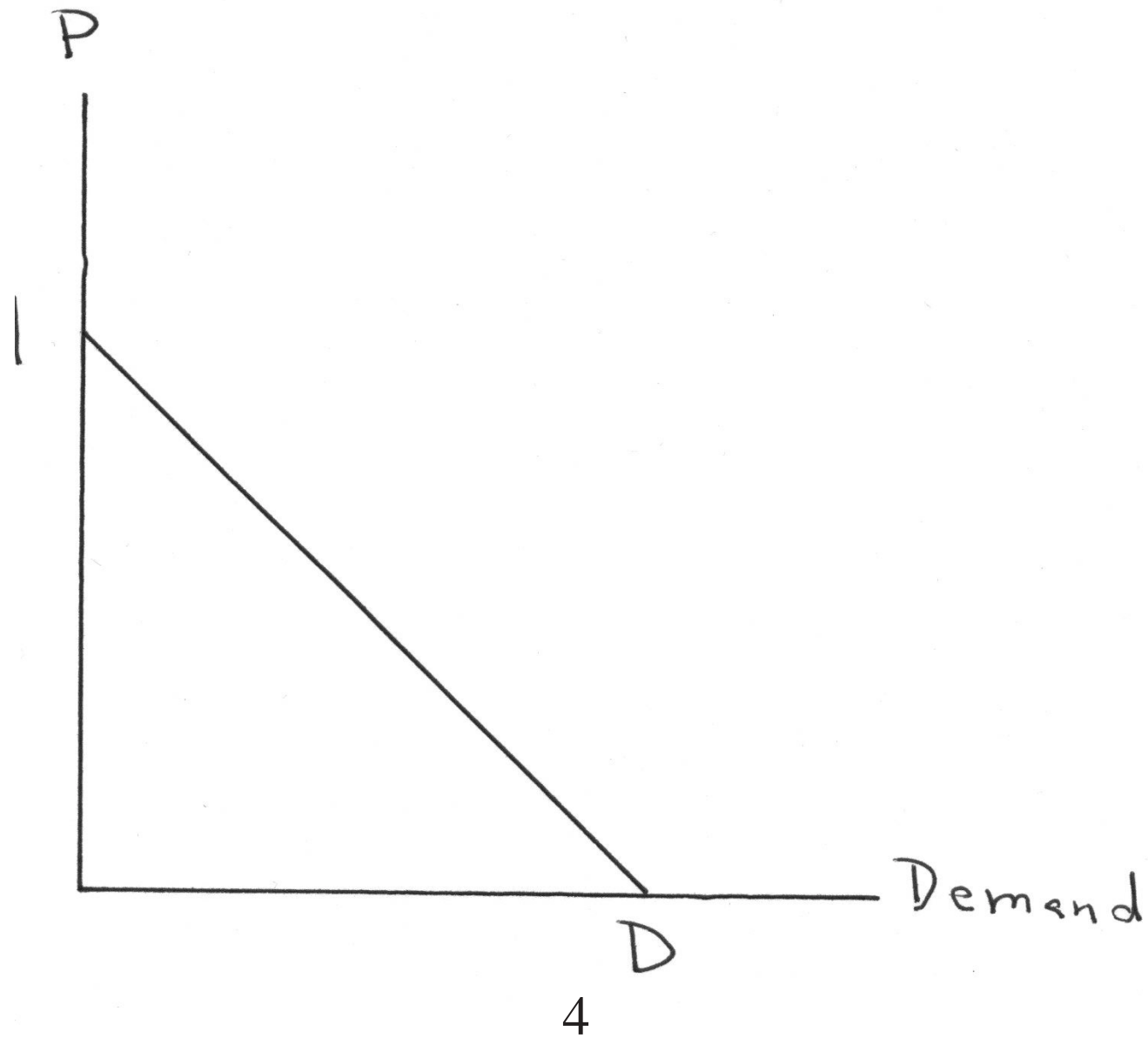
Demand

Demand (figure 1) is a linear function of P :

$$(1 - P)D.$$

Demand is zero when $P = 1$; for a lower price, the demand is higher.

Figure 1: Demand



Oil Price

Since the price rises as time passes, demand gradually falls. The demand depletes the stock, until the stock falls to zero, at time T , the end of the oil age. After that time, no oil remains, and the demand is zero.

At time T , to make demand zero

$$P(T) = 1.$$

From the condition (1) for asset-market equilibrium,

$$P(0) = 1 - RT.$$

Total Demand

Demand starts at

$$[1 - P(0)]D = RTD.$$

and declines to zero, falling linearly as time passes. The average demand during the oil age is therefore half this amount, so total consumption is

$$\frac{1}{2}RTD \times T.$$

Market Equilibrium

Setting this total consumption equal to the initial stock S obtains the market-equilibrium values:

$$T = \sqrt{\frac{2S}{RD}}$$

$$P(0) = 1 - \sqrt{\frac{2RS}{D}}.$$

Change in Demand and Supply

Here a higher D represents an increase in demand, and a higher S represents an increase in supply.

As the ratio of supply to demand S/D rises, the oil age lasts longer: T increases and $P(0)$ falls.

Increase in the Interest Rate

An increase in the interest rate shifts oil consumption from the future toward the present. Both T and $P(0)$ fall.