The extraction costs are $17 per barrel. The forward price is $20, and you know that oil prices next year will be either $15 per barrel or $25 per barrel depending on demand conditions. Are you better off extracting the oil today or waiting one year? Explain how your answer might be different if prices next year are either more or less certain but have the same mean.

11-2 CONCEPTUAL ANALYSIS OF REAL OPTIONS Huntsman Chemical is a relatively small chemical company located in Port Arthur, Texas. The firm's management is contemplating its first international investment, which involves the construction of a petrochemical plant in Sao Paulo, Brazil. The proposed plant will have the capacity to produce 100,000 tons of the plastic pellets that are then used to manufacture soft drink bottles. In addition, the plant can be converted over to produce the pellets used in the manufacture of opaque plastic containers such as milk containers.

The initial plant will cost $50 million to build, but its capacity can later be doubled at a cost of $30 million should the economics warrant it. The plant can be financed with a $40 million nonrecourse loan provided by a consortium of banks and guaranteed by the Export Import Bank. Huntsman's management is enthusiastic about the project, as its analysts think the Brazilian economy will continue to grow into the foreseeable future. This growth, in turn, may offer Huntsman Chemical many additional opportunities in the future as the company becomes better known in the region.

Based on a traditional discounted cash flow analysis, Huntsman's analysts estimate that the project has a modest NPV of about $5 million. However, when Huntsman's executive committee members review the proposal, they express concern about the risk of the venture based primarily on the fact that the Brazilian economy is also very uncertain. Toward the close of their deliberations, the company CEO turns to the senior financial analyst and asks him whether he has considered something he had recently read about called "real options" in performing his discounted cash flow estimate of the project's NPV.

Assume the role of the senior analyst and provide your boss with a brief discussion of the various options that may be embedded in this project, and very roughly sketch out how these options can add to the value of the project. (*Hint:* No computations are required.)

11-3 OPTION TO ABANDON Newport Mining has a lease with two years remaining in which it can extract copper ore on a remote island in Indonesia. The company has completed the exploration phase and estimates that the mine contains five million pounds of ore that can be extracted. The ore deposit is particularly rich and contains 37.5% pure copper.

Newport can contract with a local mining company to develop the property in the coming year at a cost of $1.2 million. Three-fourths of the cost of development must be paid immediately and the remainder at the end of one year. Once the site is

developed, Newport can contract with a mine operator to extract the ore for a cash payment equal to $0.60 per pound of ore processed or $1.60 per pound of copper produced.[13] The total cost must be paid in advance at the beginning of the second year of operations. This amounts to a cash payment in one year of $3 million.

At the end of one year, Newport can contract to sell the copper ore for the prevailing spot price at that time. However, since the spot price at the end of the year is unknown today, the proceeds from the sale of the refined copper are uncertain.

The current price is $2.20 per pound, and commodity analysts estimate that it will be $2.50 a pound at year-end. However, since the price of copper is highly volatile, industry analysts have estimated that it might be as high as $2.80 or as low as $1.20 per pound by the end of the year. The price of copper is expected to stay at $2.80 or as low as $1.20 throughout the second year. As an alternative to selling the copper at the end-of-year spot price, Newport could sell the production today for the forward price of $2.31 and eliminate completely the uncertainty surrounding the future price of copper. However, this strategy would require that the firm commit today to producing the copper. This, in turn, means that Newport's management would forfeit the option to shut down the plant should the price be less than the cost of producing the copper.

Given the risk inherent in exploration, Newport requires a rate of return of 25% for investments at the exploration stage but requires only 15% for investments at the development stage. The risk-free rate of interest is currently only 5%.

a. What is the expected NPV for the project if Newport commits itself to the development, extraction, and sale of the copper today and sells the copper in the forward market?

b. What is the NPV of the project if the production is *not* sold forward and Newport subjects itself to the uncertainties of the copper market?

c. Using the decision tree on page 498, construct a diagram that describes Newport's payoff from the investment that includes the option to extract the ore at the end of one year.

d. What is the lease worth to Newport if it exercises its option to abandon the project at the end of Year 1? Should the firm proceed with the development today?

e. If Newport decided to extract the ore itself, how could it use the copper call options to hedge the risk of mining for the copper? The price of a European call option on one pound of copper with an exercise price of $1.68 and maturity of two years is $0.70.

[13]Since the ore contains 37.5% copper and there are five million pounds of ore in the mine, the total is 1.875 million pounds of copper to be produced at a cost equal to $0.60 × 5 million pounds of ore, or $3.0 million. Thus, the cost per pound to produce the ore is $3.0 million/1.875 million pounds, or $1.60 per pound.