Chapter 5
Uncertainty and Consumer Behavior

■ Questions for Review

1. **What does it mean to say that a person is *risk averse*? Why are some people likely to be risk averse while others are risk lovers?**

   A risk-averse person has a diminishing marginal utility of income and prefers a certain income to a gamble with the same expected income. A risk lover has an increasing marginal utility of income and prefers an uncertain income to a certain income when the expected value of the uncertain income equals the certain income. To some extent, a person's risk preferences are like preferences for different vegetables. They may be inborn or learned from parents or others, and we cannot easily say why some people are risk averse while others like taking risks. But there are some economic factors that can affect risk preferences. For example, a wealthy person is more likely to take risks than a moderately well-off person, because the wealthy person can better handle losses. Also, people are more likely to take risks when the stakes are low (like office pools around NCAA basketball time) than when stakes are high (like losing a house to fire).

2. **Why is the variance a better measure of variability than the range?**

   Range is the difference between the highest possible outcome and the lowest possible outcome. Range ignores all outcomes except the highest and lowest, and it does not consider how likely each outcome is. Variance, on the other hand, is based on all the outcomes and how likely they are to occur. Variance weights the difference of each outcome from the mean outcome by its probability, and thus is a more comprehensive measure of variability than the range.

3. **George has $5000 to invest in a mutual fund. The expected return on mutual fund *A* is 15% and the expected return on mutual fund *B* is 10%. Should George pick mutual fund *A* or fund *B*?**

   George's decision will depend not only on the expected return for each fund, but also on the variability of each fund's returns and on George's risk preferences. For example, if fund *A* has a higher standard deviation than fund *B*, and George is risk averse, then he may prefer fund *B* even though it has a lower expected return. If George is not particularly risk averse he may choose fund *A* even if its return is more variable.

4. **What does it mean for consumers to maximize expected utility? Can you think of a case in which a person might *not* maximize expected utility?**

   To maximize expected utility means that the individual chooses the option that yields the highest average utility, where average utility is the probability-weighted sum of all utilities. This theory requires that the consumer knows each possible outcome that may occur and the probability of each outcome. Sometimes consumers either do not know all possible outcomes and the relevant probabilities, or they have difficulty evaluating low-probability, extreme-payoff events. In some cases, consumers cannot assign a utility level to these extreme-payoff events, such as when the payoff is the loss of the consumer's life. In cases like this, consumers may make choices based on other criteria such as risk avoidance.

5. **Why do people often want to insure fully against uncertain situations even when the premium paid exceeds the expected value of the loss being insured against?**

Risk averse people have declining marginal utility, and this means that the pain of a loss increases at an increasing rate as the size of the loss increases. As a result, they are willing to pay more than the expected value of the loss to insure against suffering the loss. For example, consider a homeowner who owns a house worth $200,000. Suppose there is a small 0.001 probability that the house will burn to the ground and be a total loss and a high probability of 0.999 that there will be no loss. The expected loss is $0.001(200,000) + 0.999(0) = \$200$. Many risk averse homeowners would be willing to pay a lot more than $200 (like $400 or $500) to buy insurance that will replace the house if it burns. They do this because the disutility of losing their $200,000 house is more than 1000 times larger than the disutility of paying the insurance premium.

6. **Why is an insurance company likely to behave as if it were risk neutral even if its managers are risk-averse individuals?**

A large insurance company sells hundreds of thousands of policies, and the company's managers know they will have to pay for losses incurred by some of their policyholders even though they do not know which particular policies will result in claims. Because of the law of large numbers, however, the company can estimate the total number of claims quite accurately. Therefore, it can make very precise estimates of the total amount it will have to pay in claims. This means the company faces very little risk overall and consequently behaves essentially as if it were risk neutral. Each manager, on the other hand, cannot diversify his or her own personal risks to the same extent, and thus each faces greater risk and behaves in a much more risk-averse manner.

7. **When is it worth paying to obtain more information to reduce uncertainty?**

It is worth paying for information if the information leads the consumer to make different choices than she would have made without the information, and the expected utility of the payoffs (deducting the cost of the information) is greater with the information than the expected utility of the payoffs received when making the best choices without knowing the information.

8. **How does the diversification of an investor's portfolio avoid risk?**

An investor reduces risk by investing in many assets whose returns are not highly correlated and, even better, some whose returns are negatively correlated. A mutual fund, for example, is a portfolio of stocks of many different companies. If the rate of return on each company's stock is not highly related to the rates of return earned on the other stocks in the portfolio, the portfolio will have a lower variance than any of the individual stocks. This occurs because low returns on some stocks tend to be offset by high returns on others. As the number of stocks in the portfolio increases, the portfolio's variance decreases. While there is less risk in a portfolio of stocks, risk cannot be completely avoided; there is still some market risk in holding a portfolio of stocks compared to a low-risk asset, such as a U.S. government bond.

9. **Why do some investors put a large portion of their portfolios into risky assets, while others invest largely in risk-free alternatives? (*Hint*: Do the two investors receive exactly the same return on average? If so, why?)**

Most investors are risk averse, but some are more risk averse than others. Investors who are highly risk averse will invest largely in risk-free alternatives while those who are less risk averse will put a larger portion of their portfolios into risky assets. Of course, because investors are risk averse, they will demand higher rates of return on investments that have higher levels of risk (i.e., higher variances). So investors who put larger amounts into risky assets expect to earn greater rates of return than those who invest primarily in risk-free assets.

10. What is an endowment effect? Give an example of such an effect.

An endowment effect exists if an individual places a higher value on an item that is in her possession as compared to the value she places on the same item when it is not in her possession. For example, some people might refuse to pay $5 for a simple coffee mug but would also refuse to sell the same mug for $5 if they already owned it or had just gotten it for free.

11. Jennifer is shopping and sees an attractive shirt. However, the price of $50 is more than she is willing to pay. A few weeks later, she finds the same shirt on sale for $25 and buys it. When a friend offers her $50 for the shirt, she refuses to sell it. Explain Jennifer's behavior.

To help explain Jennifer's behavior, we need to look at the reference point from which she is making the decision. In the first instance, she does not own the shirt so she is not willing to pay the $50 to buy the shirt. In the second instance, she will not accept $50 for the shirt from her friend because her reference point has changed. Once she owns the shirt, the value she attaches to it increases. Individuals often value goods more when they own them than when they do not. This is called the endowment effect.

■ Exercises

1. Consider a lottery with three possible outcomes:

- **$125 will be received with probability 0.2**
- **$100 will be received with probability 0.3**
- **$50 will be received with probability 0.5**

a. What is the expected value of the lottery?

The expected value, *EV*, of the lottery is equal to the sum of the returns weighted by their probabilities:

$$EV = (0.2)(\$125) + (0.3)(\$100) + (0.5)(\$50) = \$80.$$

b. What is the variance of the outcomes?

The variance, σ^2, is the sum of the squared deviations from the mean, $80, weighted by their probabilities:

$$\sigma^2 = (0.2)(125 - 80)^2 + (0.3)(100 - 80)^2 + (0.5)(50 - 80)^2 = \$975.$$

c. What would a risk-neutral person pay to play the lottery?

A risk-neutral person would pay the expected value of the lottery: $80.

2. Suppose you have invested in a new computer company whose profitability depends on two factors: (1) whether the U.S. Congress passes a tariff raising the cost of Japanese computers and (2) whether the U.S. economy grows slowly or quickly. What are the four mutually exclusive states of the world that you should be concerned about?

The four mutually exclusive states may be represented as:

	Congress passes tariff	Congress does not pass tariff
Slow growth rate	State 1: Slow growth with tariff	State 2: Slow growth without tariff
Fast growth rate	State 3: Fast growth with tariff	State 4: Fast growth without tariff

3. **Richard is deciding whether to buy a state lottery ticket. Each ticket costs $1, and the probability of winning payoffs is given as follows:**

Probability	Return
0.50	$0.00
0.25	$1.00
0.20	$2.00
0.05	$7.50

a. **What is the expected value of Richard's payoff if he buys a lottery ticket? What is the variance?**

The expected value of the lottery is equal to the sum of the returns weighted by their probabilities:

$$EV = (0.5)(0) + (0.25)(\$1.00) + (0.2)(\$2.00) + (0.05)(\$7.50) = \$1.025$$

The variance is the sum of the squared deviations from the mean, $1.025, weighted by their probabilities:

$$\sigma^2 = (0.5)(0 - 1.025)^2 + (0.25)(1 - 1.025)^2 + (0.2)(2 - 1.025)^2 + (0.05)(7.5 - 1.025)^2, \text{ or}$$

$$\sigma^2 = 2.812.$$

b. **Richard's nickname is "No-Risk Rick" because he is an extremely risk-averse individual. Would he buy the ticket?**

An extremely risk-averse individual would probably not buy the ticket. Even though the expected value is higher than the price of the ticket, $1.025 > $1.00, the difference is not enough to compensate Rick for the risk. For example, if his wealth is $10 and he buys a $1.00 ticket, he would have $9.00, $10.00, $11.00, and $16.50, respectively, under the four possible outcomes. If his utility function is $U = W^{0.5}$, where W is his wealth, then his expected utility is:

$$EU = (0.5)(9^{0.5}) + (0.25)(10^{0.5}) + (0.2)(11^{0.5}) + (0.05)(16.5^{0.5}) = 3.157.$$

This is less than 3.162, which is his utility if he does not buy the ticket ($U(10) = 10^{0.5} = 3.162$). Therefore, he would not buy the ticket.

c. **Richard has been given 1000 lottery tickets. Discuss how you would determine the smallest amount for which he would be willing to sell all 1000 tickets.**

With 1000 tickets, Richard's expected payoff is $1025. He does not pay for the tickets, so he cannot lose money, but there is a wide range of possible payoffs he might receive ranging from $0 (in the extremely unlikely event that all 1000 tickets pay nothing) to $7500 (in the even more unlikely case that all 1000 tickets pay the top prize of $7.50), and virtually everything in between. Given this variability and Richard's high degree of risk aversion, we know that Richard would be willing to sell all the tickets for less (and perhaps considerably less) than the expected payoff of $1025. More precisely, he would sell the tickets for $1025 minus his risk premium. To find his selling price, we would first have to calculate his expected utility for the lottery winnings. This

would be like point *F* in Figure 5.4 in the text, except that in Richard's case there are thousands of possible payoffs, not just two as in the figure. Using his expected utility value, we then would find the certain amount that gives him the same level of utility. This is like the $16,000 income at point *C* in Figure 5.4. That certain amount is the smallest amount for which he would be willing to sell all 1000 lottery tickets.

d.   In the long run, given the price of the lottery tickets and the probability/return table, what do you think the state would do about the lottery?

Given the price of the tickets, the sizes of the payoffs and the probabilities, the lottery is a money loser for the state. The state loses $1.025 − 1.00 = $0.025 (two and a half cents) on every ticket it sells. The state must raise the price of a ticket, reduce some of the payoffs, raise the probability of winning nothing, lower the probabilities of the positive payoffs, or some combination of the above.

4.   Suppose an investor is concerned about a business choice in which there are three prospects— the probability and returns are given below:

Probability	Return
0.4	$100
0.3	30
0.3	−30

What is the expected value of the uncertain investment? What is the variance?

The expected value of the return on this investment is

$$EV = (0.4)(100) + (0.3)(30) + (0.3)(-30) = \$40.$$

The variance is

$$\sigma^2 = (0.4)(100 - 40)^2 + (0.3)(30 - 40)^2 + (0.3)(-30 - 40)^2 = 2940.$$

5.   You are an insurance agent who must write a policy for a new client named Sam. His company, Society for Creative Alternatives to Mayonnaise (SCAM), is working on a low-fat, low-cholesterol mayonnaise substitute for the sandwich-condiment industry. The sandwich industry will pay top dollar to the first inventor to patent such a mayonnaise substitute. Sam's SCAM seems like a very risky proposition to you. You have calculated his possible returns table as follows:

Probability	Return	Outcome
0.999	−$ 1,000,000	(he fails)
0.001	$ 1,000,000,000	(he succeeds and sells his formula)

a.   What is the expected return of Sam's project? What is the variance?

The expected return, *ER*, of Sam's investment is

$$ER = (0.999)(-1,000,000) + (0.001)(1,000,000,000) = \$1000.$$

The variance is

$$\sigma^2 = (0.999)(-1,000,000 - 1000)^2 + (0.001)(1,000,000,000 - 1000)^2 \text{ , or}$$

$$\sigma^2 = 1,000,998,999,000,000.$$

b.   What is the most that Sam is willing to pay for insurance? Assume Sam is risk neutral.

Suppose the insurance guarantees that Sam will receive the expected return of $1000 with certainty regardless of the outcome of his SCAM project. Because Sam is risk neutral and because his expected return is the same as the guaranteed return with insurance, the insurance has no value to Sam. He is just as happy with the uncertain SCAM profits as with the certain outcome guaranteed by the insurance policy. So Sam will not pay anything for the insurance.

c. **Suppose you found out that the Japanese are on the verge of introducing their own mayonnaise substitute next month. Sam does not know this and has just turned down your final offer of $1000 for the insurance. Assume that Sam tells you SCAM is only six months away from perfecting its mayonnaise substitute *and* that you know what you know about the Japanese. Would you raise or lower your policy premium on any subsequent proposal to Sam? Based on his information, would Sam accept?**

The entry of the Japanese lowers Sam's probability of a high payoff. For example, assume that the probability of the billion-dollar payoff cut in half. Then the expected outcome is:

$$ER = (0.9995)(-\$1,000,000) + (0.0005)((\$1,000,000,000) = -\$499,500.$$

Therefore you should raise the policy premium substantially. But Sam, not knowing about the Japanese entry, will continue to refuse your offers to insure his losses.

6. **Suppose that Natasha's utility function is given by $u(I) = \sqrt{10I}$, where I represents annual income in thousands of dollars.**

a. **Is Natasha risk loving, risk neutral, or risk averse? Explain.**

Natasha is risk averse. To show this, assume that she has $10,000 and is offered a gamble of a $1000 gain with 50% probability and a $1000 loss with 50% probability. The utility of her current income of $10,000 is $u(10) = \sqrt{10(10)} = 10$. Her expected utility with the gamble is:

$$EU = (0.5)(\sqrt{10(11)}) + (0.5)(\sqrt{10(9)}) = 9.987 < 10.$$

She would avoid the gamble. If she were risk neutral, she would be indifferent between the $10,000 and the gamble, and if she were risk loving, she would prefer the gamble.

You can also see that she is risk averse by noting that the square root function increases at a decreasing rate (the second derivative is negative), implying diminishing marginal utility.

b. **Suppose that Natasha is currently earning an income of $40,000 ($I = 40$) and can earn that income next year with certainty. She is offered a chance to take a new job that offers a 0.6 probability of earning $44,000 and a 0.4 probability of earning $33,000. Should she take the new job?**

The utility of her current salary is $\sqrt{10(40)} = 20$. The expected utility of the new job is

$$EU = (0.6)(\sqrt{10(44)}) + (0.4)(\sqrt{10(33)}) = 19.85,$$

which is less than 20. Therefore, she should not take the job. You can also determine that Natasha should reject the job by noting that the expected value of the new job is only $39,600, which is less than her current salary. Since she is risk averse, she should never accept a risky salary with a lower expected value than her current certain salary.

c. **In (b), would Natasha be willing to buy insurance to protect against the variable income associated with the new job? If so, how much would she be willing to pay for that insurance? (*Hint*: What is the risk premium?)**

This question assumes that Natasha takes the new job (for some unexplained reason). Her expected salary is $0.6(44,000) + 0.4(33,000) = \$39,600$. The risk premium is the amount Natasha would be

willing to pay so that she receives the expected salary for certain rather than the risky salary in her new job. In (b) we determined that her new job has an expected utility of 19.85. We need to find the certain salary that gives Natasha the same utility of 19.85, so we want to find I such that $u(I) = 19.85$. Using her utility function, we want to solve the following equation: $\sqrt{10I} = 19.85$. Squaring both sides, $10I = 394.0225$, and $I = 39.402$. So Natasha would be equally happy with a certain salary of $39,402 or the uncertain salary with an expected value of $39,600. Her risk premium is $39,600 – 39,402 = $198. Natasha would be willing to pay $198 to guarantee her income would be $39,600 for certain and eliminate the risk associated with her new job.

7. **Suppose that two investments have the same three payoffs, but the probability associated with each payoff differs, as illustrated in the table below:**

Payoff	Probability (Investment *A*)	Probability (Investment *B*)
$300	0.10	0.30
$250	0.80	0.40
$200	0.10	0.30

a. **Find the expected return and standard deviation of each investment.**

The expected value of the return on investment *A* is

$$EV = (0.1)(300) + (0.8)(250) + (0.1)(200) = \$250.$$

The variance on investment *A* is

$$\sigma^2 = (0.1)(300 - 250)^2 + (0.8)(250 - 250)^2 + (0.1)(200 - 250)^2 = 500,$$

and the standard deviation on investment *A* is $\sigma = \sqrt{500} = \$22.36$.

The expected value of the return on investment *B* is

$$EV = (0.3)(300) + (0.4)(250) + (0.3)(200) = \$250.$$

The variance on investment *B* is

$$\sigma^2 = (0.3)(300 - 250)^2 + (0.4)(250 - 250)^2 + (0.3)(200 - 250)^2 = 1500,$$

and the standard deviation on investment *B* is $\sigma = \sqrt{1500} = \$38.73$.

b. **Jill has the utility function $U = 5I$, where I denotes the payoff. Which investment will she choose?**

Jill's expected utility from investment *A* is

$$EU = (0.1)(5 \times 300) + (0.8)(5 \times 250) + (0.1)(5 \times 200) = 1250.$$

Jill's expected utility from investment *B* is

$$EU = (0.3)(5 \times 300) + (0.4)(5 \times 250) + (0.3)(5 \times 200) = 1250.$$

Since both investments give Jill the same expected utility she will be indifferent between the two. Note that Jill is risk neutral, so she cares only about expected values. Since investments *A* and *B* have the same expected values, she is indifferent between them.

c. **Ken has the utility function $U = 5\sqrt{I}$. Which investment will he choose?**

Ken's expected utility from investment *A* is

$$EU = (0.1)(5)\sqrt{300} + (0.8)(5)\sqrt{250} + (0.1)(5)\sqrt{200} = 78.98.$$

Ken's expected utility from investment B is

$$EU = (0.3)(5)\sqrt{300} + (0.4)(5)\sqrt{250} + (0.3)(5)\sqrt{200} = 78.82.$$

Ken will choose investment A because it has a slightly higher expected utility. Notice that Ken is risk averse, and since the two investments have the same expected return, he prefers the investment with less variability.

d. Laura has the utility function $U = 5I^2$. Which investment will she choose?

Laura's expected utility from investment A is

$$EU = (0.1)(5 \times 300^2) + (0.8)(5 \times 250^2) + (0.1)(5 \times 200^2) = 315,000.$$

Laura's expected utility from investment B is

$$EU = (0.3)(5 \times 300^2) + (0.4)(5 \times 250^2) + (0.3)(5 \times 200^2) = 320,000.$$

Laura will choose investment B since it has a higher expected utility. Notice that Laura is a risk lover, and since the two investments have the same expected return, she prefers the investment with greater variability.

8. As the owner of a family farm whose wealth is $250,000, you must choose between sitting this season out and investing last year's earnings ($200,000) in a safe money market fund paying 5.0% or planting summer corn. Planting costs $200,000, with a six-month time to harvest. If there is rain, planting summer corn will yield $500,000 in revenues at harvest. If there is a drought, planting will yield $50,000 in revenues. As a third choice, you can purchase AgriCorp drought-resistant summer corn at a cost of $250,000 that will yield $500,000 in revenues at harvest if there is rain, and $350,000 in revenues if there is a drought. You are risk averse, and your preference for family wealth (W) is specified by the relationship $U(W) = \sqrt{W}$. The probability of a summer drought is 0.30, while the probability of summer rain is 0.70. Which of the three options should you choose? Explain.

Calculate the expected utility of wealth under the three options. Wealth is equal to the initial $250,000 plus whatever is earned growing corn or investing in the safe financial asset. Expected utility under the safe option, allowing for the fact that your initial wealth is $250,000, is:

$$E(U) = (250,000 + 200,000(1 + 0.05))^{0.5} = 678.23.$$

Expected utility with regular corn, again including your initial wealth, is:

$$E(U) = 0.7(250,000 + (500,000 - 200,000))^{0.5} + 0.3(250,000 + (50,000 - 200,000))^{0.5}$$

$$= 519.13 + 94.87 = 614.$$

Expected utility with drought-resistant corn is:

$$E(U) = 0.7(250,000 + (500,000 - 250,000))^{0.5} + 0.3(250,000 + (350,000 - 250,000))^{0.5}$$

$$= 494.975 + 177.482 = 672.46.$$

You should choose the option with the highest expected utility, which is the safe option of not planting corn.

Note: There is a subtle time issue in this problem. The returns from planting corn occur in 6 months while the money market fund pays 5%, which is presumably a yearly interest rate. To put everything on equal footing, we should compare the returns of all three alternatives over a 6-month period. In this case, the money market fund would earn about 2.5%, so its expected utility is:

$$E(U) = (250,000 + 200,000(1 + 0.025))^{0.5} = 674.54.$$

This is still the best of the three options, but by a smaller margin than before.

9. **Draw a utility function over income *u(I)* that describes a man who is a risk lover when his income is low but risk averse when his income is high. Can you explain why such a utility function might reasonably describe a person's preferences?**

The utility function will be *S*-shaped as illustrated below. Preferences might be like this for an individual who needs a certain level of income, *I**, in order to stay alive. An increase in income above *I** will have diminishing marginal utility. Below *I**, the individual will be a risk lover and will take unfavorable gambles in an effort to make large gains in income. Above *I**, the individual will purchase insurance against losses and below *I** will gamble.
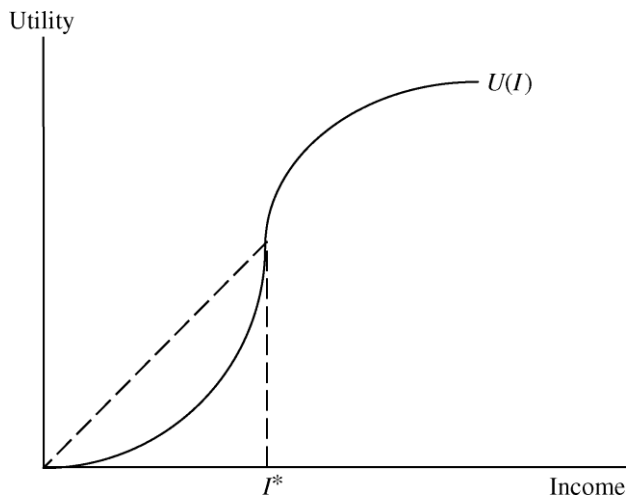
10. **A city is considering how much to spend to hire people to monitor its parking meters. The following information is available to the city manager:**

   - **Hiring each meter monitor costs $10,000 per year.**

   - **With one monitoring person hired, the probability of a driver getting a ticket each time he or she parks illegally is equal to 0.25.**

   - **With two monitors, the probability of getting a ticket is 0.5; with three monitors, the probability is 0.75; and with four, it's equal to 1.**

   - **With two monitors hired, the current fine for overtime parking is $20.**

   a. **Assume first that all drivers are risk neutral. What parking fine would you levy, and how many meter monitors would you hire (1, 2, 3, or 4) to achieve the current level of deterrence against illegal parking at the minimum cost?**

   If drivers are risk neutral, their behavior is influenced only by their expected fine. With two meter monitors, the probability of detection is 0.5 and the fine is $20. So, the expected fine is (0.5)($20) + (0.5)(0) = $10. To maintain this expected fine, the city can hire one meter monitor and increase the fine to $40, or hire three meter monitors and decrease the fine to $13.33, or hire four meter monitors and decrease the fine to $10.

   If the only cost to be minimized is the cost of hiring meter monitors at $10,000 per year, you (as the city manager) should minimize the number of meter monitors. Hire only one monitor and increase the fine to $40 to maintain the current level of deterrence.

b. Now assume that drivers are highly risk averse. How would your answer to (a) change?

If drivers are risk averse, they would want to avoid the possibility of paying parking fines even more than would risk-neutral drivers. Therefore, a fine of less than $40 should maintain the current level of deterrence.

c. (For discussion) What if drivers could insure themselves against the risk of parking fines? Would it make good public policy to permit such insurance?

Drivers engage in many forms of behavior to insure themselves against the risk of parking fines, such as checking the time often to be sure they have not parked overtime, parking blocks away from their destination in non-metered spots, or taking public transportation. If a private insurance firm offered insurance that paid the fine when a ticket was received, drivers would not worry about getting tickets. They would not seek out unmetered spots or take public transportation; they would park in metered spaces for as long as they wanted at zero personal cost. Having the insurance would lead drivers to get many more parking tickets. This is referred to as moral hazard and may cause the insurance market to collapse, but that's another story (see Section 17.3 in Chapter 17).

It probably would not make good public policy to permit such insurance. Parking is usually metered to encourage efficient use of scarce parking space. People with insurance would have no incentive to use public transportation, seek out-of-the-way parking locations, or economize on their use of metered spaces. This imposes a cost on others who are not able to find a place to park. If the parking fines are set to efficiently allocate the scarce amount of parking space available, then the availability of insurance will lead to an inefficient use of the parking space. In this case, it would not be good public policy to permit the insurance.

11. A moderately risk-averse investor has 50% of her portfolio invested in stocks and 50% in risk-free Treasury bills. Show how each of the following events will affect the investor's budget line and the proportion of stocks in her portfolio:

a. The standard deviation of the return on the stock market increases, but the expected return on the stock market remains the same.

From Section 5.4, the equation for the budget line is

$$R_p = \left[\frac{R_m - R_f}{\sigma_m}\right]\sigma_p + R_f,$$

where R_p is the expected return on the portfolio, R_m is the expected return from investing in the stock market, R_f is the risk-free return on Treasury bills, σ_m is the standard deviation of the return from investing in the stock market, and σ_p is the standard deviation of the return on the portfolio. The budget line is linear and shows the positive relationship between the return on the portfolio, R_p, and the standard deviation of the return on the portfolio, σ_p, as shown in Figure 5.6.

In this case σ_m, the standard deviation of the return on the stock market, increases. The slope of the budget line therefore decreases, and the budget line becomes flatter. The budget line's intercept stays the same because R_f does not change. Thus, at any given level of portfolio return, the portfolio now has a higher standard deviation. Since stocks have become riskier without a compensating increase in expected return, the proportion of stocks in the investor's portfolio will fall.

b. The expected return on the stock market increases, but the standard deviation of the stock market remains the same.

In this case, R_m, the expected return on the stock market, increases, so the slope of the budget line becomes steeper. At any given level of portfolio standard deviation, σ_p, there is now a higher expected return, R_p. Stocks have become relatively more attractive because investors now get greater expected returns with no increase in risk, and the proportion of stocks in the investor's portfolio will rise as a consequence.

c.   The return on risk-free Treasury bills increases.

In this case there is an increase in R_f, which affects both the intercept and slope of the budget line. The budget line shifts up and becomes flatter as a result. The proportion of stocks in the portfolio could go either way. On one hand, Treasury bills now have a higher return and so are more attractive. On the other hand, the investor can now earn a higher return from each Treasury bill and so could hold fewer Treasury bills and still maintain the same level of risk-free return. In this second case, the investor may be willing to place more of her money in the stock market. It will depend on the particular preferences of the investor as well as the magnitude of the returns to the two asset classes. An analogy would be to consider what happens to savings when the interest rate increases. On the one hand, savings tend to increase because the return is higher, but on the other hand, spending may increase and savings decrease because a person can save less each period and still wind up with the same accumulation of savings at some future date.

12. **Suppose there are two types of e-book consumers: 100 "standard" consumers with demand $Q = 20 - P$ and 100 "rule-of-thumb" consumers who buy 10 e-books only if the price is less than $10. (Their demand curve is given by $Q = 10$ if $P < 10$ and $Q = 0$ if $P \geq 10$.) Draw the resulting total demand curve for e-books. How has the "rule-of-thumb" behavior affected the elasticity of total demand for e-books?**

The demand for e-books is shown below. The upper part of the demand curve will look like the demands of the standard consumers. For example, when $P = \$20$, no e-books will be demanded, and when $P = \$10$, each standard consumer will demand 10 e-books and each rule-of-thumb consumer will demand zero e-books. Since there are 100 standard consumers, the total quantity demanded will be 1000. When the price drops to $9.99, all 100 rule-of-thumb consumers will demand 10 e-books

each, so the total quantity demanded will jump out to 2000 e-books. Finally, when price drops to zero, each standard consumer will demand 20 e-books, making the total number demanded 3000.
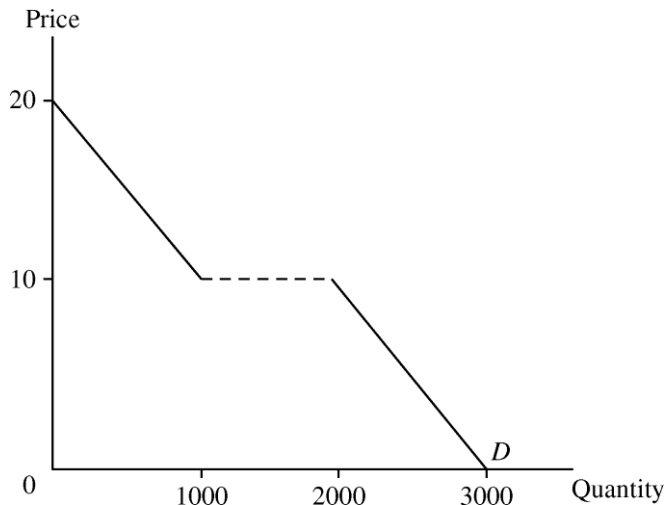
The equation for the upper part of the market demand curve is 100 times the standard demand equation, so it is $Q = 2000 - 100P$. Therefore, the slope of the demand curve is $\dfrac{\Delta Q}{\Delta P} = -100$. The elasticity of demand is $E_D = \dfrac{P}{Q}\dfrac{\Delta Q}{\Delta P}$, and at $P = \$10$, elasticity is therefore $E_D = \dfrac{10}{1000}(-100) = -1$.

When price drops to $P = \$9.99$ and the rule-of-thumb consumers jump into the market, elasticity becomes $E_D = \dfrac{9.99}{2000}(-100) = -0.50$. So elasticity drops considerably as a result of the behavior of the rule-of-thumb consumers. This makes sense, because the rule-of-thumb consumers have a perfectly inelastic demand once they enter the market, so they will lower the overall elasticity of demand for e-books at prices below $10.