



UNCERTAINTY  
*in* ECONOMICS  
Readings and Exercises

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## Preface

For a number of years we have been teaching courses on the economics of uncertainty. Since no textbook presented the material we wanted to cover, we relied on published and unpublished articles for the reading material. These articles make up the selections of this book. We think this book can serve several purposes. For students in places without courses in uncertainty, it provides a guide to what at least two economists think most interesting in the literature. Being in the habit of commenting on, as well as presenting, the materials we lecture on, it was natural to include some commentary. Feeling that mastery of theory comes as much from doing theory as from reading it, we have included a fair number of problems. These come from several sources and vary greatly in difficulty. In some papers we have eliminated the examples and replaced them with problems. Some comments we might have made seemed better made by problems. Some problems were designed to try to develop simple computational skills. Others require some development of techniques of proof. A few move into the area of design of models in which to prove results. These are the hardest, and may well be too difficult to include in a volume that comes without answers. Some of the problems have been found very difficult by our students; none of them seem worth spending a lifetime on, or even more than a weekend.

We have not attempted complete coverage of the economics of uncertainty. The readings are based on what we like to teach and what we feel is necessary to cover to reach what we like to teach. We are most fascinated by the ways in which markets function (and malfunction) when market participants have incomplete information. To understand this, one must study how uncertainty affects both individual behavior and standard equilibrium theory. We have no doubt left out many areas of real significance, many items other people like to teach, and quite possibly some things we would like to teach.

We must express our debt to our students who have made the development of this material worthwhile for us. In addition we would like to thank the many people with whom we have discussed uncertainty over the years. We are particularly indebted to Dennis Carlton, Oliver Hart, Steven Shavell, and Charles Wilson for reading, commenting on, and correcting a draft of this manuscript, and to Barbara Feldstein for flawless typing and retyping.

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## **I. Individual Choice in a Static Setting**

The papers in this first section examine individual choice under uncertainty where the individual is making a single decision. The first three papers discuss the relevance of expected utility maximization for positive and normative theories of individual choice. (We have not included anything on stochastic, as opposed to determinate, choice.) We then turn to the comparative statics of behavior of individuals who are expected utility maximizers. This is the most commonly used assumption in economic analyses, and so one should understand it without losing sight of the criticisms that have been made of it or of the availability of alternatives. Most of the selections in Parts II and III model individual behavior as expected utility maximization.



# 1

J. S. Tamerin and H. L. P. Resnik, Risk taking by individual option — Case study — Cigarette smoking, *in* “Perspectives on Benefit Risk Decision Making,” pp. 73–84. Washington, D.C.: National Academy of Engineering, 1972

In this paper, two psychiatrists discuss the possibility that some of the people, some of the time, are not trying to make rational decisions, whatever they may be. This very real possibility is relevant both for considering how to do welfare analysis for individuals behaving in this mode and for examining markets where suppliers are dealing with several types of demanders. A recurring question in normative analysis is how much respect is to be given consumer sovereignty? The answer invariably involves balancing the desire to help individuals to make better choices against the danger of forcing them to do what they do not really want to do and the unpleasantness of using force *per se*. An issue in positive analysis is how markets with imperfect information work when some of the consumers live by the rules set down by theorists and others do not. Does one group ruin the market for the other, or improve it for the other, or are there niches for suppliers who will choose to specialize in one group or the other? The analysis of markets with imperfect information is the subject of Parts II and III.



# Risk Taking by Individual Option—Case Study: Cigarette Smoking

How does an individual decide to expose himself to risk? Since risk is defined as a chance of injury, damage, or loss,<sup>1</sup> an individual in taking a risk must, presumably, have some notion of benefit or gain. The benefits are obvious in some types of risk taking. These vary from the potential monetary rewards associated with entrepreneurial activity in business, to the satisfactions of professional recognition<sup>2</sup> and societal improvement for the innovative scientist.

Risk taking of this kind may be constructive, creative, and healthy. It frequently yields positive results for the individual and society.<sup>3</sup> Constructive risk taking, in addition to the obvious benefits, can be distinguished from other kinds of risk taking by certain characteristic features:

1. Conscious deliberation. In healthy risk taking, the individual takes a calculated risk. He carefully weighs benefits against costs, and makes a deliberate choice.<sup>4,5,6</sup>

2. Adequate preparation. Healthy risk taking is not impulsive or haphazard. Individuals carefully plan and train for such activities (whether they are in industry or in space).<sup>7,8</sup>

3. Positive rather than negative aims. Healthy risk taking arises out of a desire to grow, to achieve, to test oneself, to master and control the environment.<sup>9</sup> It does not originate from the need to diminish or deny basic feelings of worthlessness or inadequacy. It does not come from an ingrained wish for self-destruction. Such acts are, characteristically, undertaken to heighten awareness or for self-actualization,<sup>10</sup> and not to reduce tension or psychic pain. In fact, self-discipline, self-confidence, security, and high self-esteem may be necessary for healthy, constructive risk taking.<sup>11,12</sup> The individual must trust his abilities and his environment. He must feel secure in his capacity to cope.<sup>13</sup> Such risk takers choose oc-

cupations where boldness and independence are necessary factors in success. In fact, in creative and competitive occupations, those who achieve prominence are likely to be greater risk takers than are their less productive peers.<sup>14</sup>

4. *Personal responsibility for outcome.* In healthy risk taking the individual takes chances in which he can, to a considerable extent, have the responsibility for the outcome. He avoids risks in which outcome is left entirely to chance or is otherwise completely beyond his control, because such activities give him no sense of personal achievement.<sup>15</sup>

In contrast to constructive risk taking, there are other areas of human behavior where the benefits seem less apparent and the risks more obvious. In these situations, the actions are characteristically taken with little deliberation, incomplete planning (or no planning at all), for negative reasons, and without responsibility for outcome. This kind of risk taking is generally associated with individual psychopathology and may thus come to the attention of the psychotherapist. Such acts are usually impulsive or compulsive. They have a driven quality and the inner pressure is often described as irresistible. The act may vary from compulsive gambling to kleptomania, from drug abuse to skyjacking, from wrist slashing to automobile recklessness. In all instances, an absence of rational decision making is apparent. The individuals involved typically respond in a patterned, repetitive, and maladaptive manner. Furthermore, they are unable to stop this repetitive behavior of their own accord, nor can they be distracted by substitute gratifications or dissuaded by rewards or punishments. The capacity to adapt behavior to reality considerations has been lost. These people are not free to act by individual option. Whether symptomatically an alcoholic or a compulsive gambler, these individuals appear to be driven by inflexible, irrational forces beyond their conscious control.

It is characteristic of this type of neurotic risk taking that the reality risk far outweighs the reality benefits. In fact, although the risks are clear and apparent, the reality benefits are uncertain or questionable. This is evident in such acts as kleptomania, particularly when practiced by the affluent. In these instances, the gain is clearly more symbolic than real. When kleptomaniacs are studied psychologically, it becomes evident that the real aim of their behavior is something quite different from obtaining the stolen object for its monetary value. Fenichel<sup>16</sup> illustrated this point in describing the case of a middle-aged woman driven to petty thievery. During the psychiatric evaluation of this patient, the real benefit of her stealing became obvious. Although invariably frigid during sexual intercourse, she consistently experienced sexual excitement at the moment of theft. The gain in stealing was, therefore, more sexual (i.e., a symbolic representation of doing the forbidden) than monetary.

Neurotic risk taking is motivated primarily by negative aims rather than by

the achievement of any positive goals. Such acts are carried out to rid the individual of tension and to diminish subjective feelings of distress. The kinds of behavior used to decrease feelings of discomfort vary widely—compulsive gambling, kleptomania, narcotic abuse, alcohol abuse, and many others. Often, the individual who takes neurotic risks will choose several of these patterns almost indiscriminately, to relieve feelings of psychic pain. It is well known that a drug user frequently abuses a variety of addicting and habituating substances. A considerable number of heroin addicts began as alcoholics.<sup>17</sup> Conversely, the heroin addict who is thought to be stabilized on methadone will often turn to abuse of alcohol or other drugs. Sometimes the individual hopes to remove negative feelings by a single act. Hence, he may impulsively, in a single dramatic act such as a highly lethal suicide attempt, or skyjacking, or even a political assassination, attempt to rapidly and magically solve chronic feelings of despair, hopelessness, and low self-esteem.

Finally, in neurotic risk taking the outcome is invariably left to chance. The successful solution rests not on personal competence or mastery, but on magic or powerful forces external to the individual. Nowhere is this more clearly demonstrated than in the compulsive gambler. Gamblers characteristically believe in the magical significance of numbers and make important monetary decisions based on hunches about them. Psychoanalytic studies<sup>18, 19</sup> have revealed that gambling represents an attempt to conquer and compel fate in a magical way to protect and reward the individual. Quite literally the gambler is constantly looking to be smiled on and taken care of by Lady Luck. The gamble with death is a well-recognized aspect of repetitive suicidal behaviors.<sup>20</sup>

How prevalent is neurotic risk taking? We know that most of the conditions described as manifestations of neurotic risk taking are encountered in a relatively small segment of the population. Even alcoholism, clearly the most prevalent of the risk-taking behaviors cited, is estimated to be present in only about 7 percent of the adult drinking population, or 4 percent of the total adult population.<sup>21</sup>

A less obvious form of individual risk taking, but one which must now be considered in that category, is cigarette smoking. In 1970, 36 percent of the adult population in the United States (or 44.5 million adults) smoked cigarettes.<sup>22</sup> This grim figure raises the question of whether neurotic risk taking is primarily the province of a relatively small group of extremely disturbed individuals, or whether it may be the national pasttime.

To consider this question, the first issue is whether or not continued cigarette smoking, in the year 1971, represents a neurotic risk-taking behavior. As we have indicated, a neurotic act is characterized by its maladaptive qualities, its repetitiveness, and by an inflexibility in the face of reality considerations. Stated in terms of a rational decision-making process, the risk in a neurotic act

far exceeds the reality benefits. Is this true of cigarette smoking? What are the risks? What are the benefits?

Among the major risks of cigarette smoking in terms of disability, morbidity, and mortality, are the following:

1. *As a cause of excess disability.* Whether measured by working days lost, days spent in bed, or days of restricted activity due to illness or injury, the rates are higher for smokers. Each year, 77 million working days are lost, 88 million days are spent ill in bed, and 306 million days are spent in restricted activity as a result of smoking.<sup>23</sup> Heavy smokers between the ages of 40 and 69 are hospitalized 50 percent more frequently than nonsmokers.<sup>24</sup>

2. *As a cause of excess morbidity.* In all countries for which reliable statistics are available, there has been a striking increase in lung cancer in recent decades—paralleling the rapid rise in cigarette smoking.<sup>23</sup> More than 30 retrospective studies in 10 countries have shown that the risk of lung cancer is 15 to 30 times greater for smokers than for nonsmokers.<sup>23</sup>

Though the risk of disease attributable to smoking is most dramatically seen in lung cancer, this is but one of many risked by the smoker. Heart disease, bronchitis, emphysema, peptic ulcer, sinusitis and other chronic illnesses are found much more frequently among smokers than nonsmokers.

3. *As a cause of excess mortality.* Repeatedly, studies have shown that the greatest risk the smoker takes is that of shortening his life span. The life expectancy of a man 25 years of age is reduced by 4.6 years if he smokes less than half a pack a day; by 5.5 years if he smokes half a pack to 1 pack a day; by 6.2 years if he smokes 1 to 2 packs; and by 8.3 years if he smokes 2 or more packs a day. Since 8.3 years is equivalent to 4.4 million minutes, this amounts to a loss of almost 6 minutes for each cigarette smoked. In effect, a minute of life is forfeited for each minute of smoking.<sup>24</sup>

Another way of looking at this risk is in terms of percentages. The chances of a man of 25 dying before he becomes 65 (i.e., during his peak years of family and professional responsibilities) are 50 percent greater if he smokes less than half a pack of cigarettes a day than if he is a nonsmoker; 70 percent greater if he smokes half a pack to 1 pack a day; 77 percent greater if he smokes 1 to 2 packs a day; and 109 percent greater (more than twice as great) if he smokes 2 or more packs a day.<sup>24</sup> The decrease in life expectancy of the 2-pack-a-day smoker is almost equal to the increase in life expectancy that medical science has made possible over the past 50 years. In effect, the cigarette smoker is sacrificing all of the health gains that have been made in the last half-century. In 1965, it was estimated by the Surgeon General that 240,000 men would die prematurely from cigarette-associated diseases. By 1967, the estimate was up to more than 300,000. Translated into daily averages, these figures mean an estimate of about 800 premature deaths a day attributable to cigarette smoking.<sup>24</sup>

The very personal risk of cigarette smoking is clear. Why, then, do people continue to smoke cigarettes? What are the personal benefits of smoking? These may be roughly divided into pharmacological and psychological benefits.

## PHARMACOLOGICAL BENEFITS

The nicotine in cigarettes has been considered by many investigators to be the most important element in smoking. In fact, Lewin commented in 1931, "The decisive factor in the effect of tobacco is nicotine and it matters little whether it passes directly into the organism or whether it is smoked."<sup>25</sup> This was further highlighted by Johnston's research.<sup>26</sup> He gave nicotine hypodermically to 35 volunteers, comparing its effects, and particularly its psychic effects, to those of tobacco smoking. It was found that all of the volunteers who were smokers reported a pleasant sensation and, when given an adequate dose of nicotine, were disinclined to smoke for some time thereafter.

Nicotine acts on the central nervous system, exerting an interesting bi-phasic effect that is unique among the pleasure poisons. This was observed over two centuries ago by the pipe-smoking country people who remarked:

Tobacco reek, tobacco reek,  
It makes me hale when I am sick.  
Tobacco reek, tobacco reek,  
When I am hale, it makes me sick.<sup>25</sup>

More recently, this important biphasic action has been concisely described by Johns<sup>25</sup>: "We use tobacco because when the nervous system is stimulated, nicotine sedates; and when it is depressed, nicotine stimulates." Although the bi-phasic response can be observed in the individual smoker, it has been found clinically that in a total population of smokers, some are predominantly stimulated whereas others are predominantly relaxed by smoking. Factor analytic studies<sup>27</sup> have distinguished the individual who smokes to enhance pleasure and stimulation from the smoker who smokes to reduce tension, or for purposes of sedation. In the latter group, the tranquilizing effect is so pronounced that a number of investigators<sup>25</sup> have suggested considering tobacco as a tranquilizing drug. Such a concept has received further experimental support from studies of the localized effect of nicotine on specific areas of the brain. These studies have revealed that nicotine accumulates in the hippocampus, one of the major components of the limbic system, which is that portion of the brain known to play a central role in the experiencing of emotion. After large doses of nicotine, the electroencephalographic recordings from the hippocampus show the same changes observed following the administration of certain tranquilizers.<sup>28</sup>

## PSYCHOLOGICAL BENEFITS

The psychological benefits of cigarette smoking are multiple and complex. Cigarette smoking is often initiated during adolescence with a feeling of defiance for authority. By this act, the individual fantasizes being at least as strong or as powerful as the adults who have made the rules. The rebellion against authority that is symbolized by smoking, combined with a fantasy of strong individuality and manliness,<sup>29</sup> has been picked up by the advertising industry and linked to various brands of cigarettes. This fantasy of individuality and manliness is personified by the Marlboro man, and the defiance and rebellion have been cast either in strident sexual terms, as with Virginia Slims or Silva Thins, or in a more humorous, light-hearted manner, as with Benson and Hedges 100's. Obviously, the success of these brands reflects the fact that important psychological needs are being addressed by the advertising images—images the individual smoker unconsciously identifies with through the act of smoking.

Another obvious psychological benefit of smoking that has been dealt with extensively in the psychoanalytic literature is oral gratification. As early as 1922, commenting on the role of orality in smoking, Brill said that “As the receptor of nourishment, the mouth zone seems to require almost constant stimulation, especially when the individual is laboring under difficulties.”<sup>30</sup>

In the child, oral activity increases in the face of stress or frustration. The adult smoker similarly increases his smoking in response to stress. When the smoker is compelled to give up this gratification, reversion to another form of orality such as nail-biting, compulsive eating, drinking, or gum chewing, is almost invariably noted. The capacity of cigarettes to serve as pacifiers for human tension had, in fact, been recognized long before psychiatry emerged as a separate medical discipline. Jean Nicot, who introduced tobacco into France, reported to his Queen, Catherine de Medici, that smoking led to “a quiet tranquility and great submissiveness of disposition, so that through general use of tobacco, Her Majesty’s subjects would become easy to govern.”<sup>25</sup>

In addition to reducing tension, cigarettes have the positive capacity of inducing feelings of pleasure and well-being. This is recognized in the well-established customs of cigarette breaks, the cigarette with a cup of coffee at the end of a meal, and the cigarette with a drink in a convivial social setting. This linkage of cigarettes with pleasure has been further intensified by the advertising industry, which has coupled smoking with the moment of relaxation—“The late nights, and skipping lunch, and now the job is done and it’s the L & M moment”; or with the return of pleasurable memories from the past (Winston) “That down home taste”; or to a bucolic retreat from urban pressures “Never hot, never dry, always Kool” or “You can’t take the country out of Salem”

But nowhere has the pleasure of tobacco been more joyfully expressed than in the jingle: