RELAXING THE EXPECTED UTILITY HYPOTHESIS AND ENTRY/EXIT DECISIONS OF THE RISK-AVERSE FIRM

by Israel Finkelshtain and Julie Hewitt *

Paper presented at the 1990 AAEA Meetings
held at Vancouver, British Columbia

Abstract

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*The authors are post-doctoral fellow and Ph.D. candidate, respectively, in the Department of Agricultural and Resource Economics, University of California at Berkeley. Dr. Finkelshtain will be an Assistant Professor in the Department of Agricultural Economics and Management at the Hebrew University in Israel beginning in the fall of 1990.

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ABSTRACT

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1. Introduction

Recent years have witnessed accumulating evidence against the expected utility model (*e.g.*, Conlisk (1989)). In response, numerous studies have suggested various alternatives to expected utility theory (see Machina (1987)). These theories were developed with the idea of maintaining the mathematical tractability and intuitive appeal of expected utility theory, yet accommodating the experimental evidence.

The question arises as to which qualitative results derived under the expected utility hypothesis would generalize under any alternative representation. That is, which results are robust to the underlying axioms? An important step toward the resolution of this question was taken by Machina (1989), who examined which type of comparative statics results would generalize when the agent's preferences are represented by a "smooth functional" (a Fréchet differentiable utility function). An alternative approach was taken by Safra and Zilcha (1986), who examined firm behavior under price risk, when futures markets are accessible. Using the elementary axiom that preferences are increasing (the firm prefers first order stochastic dominant distributions), they show that the separation result generalizes—the firm equates marginal cost to the future price, regardless of the specific representation.

This paper follows the second approach. Using a minimal set of assumptions, we formulate a theory of risk aversion without a representation of a utility functional. We then apply this theory to the analysis of firm behavior in the long-run. We show that entry and exit decisions and the long run equilibrium condition developed with expected utility theory are generalized to an arbitrary representation of preferences, as long as the preference relation is risk averse.

The paper contributes to the literature on long-run firm behavior by showing that important results derived in this literature are immune to the criticisms of the expected utility hypothesis. Moreover, our approach makes explicit the assumptions regarding firms' preferences needed to obtain specific results, a feature missing from analyses that use a utility-functional representation. It also contributes to the ongoing discussion on "non-expected utility" by showing that qualitative results from the expected utility model can be generalized to any preference relation that obeys minimal restrictions. No less important, it suggests behavioral rules that are common to many representations and, hence, cannot be used to test the expected utility hypothesis.

The paper proceeds as follows. The next section presents the formal model and necessary definitions. Section three reviews the axioms that are the basis of expected utility and some experimental evidence against them. The fourth section introduces a theory of risk aversion and the fifth uses this theory to derive the rules for entry and exit without the expected utility hypothesis. This section also considers the implications for the long run equilibrium and comparisons between producers with different risk attitudes.

2. A Model of Entry/Exit Decisions under Price Risk

A producer's total income is given by the sum of a fixed amount of initial wealth, W_0, and profits, $\pi = p_x \cdot x - C(x)$, where x is the output level and $C(x)$ is a deterministic cost function, with $C(0)=0$. The output price, p_x, is risky with a known cumulative distribution function, $F(p_x)$, assumed to have finite mean. Output is assumed to be non-stochastic[1] and must be chosen prior to the realization of p_x.

A producer's choice of x, together with $F(p_x)$, induces a CDF of the producer's final wealth. The set of all such CDF's is denoted by G. We assume that a CDF, $g \in G$, has support $[-W_0, \infty]$, and finite mean, $M(g) = \int \theta \, dg(\theta)$. The producer is endowed with a preference relation, $\gg$, with which he compares and ranks different levels of x, and in essence chooses $g \in G$.[2] $\geqq$ is used to denote that one CDF is at least as preferred as another and ~ is

[1] Treating output and costs as non-random is not essential, but simplifies the analysis and allows comparison with the results of Sandmo (1971) and Flacco (1983).

[2] The complete argument in for using a set of CDF's as the choice set under risk is presented in Weiss (1987). He noted that an attractive feature of using a set of CDFs (such as G) for the choice set is that it is convex.

used to denote indifference between two CDF's.

We now introduce three definitions which will be useful below.

Definition I: Stochastic Dominance in the First Degree.

Let $g^1, g^2 \in G$. g^1 dominates g^2 in the first degree (which we denote as $g^1 >_1 g^2$), if and only if $g^1(\theta) \leq g^2(\theta)$ for all θ and for at least one θ, say $\overline{\theta}$, $g^1(\overline{\theta}) < g^2(\overline{\theta})$.

Thus, a CDF which dominates another in the first degree, simply assigns at least as large a probability to the event that $\theta > \theta_0$ for any $\theta_0 \in R$.

Definition II: A Monotonic Preference Relation

A preference relation, $\gg$, is said to be monotone if and only if for any $g^1, g^2 \in G$, such that $g^1 >_1 g^2$, $g^1 \gg g^2$.

Definition III: A Degenerate Distribution.

A CDF, $\delta_a \in G$, is said to be degenerate at a if and only if

$$\delta_a(\theta) = \begin{cases} 0 & \text{where} \quad \theta < a \\ 1 & \text{where} \quad \theta \geq a \end{cases}$$

Thus, a degenerate CDF at a assigns probability one to a and zero to any other scalar.

3. The Expected Utility Model: Review of Axioms and Evidence

As our aim is to relax the assumption of the expected utility model, we catalog here the von Neumann-Morganstern (vNM) axioms it is based upon. The vNM axioms are <u>sufficient</u> for the existence of a measurable utility function, which ranks CDFs consistently with the individual's preferences.

Axiom I: Complete Ordering.

For any CDFs $g^1, g^2 \in G$, either $g^1 \gg g^2$, $g^2 \gg g^1$, or $g^1 \sim g^2$. Also, if $g^1 \gg g^2$ and $g^2 \gg g^3$, then $g^1 \gg g^3$.

Axiom II: Continuity.

Suppose $g^1 \gg g^2 \gg g^3$. Then there exists a probability, ρ, such that $\rho g^1 + (1-\rho) g^3 \sim g^2$.

Axiom III: Independence.

For $g^1 \gg g^2$ and any $g^3 \in G$, $\rho \in [0,1]$, $\rho g^1 + (1-\rho) g^3 \gg \rho g^2 + (1-\rho) g^3$.

Axiom IV: Unequal Probabilities.

If $g^1 \gg g^2$, then $\rho g^1 + (1-\rho) g^2 \gg \tau g^1 + (1-\tau) g^2$, if and only if $\rho > \tau$.

Axiom V: Compound Lotteries.

For $g^1, g^2, g^3, g^4 \in G$ and $\rho, \tau, \gamma \in [0,1]$, $\rho(\tau g^1 + (1-\tau) g^2) + (1-\rho)(\gamma g^3 + (1-\gamma) g^4) \sim \rho\tau g^1 + \rho(1-\tau) g^2 + (1-\rho)\gamma g^3 + (1-\rho)(1-\gamma) g^4$.

Before referring to the empirical evidence regarding the validity of these axioms, we note that Fishburn (1970) offers proof of the vNM theorem based on a subset of these axioms, specifically axioms I, II, and III. However, even this subset of axioms cannot be justified on empirical grounds.

Several studies have shown that preferences are not transitive (*e.g.*, Tversky (1969)). These experiments often found situations in which individuals' preferences are lexicographic, a behavioral model that is generally ruled out in decision-making under certainty. Also, many studies of the preference reversal phenomenon provide strong evidence that individuals' preferences are not consistent (*e.g.*, Grether and Plott (1979)). A study of the continuity axiom by Coombs (1975) found that nearly half the subjects violated this axiom, sometimes referred to as in-betweenness. The fourth axiom can be derived from other axioms (Varian (1984)), and it may be for this reason that no empirical evidence directly regarding its validity has been found. The compound lotteries axiom was studied by Bar-Hillel (1973), who found that individuals were not very successful at judging the compound structure of a lottery.

The most striking evidence regarding the inadequacy of the expected utility model is with regard to the independence axiom, as demonstrated by the Allais (1953) paradox. A recent paper by Conlisk (1989) argues that the format usually used to demonstrate the Allais paradox masks the independence axiom. He presents individuals with three other formats, and observes, in two cases, behavior much more consistent with the expected utility model and in the third, behavior consistent with Machina's (1982) fanning-out hypothesis. Although

Conlisk's study calls into question the results of previous Allais paradox experiments, it does not provide a definitive argument for any one of the alternative behavioral models proposed, or even for "standard economic theory," which would argue that individuals have stable, well-behaved preferences. One practical conclusion we may draw is that there is considerable value to results which are derived from a minimal set of axioms, rather than from a utility functional representation derived from a specific set of axioms.

4. Risk Aversion

We now introduce elements of risk aversion theory which are required for the analysis of the problem at hand. A more complete theory of risk aversion, formulated directly from the preference relation, was introduced by Yaari (1969). Yaari's approach, however, assumes several axioms on the underlying preference relation which are fruitful, but not necessary for our problem. Our definition of risk aversion follows that of Safra and Zilcha (1986).

Axiom VI: Weak Risk-Aversion.

A preference relation, $\gg$, defined over G, is said to be weakly risk averse if and only if for any nondegenerate CDF, $g \in G$, $\delta_{M(g)} \gg g$.

Thus a weakly risk averse agent prefers the mean of any nondegenerate CDF to the CDF itself. Safra and Zilcha (1986) noted that in the case of expected utility this axiom is equivalent to a concave utility function defined over wealth. However, in the general case, weak risk aversion does not imply aversion to mean preserving spreads, which Yaari (1987) terms strong risk aversion. To provide the above, abstract concept with economic context, we prove Proposition 1 below, relating weak risk aversion to insurance demand.

Assume that the agent faces a distribution $g(L) \in G$ of potential monetary losses denoted by L, and that for at least one $L > 0$ $1-g(L) > 0$. Denoting Π as the insurance premium, and α as the share of the loss that is protected by insurance, we assume that $\Pi = \int \alpha L dg = \alpha \bar{L}$. That is, the insurance contract is assumed to be actuarially fair; the premium equals the expected indemnity payments. This will occur if the insurance underwriters are risk neutral, the insurance industry is competitive and overhead costs are negligible.

Proposition 1: Let $\gg$ be a preference relation defined over G. For any nondegenerate CDF $g \in G$, $\delta_{M(g)} \gg g$ if and only if for any nondegenerate CDF over losses (L), $\alpha = 1$.

Thus, the agent is weakly risk averse if and only if the agent purchases full insurance.

Proof: First we show that weak risk aversion implies full insurance. To see this, note that in the event of loss, final wealth of an agent who purchases an α percentage of coverage is $W_0 - L - \alpha\bar{L} + \alpha L$. Accordingly, we denote the gamble which he faces by $g_{W_0 - L - \alpha\bar{L} + \alpha L}$. Now assume that some $\alpha^* < 1$ is optimal. This implies that

$$g_{W_0 - L - \alpha^*\bar{L} + \alpha^* L} \gg g_{W_0 - L - \bar{L} + L}.$$

Note, however, that the two CDF's have the same expected value, the second one being degenerate. Thus, the above equation contradicts the assumption of weakly risk averse preferences,[3] hence, α^* must equal 1. The necessity of weak risk aversion for full insurance, follows by noting that if the agent is not weakly risk averse, then there is at least one $g \in G$ such that $g \gg \delta_{M(g)}$. Clearly, for the CDF of losses that induces this CDF of the agent's final wealth,[4] $\alpha^* = 1$ would be suboptimal. □

The result that if actuarially fair insurance is available, then a risk averse, expected utility maximizer always fully insures himself—is a well known result in the theory of insurance demand Varian (1984). Recently Karni (1985) showed this result to hold also in the case of state-dependent preferences. Proposition 1 states that if the preference relation is weakly risk averse this result holds even in the absence of the expected utility hypothesis. Further, this result still holds if the agent behaves irrationally (as economists would term it), in that his preference relation is neither monotone nor transitive.

[3] The possibility of over-insurance ($\alpha > 1$) is excluded from our discussion, but could be similarly shown to be suboptimal.

[4] Note that without loss of generality, initial wealth and the support of the CDF of "loss" can always be redefined such that the CDF of the newly defined "loss" assigns positive probabilities, only to positive values of L. Thus, ensure that L represents real losses.

For the problem at hand, it is useful to define the notion of a risk premium within the above framework. This requires the definition of the certainty equivalent.

Definition IV: Certainty Equivalent.

Given a preference relation, $\gg$, defined over G, a degenerate CDF, $\hat{\delta}_g \in G$, is said to be the certainty equivalent of $g \in G$ if and only if $\hat{\delta}_g \sim g$.

The existence of a certainty equivalent is not guaranteed unless we make additional assumptions about the preference relation. Here, we state its existence as an axiom. Our axiom is implied by the regular continuity axiom (axiom *II* above), but not *vice versa*.[5]

Axiom II': Existence of a Certainty Equivalent.

For any $g \in G$, there is a degenerate CDF, $\hat{\delta}_g$, such that $\hat{\delta}_g \sim g$.

To ensure uniqueness of the certainty equivalent we need two additional axioms which are (very) weak versions of monotonicity and transitivity.

Axiom VII: Weak Monotonicity.

A preference relation, $\gg$, defined over G, is said to be weakly monotonic if and only if for any pair of degenerate CDF's, $\hat{\delta}^1, \hat{\delta}^2 \in G$, $\hat{\delta}^1 \gg \hat{\delta}^2$ if and only if $M(\hat{\delta}^1) > M(\hat{\delta}^2)$.

All this says is that the agent prefers more money to less. The last axiom we need is a weak version of transitivity, which relates the preferences for one nondegenerate CDF and preferences to two degenerate CDF's.

Axiom I': Weak Transitivity.

A preference relation, $\gg$, defined over G, is said to be weakly transitive if and only if for any pair of degenerate CDF's, $\hat{\delta}^1, \hat{\delta}^2 \in G$ and a nondegenerate CDF, $g \in G$, if $\hat{\delta}^1 \gtrsim g$ and $\hat{\delta}^2 \gg \hat{\delta}^1$, then $\hat{\delta}^2 \gg g$.

[5] One implication of the regular continuity axiom is that infinitely desirable and infinitely undesirable outcomes are ruled out. With either extreme having nonzero probability, it would be impossible to find a certainty equivalent.

Note that axiom I' is implied by the regular transitivity axiom (axiom I above) of expected utility, but not *vice versa*. If the certainty equivalent exists and the preference relation satisfies axioms VII and I', then it is also unique. We turn now to the risk premium.

Definition V: Risk Premium.

Given a preference relation, $\gg$, defined over G, and a CDF $g \in G$, the risk premium, S, is defined by $S \equiv M(g) - M(\hat{\delta}_g)$.

Existence and uniqueness of the certainty equivalent guarantee existence and uniqueness of the risk premium. As in the Arrow-Pratt theory of risk aversion, it is possible to relate the sign of the risk premium to the agent's risk attitude. This is done in Proposition 2.

Proposition 2: Let $\gg$ be a preference relation defined over G, satisfying axioms VII and I'. $\delta_{M(g)} \gg g$ for any nondegenerate CDF $g \in G$ if and only if $S > 0$ for any $g \in G$.

Thus, similarly to the Arrow-Pratt result, the individual is weakly risk averse if and only if the risk premium is always positive.

Proof: To see that weak risk aversion implies a positive risk premium, recall that by weak risk aversion $\delta_{M(g)} \gg g$. Moreover, by weak monotonicity for any $K \geq M(g)$, $\delta_K \gg \delta_{M(g)}$. Therefore, weak transitivity implies that for any $K \geq M(g)$, $\delta_K \gg g$. Thus, $M(\hat{\delta}_g) < M(g)$ and it follows that $S > 0$. Using similar arguments, necessity can be shown as well. □

4.1. Comparative Risk Aversion

The above definitions of weak risk aversion and certainty equivalent facilitate definition of "a higher degree of risk aversion" to which we now turn.

Definition VI: A Higher Degree of Risk Aversion.

Given two individuals with preference relations $\gg^1$ and $\gg^2$ defined over G and satisfying axioms VII and I', individual 1 is said to be at least as risk averse as individual 2 if and only if, for any $g \in G$, $\hat{\delta}^2_g \gtrsim^1 g$.

That is, individual 1 is at least as risk averse as individual 2 if and only if for any CDF, individual 1 weakly prefers individual 2's certainty equivalent of the CDF to the CDF itself.

Proposition 3 states that the risk premium of individual 1 is at least as large as the risk premium of individual 2.

Proposition 3: Let $\gg^1$ and $\gg^2$ be preference relations defined over G satisfying axioms *VII* and I'. $S^1 \geq S^2$ for any $g \in G$, if and only if $\gg^1$ is at least as risk averse as $\gg^2$.

Proof: By definition, $S^1 \geq S^2$ implies that $M(\hat{\delta}^1{}_g) \geq M(\hat{\delta}^2{}_g)$ and, hence, by weak monotonicity $\hat{\delta}^2{}_g \underline{\gg}^1 \hat{\delta}^1{}_g$. By the definition of the certainty equivalent $\hat{\delta}^1{}_g \sim^1 g$ and, hence, weak transitivity implies that $\hat{\delta}^2{}_g \underline{\gg}^1 g$. Necessity can be proven similarly. □

We now own the tools necessary for the analysis of the long run decisions of the firm.

5. Long-Run Entry and Exit Decisions of the Risk Averse Firm

Research on the long-run behavior of the firm under uncertainty was originated, two decades ago, in the seminal paper by Sandmo (1971). Restricting the discussion to the small, Sandmo showed that a risk averse firm, facing output price risk, would require a positive expected profit to enter business. Following this pioneering study, extensive research of the problem has evolved in the economic literature. Several authors (*e.g.*, Appelbaum and Katz (1986)) examined the effects of mean preserving spread on various parameters of the equilibrium. Other studies generalized Sandmo's results. Flacco (1983) showed that a more risk averse firm demands a higher expected price to enter business. Flacco and Larson (1987) showed that a risk averse firm is indifferent between operating or quitting business when expected profits equal the Arrow-Pratt risk premium. Later, Finkelshtain and Chalfant (1989) generalized these results to the case where the firm's preferences are state-dependent.

In this section, we consider the the entry/exit decision of a risk averse firm, ranking risky prospects according to a preference relation which does not necessarily imply expected utility maximization. We also examine the implications for the long-run equilibrium of the industry. Proposition 4 establishes the relationships between risk attitude and the difference between expected price and average cost which induces entry/exit.

Proposition 4: Entry occurs where average cost is smaller (larger) than expected price, if and only if the producer is weakly risk averse (seeking).

Proof: We shall prove the result for the case of risk aversion; the case of risk seeking can be proved similarly. We assume that $\bar{p}=C(x^*)/x^*$ and $x^*>0$, and show a contradiction. Denote by f the CDF of $[\pi(x^*)+W_0]$. Clearly, $M(f)=W_0$. Thus by weak risk aversion $\delta_{W_0} \gg f$, which contradicts $x^*>0$. Using weak monotonicity and weak transitivity the case where $\bar{p}_x<C(x^*)/x^*$ can be similarly shown to result in $x^*=0$. □

For the industry to be in long run equilibrium, each firm in the industry must be indifferent between operating or quitting business. This implies the following characteristics of the long run equilibrium that are stated as Corollary 1. The corollary is an immediate result of Proposition 4.

Corollary 1: If the industry consists of risk averse firms, the long run equilibrium is characterized by positive expected profits. Moreover, using the risk premium defined in Section 2, the equilibrium level of output of each individual firm satisfies,

$$\bar{p}_x=C(x^*)/x^*+S(x^*)/x^*.$$

The above condition replaces the traditional "price equals average cost" condition for long run equilibrium of the industry under certainty. Thus, the average risk premium drives a wedge between expected price and average cost. As is true in the case of expected utility, production under risk and risk aversion does not take place where long-run average cost is at a minimum. Note that weak risk aversion as defined above is both necessary and sufficient for the expected price to exceed average cost, while, in the general case, risk aversion in the Arrow-Pratt sense is neither.

We turn to comparisons between producers. Using the expected utility hypothesis, Flacco (1983) found that a producer who is more risk averse in the Arrow-Pratt sense requires a higher expected price to enter business. We show that the analogous result holds for an arbitrary risk averse preference relations, satisfying the mild axioms VII and I'.

Proposition 5: Let two producers have identical cost functions and probability beliefs. The producer with the greater degree of risk aversion, according to Definition VI, will require a higher expected price to enter the industry.

Proof: Let producer i be at least as risk averse as producer j, according to Definition VI. Assuming axioms VII and I', any nondegenerate CDF $g \in G$ has a certainty equivalent degenerate CDF. Thus, the producer's problem can be described as if he ranks only degenerate CDF's—the certainty equivalents of final wealth. By weak monotonicity, producer j is just indifferent between entering and not doing so if and only if

$$\bar{p}_x = C(x^j)/x^j + S^j(x^j)/x^j.$$

where x^j is his long run optimal level of output. Since x^j is optimal, for every other level of output, including x^i, it must be true that $\bar{p}_x < C(x^i)/x^i + S^j(x^i)/x^i$. By assumption, $S^i(x^i) > S^j(x^i)$. Upon substituting $S^i(x^i)$ in the above inequality, we find that producer i will not enter the market unless the expected price is greater than $\bar{p}_x$. □

6. Conclusions

This paper has used an axiomatic approach to formulate a theory of risk aversion. This theory was shown to be useful for the analysis of entry/exit decisions of risk averse firms. It was shown that important qualitative results concerning behavior of firms and consumers under risk, which were derived within the traditional framework of expected utility, are immune to critiques of this theory. These results hold for any risk averse preferences, regardless of the specific utility-functional representation of preferences.

These findings have several important implications. First, they suggest that certain results that have been derived are robust to the underlying assumption about the preference relation. Second, the findings suggest that certain behavioral rules cannot be used to test the expected utility model against other models, simply because these rules hold for both. Third, this paper represents an alternate line of research that contributes to the literature on non-expected utility. Finally, an advantage of our approach is that there is no masking of the link between behavioral results derived and the axioms of behavior used to derive the results.

Hopefully, the approach taken here can be extended to show that other fundamental results in the theory of firms' and consumers' behavior under uncertainty are generalized. As for the theory of risk aversion suggested above, it seems that it is most useful in describing situations where the decision maker chooses "certainty" versus "uncertainty" (as in the case of entry/exit decision), rather than different degrees of uncertainty. To analyze problems that involve different degrees of risk (*e.g.*, the optimal output level in the short run), an extension of the theory is required and is an interesting subject for further research.

REFERENCES

Allais, Maurice, "Le Comportement de l'Homme Rationnel Devant le Risque: Critique des Postulates et Axiomes de l'Ecole Americaine," *Econometrica,* (October 1953), 503-546.

Appelbaum, E., and E. Katz, "Measures of Risk Aversion and Comparative Statics of Industry Equilibrium," *American Economic Review* 76 (June, 1986), 524-29.

Arrow, Kenneth J., *Aspects of the Theory of Risk-Bearing,* (Helsinki, 1965). Reprinted in *Essays in the Theory of Risk Bearing,* (Amsterdam: North-Holland, 1970).

Bar-Hillel, Maya, "On the Subjective Probability of Compound Events," *Organ. Beh. H.* (June 1973), 396-406.

Conlisk, John, "Three Variants on the Allais Example," *American Economic Review* 79 (June, 1989), 392-407.

Coombs, Clyde H., "Portfolio Theory and the Measurement of Risk," in *Human Judgment and Decision Processes,* ed. by Martin F. Kaplan and Steven Schwartz. New York: Academic Press, (1975), 63-86.

Finkelshtain, Israel, and James A. Chalfant, "Aversion to Income Risk in the Presence of Multivariate Risk," Working Paper No. 496, Department of Agricultural and Resource Economics, University of California, Berkeley, (1989).

Fishburn, Peter C., *Utility Theory for Decision Making,* New York: Wiley, 1970.

Flacco, Paul R., "Output, Entry, and Competitive Production Under Price Uncertainty," *Southern Economic Journal* 50 (October, 1983), 565-71.

Flacco, Paul R., and Douglas M. Larson, "Marginal and Average Risk Premiums in The Long Run Competitive Equilibrium Under Price Uncertainty," *Presented at the Annual Meetings of the AAEA East Lansing, Michigan* (August, 1987).

Grether, D.M. and C.R. Plott, "Economic Theory of Choice and the Preference Reversal Phenomenon," *American Economic Review* 69 (1979), 623-638.

Karni, Edi. *Decision Making Under Uncertainty:* The Case of State-Dependent Preferences (Cambridge, Massachusetts: Harvard University Press, 1985).

Machina, Mark J., "Expected Utility Without the Independence Axiom" *Econometrica* 50 (March, 1982),277-323.

Machina, Mark J., "Choice Under Uncertainty: Problems Solved and Unsolved" *Journal Economic Perspectives* 1 (Summer, 1987),121-54.

Machina, Mark J., "Comparative Statics and Non-Expected Utility Preferences" *Journal Economic Theory* 47 (1989), 393-405.

Machina, Mark J., Pratt, J. W., "Risk Aversion in the Small and in the Large" *Econometrica* 32 (January, 1964), 122-36.

Safra Zvi and Itzhak Zilcha, "Firms Hedging Behavior Without the Expected Utility Hypothesis" The Forder Institute for Economic Research, Tel-Aviv University, Ramat Aviv Israel, Working Paper No. 4-86 (February, 1986).

Sandmo, Angmar, "On the Theory of the Competitive Firm under Price Uncertainty," *American Economic Review* 61 (March, 1971), 65-73.

Tversky, Amos, "Intransitivity of Preferences," *Psychological Review* 76 (1969),31-48.

Varian, Hal R., *Microeconomic Analysis,* New York: W.W. Norton, 2e (1984).

Weiss, Michael D., "*Conceptual Foundation of Risk Theory*" CED/ERS/USDA, Technical Bulletin No. 1731 (July 1987).

Yaari Menahem E., "Some Remarks on Measures of Risk Aversion and on Their Uses" *Journal Economic Theory* 1 (October 1969), 315-29.

Yaari, Menahem E., "The Dual Theory of Choice Under Risk" *Econometrica* 55 (January 1987), 95-115.