The Utility of Wealth: Absolute and Relative

by Philip R.P. Coelho and James E. McClure

In a risky world, the utility of wealth can only be known in a probabilistic sense. Two hypotheses have emerged to evaluate it: "expected utility" and "non-expected utility." The expected utility hypothesis is intuitively appealing, and it is computationally convenient to use the probabilities as linear weights. But anomalies arise when the utility function depends solely on the absolute level of wealth. Expected utility addresses these anomalies by endogenizing the taste for wealth; non-expected utility addresses them by relaxing the assumption that expected utility must be linear in the probabilities.

We refine the expected utility approach by endogenizing the taste for wealth in accordance with arguments derived from the theory of natural selection. Over millions of years humanity has evolved from populations of pre-humans, proto-humans, and humans.[1] Throughout this period, traits that were relatively successful in allowing their possessors to reproduce were "selected."[2] At a

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[1]Darwinian Theory has humanity evolving over hundreds of millions of years. The direct ancestor of contemporary humans (*Homo sapiens*) is unclear: Neanderthal man has been estimated to be over 500,000 years old (Erik Trinkhaus and William H. Howells, 1979); *Homo sapiens* has been dated going back at least 40,000 years ago (Sherwood Washburn, 1978; and Trinkhaus and Howells, 1979).

[2]A relatively small differential in survival rates from one generation to another will lead to an advantaged population swamping a disadvantaged one over many generations.

fundamental level, human behaviors, tastes, and thought processes are a product of natural selection. This insight is key to our theory.[3]

I. Literature Review

A. Expected Utility Theories

The assumption that, in the face of risk, people maximize a function in which utility is linearly weighted by the probabilities has a long tradition in economics.[4] This approach is the expected utility hypothesis.[5] John Von Neuman and Oskar Morgenstern (1944, 1964) contributed a precise formulation of this approach, but they recognized that it was incomplete, and that "...[t]here are many interesting questions involved, which however lie beyond the scope of this work." [p. 29]

Among the questions left unanswered was the acceptance of some

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[3]The idea that man's evolutionary predispositions are important in economics is not new. In a review article, Jack Hirshleifer (1977) states that human (and animal) behavior make it "clear that not all preferences for commodities represent 'mere taste'" (p. 17). Paul H. Rubin and Chris W. Paul II (1979) linked the taste for risk in men to mating drives. Edi Karni and David Schmeidler (1986) linked the expected utility approach to "the principle of self-preservation" (p. 74).

[4]Blaise Pascal (1623-62) and Pierre de Fermat (1601-65) were the first mathematicians to investigate games of chance. For a history of probability, see R. Von Mises and H. Pollaczek-Geiringer (1934). Prominent among economists of the past who dealt with linear expected values is Vilfredo Pareto. His utility function ("ophelimity") is almost identical to that of Von Neuman and Morgenstern (1964); see Oskar Morgenstern (1934, p. 367). Alfred Marshall (1920, 1964) rejects the concept of linearity in expected values; see pp. 111-112 and Appendices 8 and 9.

[5]For an intuitive explanation see Armen Alchian (1953).

"unfair"[6] gambles and simultaneous rejection of some "fair" gambles.[7] Milton Friedman and Leonard Savage (1948) responded with a utility function, having two inflection points, of the form:

(1) U = f(x),

where x is the individual's wealth.

The Friedman-Savage function's unique shape is illustrated in Figure 1. Their function is concave (from below)[8] at low levels of wealth, convex in the middle range, and finally concave again at the highest levels. In their formulation the individual's wealth endowment is unspecified. If the wealth endowment corresponds to either of the function's concave sections, the person insures; if it corresponds to the function's convex (middle) section, the person gambles.

Friedman and Savage contended that their theory allowed the simultaneous purchase of insurance <u>and</u> lottery tickets,[9] but their approach has not been without its critics.[10]

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[6]If the gamble's price equals its (linear) expected value it is "fair;" otherwise it is "unfair."

[7]The "St. Petersburg Paradox," with an infinite expected value, is a famous rejected "fair" gamble. Daniel Bernoulli (1738; 1954 translation) solved it with a concave utility function and a "reasonable" specification of the individual's wealth endowment.

[8]Friedman and Savage used the "from above" perspective, making their function convex, then concave, then convex. Today, the "from below" perspective is standard, making their function concave, convex, concave. We use the contemporary perspective.

[9]Friedman and Savage let the wealth endowment take on any value, but their individual insures against losses **and** gambles only when endowed near the first inflection point. In alternative theories of gambling **and** insuring, Yew Ng (1965),

[INSERT FIGURE 1 HERE; FIND IT AFTER BIBLIOGRAPHY]

Harry Markowitz (1952) observed that the Friedman-Savage formulation was deficient because its predictions for individuals with wealth endowments outside of a small neighborhood of the first inflection point were inconsistent with reality: 1) a person with an endowment roughly midway between the two inflection points must be willing to take an actuarially fair bet with a large variance; 2) a person with an endowment close to the second inflection point ("almost rich") must be unwilling to buy an insurance policy with an assured, actuarially unfair small loss to avoid a potentially large loss.

To resolve these anomalies, Markowitz asked "middle-income acquaintances for their opinion."[11] The result was a **three** inflection point function which we have reproduced in Figure 2.

[INSERT FIGURE 2 HERE; FIND IT AFTER BIBLIOGRAPHY]

J.S. Flemming (1969), Nils Hakansson (1970), and Y.C. Kim (1973) use market indivisibilities and imperfections; Michael Landsberger and Isaac Meilijson (1990) use "star-shaped" utility functions.

[10]Martin Bailey, et al. (1980) criticized their approach on methodological grounds; Menahem Yaari (1965), citing experimental results, also criticized it.

[11]Markowitz (1952, p. 153) conducted no scientific surveys.

Markowitz's function differs from that of Friedman and Savage in two important ways. First, Markowitz fixed the wealth endowment, which he called "customary wealth," at the wealth level below the middle inflection point (denoted x_c in Figure 2). He fixed the endowment so that all decisions involving risk would be "framed" with respect to "customary wealth."[12] Second, because "people avoid symmetric bets," Markowitz assumed that the distance between inflection points was a non-decreasing function of wealth, so that $(x_c - x_o) < (x_1 - x_c)$.

Markowitz recognized his notion of customary wealth was hazy, and left it to "... future researchers and reflection to classify the ambiguous, borderline cases" (p. 157). Alchian (1953) echoed these sentiments:

> Markowitz recognize[d] that until an unambiguous procedure is discovered for determining when and to what extent current income deviated from customary income, the hypotheses will remain nonverifiable because it is not capable of denying any observed behavior. [p.46]

Markowitz signaled a direction for further study which economists have been reluctant to follow. Part of this reluctance results from the endogeneity of tastes in Markowitz's model:

> The Markowitz hypothesis of a shifting utility function implies that changes in initial wealth essentially cause the individual to go back and **rerank** the entire "consumption set" of distributions over ultimate wealth levels. Such a hypothesis, asserting that preferences cannot be defined independently of the current consumption point is, in the

[12]Mark Machina (1987, pp. 141-147) suggests that the "framing" of gambles is an important unresolved problem in the theory.

> words of Eden, "disturbing to economists who use the assumption of constant tastes quite heavily... it is hard to see how positive economics can do without this assumption and it is almost impossible to think of welfare economics without it." [Machina 1982, p.286, emphasis in the original].

However "disturbing," the assumption of endogenous tastes opens an avenue for Markowitz's formulation to resolve the behavioral anomalies. Under appropriate restrictions his formulation can be used "... to save the assumption that the individual is maximizing the expectation of some utility function at each initial wealth level..." (Machina; 1982, p. 286).

Markowitz's utility of wealth function is of the form:

(2) $U = f[x, T(x,x_C)]$;

where x is wealth, x_C is customary wealth, and $T(x,x_C)$ represents the individual's taste for wealth.[13] Because the taste for wealth is unspecified, the Markowitz model is not refutable.

Replacing Markowitz's taste variable with a variable for social status, Reuven Brenner (1983) postulated a utility of wealth function of the form:

(3) $U = f\ [x_0, \alpha(x > x_0)]$;

where x_0 is the individual's current wealth, and $\alpha(x > x_0)$ denotes the fraction of the "relevant population" that is wealthier than the individual. Brenner (1983, pp. 3, 45-61, 190-202) produced

[13]Markowitz specification was meant to go beyond the "classical" notion that gambling is explained by the "fun of the game." He concluded "...the classical approach may be consistent with the existence of chance-taking, but it does not explain the particular chances which are taken" (p. 158).

results compatible with the Markowitz hypothesis.[14]

B. Non-Expected Utility Theories

In a lottery, if wealth levels $x_1,x_2,...,x_n$ occur with probabilities $p_1,p_2,...p_n$, a maximizer of non-expected utility evaluates the lottery with a value function $V(x_1,p_1;x_2,p_2;...x_n,p_n)$ that is non-linear in the probabilities. In contrast, a maximizer of expected utility evaluates the lottery as $\Sigma p_i U(x_i)$.

In the non-expected utility literature, the non-linear value function takes on various forms.[15] This literature provides an approach that addresses empirical counter examples such as the Allais paradox,[16] that, the (simple) expected utility hypothesis

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[14]Like Brenner, Nathaniel Gregory (1980) and Arthur Robson (1992) assume that increases in relative wealth increase utility. Unlike Brenner, Gregory and Robson employ inflexed utility functions. Because neither Gregory nor Robson restricts the wealth endowment, Markowitz's criticisms of Friedman-Savage apply to their theories.

Two other models have some bearing. In one, a "perceived" utility function approximates the "true" function; accommodating the behavior typifying Allais' paradox. For more, see Jonathan Leland (1986, 1988), and Daniel Friedman (1989). In the second, W. Kip Viscusi (1989) uses a Bayesian approach to derive perceived probabilities from the actual ones.

[15]For specific functional forms, see: Edwards (1955), Kahneman and Tversky (1979), Karmarkar (1978), Chew (1983), Fishburn (1983), Quiggin (1982), and Machina (1982, 1987, 1989).

[16]Maurice Allais (1953) posed what has become the most widely cited counter example to the expected utility approach. Machina (1987) and Kahneman and Tversky (1979) offer competing non-expected utility explanations of it. Kahneman and Tversky's "prospect theory" shares "many elements" with Markowitz's theory (Kahneman and Tversky, p. 276); it shares the framing issue and the asymmetric treatment of gains and losses. Machina (1982, p. 286) is critical of Kahneman and Tversky because the re-ranking of utility due to wealth endowment shifts is unspecified. Benartzi and Thaler (1993) and Jack Knetsch (1995) provide evidence consistent with the asymmetric treatment of gains and

cannot address. Regardless, many economists continue to rely upon the expected utility hypothesis.[17]

Extensive comparisons between expected and non-expected utility have appeared. John D. Hey and Chris Orme (1994), using their own experiments, stated that:

> ...behavior can be reasonably well modelled...as 'EU [expected utility] plus noise.' Perhaps we should now spend some time on thinking about the noise, rather than about even more alternatives to EU? (p. 1322)

David W. Harless and Colin F. Camerer (1994), using a wide array of data sets, concluded:

> (1) All the theories are rejected by a chi-square test. (2) ...theories, like EU ... are too lean: They could explain the data better by allowing a few more common patterns...; (3) EU predicts poorly when support is different, and predicts well when support is the same....; (4) The broadest conclusion of our analysis is that there are some losers [relative to expected utility] among competing [non-expected utility] theories, and some winners... (p.1284-1285)

The debate between the proponents of expected and non-expected utility has clarified the two hypotheses. But the debate continues because many issues remain unresolved.

II.
An Augmented Markowitz Utility of Wealth Function

Our theory maintains the expected utility hypothesis. We

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losses.

[17]For example, "tournament" literature utilizes either expected utility or expected income models. In the "auction" literature William Nielsen (1994) decries the fact that "...there has been little work analyzing auctions and other price mechanisms when the expected utility hypothesis is relaxed (p. 150)."

extend the work of Markowitz, and Brenner, by endogenizing the taste for wealth in a manner that is consistent with the evolutionary predispositions of humanity.[18] This fills a void recognized by Markowitz in his work:

> To have an exact hypothesis--of the sort one finds in physics--we should have to specify two things: (a) the conditions under which customary wealth is not equal to present wealth (i.e., the conditions referred to as recent windfall gains or losses) and (b) the value of customary wealth (i.e., the position of the second inflection point) when customary wealth is not equal to present wealth. It would be very convenient if I had a rule which in every actual situation told whether or not there had been a recent windfall gain or loss. It would be convenient if I had a formula from which customary wealth could be calculated when this was not equal to present wealth. But I do not have such a rule or formula...I leave it to future research and reflection ...(p. 157)

As indicated, Markowitz recognized that his theory was incomplete. Perhaps this is why it has largely been ignored.[19]

Our model retains the Markowitz geometry (Figure 2), but unlike other models, we assume that an individual's utility of wealth varies positively with: 1) own wealth (x); 2) the average wealth of the chosen peer group (y);[20] and 3) social status relative

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[18]For simplicity, we added evolutionary factors to an expected utility model, but these could also be added to a non-expected utility model. We lose no generality though; Mark Machina observed that these factors are "orthogonal to the assumed preferences over probabilities."

[19]In a survey of intermediate microeconomics texts referencing the Friedman-Savage theory, not one mentioned Markowitz.

[20]See Robert H. Frank (1985a) for a discussion of why heterogeneous groups of status maximizers "hang together." See Kaushik Basu (1989) for a model illustrating "clubs" exhibiting equilibria with excess demand. Adding such considerations to our model would unduly complicate it without changing its results.

to peers (S):

(4) $U = f(x, y, S)$.

III.
Human Evolution, Status, and Risk

There is an evolutionary rationale for augmenting the Markowitz utility of wealth function as $U = f(x, y, S)$.[21] Evolution uses genes to mold relatively more successful reproducers. Genes influence[22] external characteristics (such as hair, eye color, and height), and behaviors and emotions.[23] The theory of evolution

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[21]To our knowledge, this function is unique. Neither Brenner nor Robson uses the Markowitz geometry and neither assumes peer wealth to be a separate argument. Nor does Gregory incorporate peer wealth independently. James Duesenberry (1949) assumes that neither own wealth, nor peer wealth are independent arguments. Chaim Fershtman and Yoram Weiss (1993) specify utility by a weighting of consumption and occupational status.

Gary S. Becker (1974) specifies a utility of consumption in which an individual's choices (and efforts) can enter another person's utility function. Frank (1985b) also uses a utility of consumption function in which the consumer chooses quantities of what Fred Hirsch (1978) called "positional" and "non-positional" goods. The Becker and Frank formulations specify utility in terms of "goods" rather than wealth. The indirect utility functions that correspond to theirs would be in terms of the wealth levels of the individual, and of other individuals as expressed in equation (4).

[22]"Influence" because genetic inheritance acts within a given environmental context; and that context acts upon the manifestations of genetic inheritance. For example, a person growing up in a food-rich society may attain a height of 2 meters, but only 1.5 meters if nutritionally deprived.

[23]This is generally accepted by scholars who study the behavior of animals (see Alcock (1989)), and it is becoming widespread among those who study human behavior. See Robert Wright (1994) for analysis linking evolutionary biology to human

emphasizes that the totality of an organism be considered as an adaptation to the ancestral environment that existed during the time in which its progenitors were selected. Humans are no exception. Human desires for food, sex, shelter, companionship, and status are all genetically ingrained; these desires have been selected over behaviors that were less advantageous in allowing their possessors to reproduce and rear succeeding generations. Natural selection allows the behaviors that are influenced by genes and that are evolutionarily desirable[24] to spread.

The genetic inheritance of humans establishes the parameters within which our behaviors function, and it constrains the relevant set of alternatives.[25] We postulate that attitudes towards wealth, peer selection, and risk are a consequence of the genetic tendencies that allowed humanity to thrive.

A. The Utility of Status

All available evidence suggests that our ancestors lived in societies.[26] Behaviors that foster reproduction and child rearing

psychology.

[24]"Evolutionarily desirable" means that the possessors of these genes are relatively more successful in reproducing and rearing their young. The definitional circularity occurs because the sociobiological paradigm is that the purpose of life is life: no teleological assumptions are made.

[25]Genes influence behavior, they **do not** determine it. In the words of Edward O. Wilson: "genes have culture on a long leash."

[26]Evidence for this hypothesis is commonplace, but rarely direct. Anthropologists, sociologists, paleontogists all write about early societies; yet they do not consider it significant to provide evidence for the existence of societies. It is as if

in a society are pro-adaptive. The same forces that molded prehistoric *Homo* populations have shaped our genetic inheritance today.[27] What were these forces?

The basic force was scarcity, ubiquitous as always. Resources must be allocated among the members of a society. All animal societies have social rankings[28], and these rankings influence the allocation of resources necessary for the individual animals' survival and reproduction.[29] We argue that humans, like other

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human societies are so universal that explicit documentation is unnecessary.

[27]"...[T]he selection pressures of hunter-gatherer existence have persisted for over 99 percent of human evolution" (Wilson 1978, p. 84).

[28]This statement has broad support. For wolf studies see: Erik Zimen (1979), Durward Allen (1979), Michael Fox (1980) and Fred H. Harrington and Paul C. Paquet (1979). For primates studies see: Charles J. Lumsden and Edward O. Wilson (1981, 1983), Frans de Waal (1982), and Carl Sagan and Ann Druyan (1992). For a survey on animal behavior (including humans) see John Alcock (1989). For other works on human behaviors, animal behaviors, and genes see Matt Ridley (1993), Helena Cronin (1992), and Robert Wright (1994).

[29]Rank enhances both the individual's probability of survival and reproduction. High ranking animals feed before the lower ranks (Melvin Fredlund (1976), Alcock (1989) and Wilson (1975)). This tradition is still carried out in human societies: when dining with "royals" the rules of etiquette require the common people not to start eating before the "royals" and to stop when the "royals" stop.

In some species the probability of reproducing is so skewed that few middle or low ranking individuals reproduce. In wolf packs, the presence of high-ranking females (Alpha females) seems to prevent lower-ranking females from coming into estrus, and the Alpha female acts to prevent any female that achieves estrus from mating (See Zimen (1979), Allen (1979) and Fox (1979). Among elephant seals dominant males prevail in reproductive activities. Alcock (1989) reports that on South Georgia Island the top-ranking male elephant seal (the beach master) had 37 percent of all copulations (among the top ten males in the population). The top two males had 55 percent of all copulations.

social animals, seek elevated social status.

This merits further discussion because observing status seeking in non-human societies is easy, but myopia afflicts introspection. Examples in non-human societies may be helpful.

The term "pecking order," synonymous for social ranking, derives from barnyard chicken societies. In these societies, there is an established social order among egg-laying hens. If flocks are broken up and new ones formed, egg laying falls precipitously as hens contest for status (a high-ranking hen may peck a lower-ranking hen, but not the opposite -- hence the "pecking order"). Once a stable social order is established, egg laying production resumes.[30]

Among animals with greater intelligence than chickens (wolves, hyenas, chimpanzees, apes, and sea lions) there is also evidence establishing positive linkages between social status and

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In human despotisms, Matt Ridley found that high-ranking men have a widely disproportionate number of wives/concubines. For example, in the pre-contact Incan society the emperor, the Inca, had 1500 females in each of several locations for his sexual pleasure. "Beneath him, each rank of society afforded a harem of a particular legal size. Great lords had harems of more than seven hundred [women]... 'Principal persons'...[had] fifty... leaders of vassal nations...thirty; heads of provinces...twenty; leaders of 1000 people, fifteen; administrators of 500 people, twelve; governors of 100...eight; petty chiefs...seven; chiefs of 10 men, five; chiefs of 5 men, three." (p.173)

[30]A stable social order reduces conflict between hens. While pecking is indiscriminate in a newly formed flock, in an established flock each hen "knows" whom to, and whom not to, peck. Fewer conflicts over the pecking order leads to increased egg production. Joseph Bower (1965) offers ancillary experimental evidence on conflicts and productivity in human groups.

reproductive success.[31] The evidence is consistent with the sociobiological paradigm that the desire for status is genetically "hard wired" in social animals. In line with this paradigm, we have made utility a function of status.

B. The Utility of Peers' Wealth

Our assumption that utility depends on peer wealth is also consistent with evolutionary selection. Risk, just as scarcity, is a force that has always constrained evolution. Throughout humanity's evolution, risk has been managed socially. Outside of a society of our own kind, individuals do not and did not long survive, let alone reproduce. The risks of illness, starvation, predatory animals, and the risks imposed by other humans were reduced when shared. Kinship within tribes results in a genetic benefit to the individual whenever other tribal members benefit.[32] We expect close genetic ties to positively influence altruism towards tribal members.[33]

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[31]For studies linking wolves' reproductive success to their status see: Zimen (1979), Allen (1979), Fox (1980) and Fred H. Harrington and Paul C. Paquet, eds. (1979). For literature on primates-see: Lumsden and Wilson (1981; 1982) and de Waal (1982). For an introduction to human sexuality and status see: Doris Jonas and David Jonas (1980), Donald Symons (1979), and Frank (1985a). For an exhaustive approach to the sociobiological literature as it pertains to animals and humans see Alcock (1989).

[32]A child (or sibling) shares fifty percent of the individual's genes, a cousin 12.5 percent. The joke among sociobiologists who hold the "selfish gene" theory (see Richard Dawkins, 1989) is that they wouldn't sacrifice themselves for a brother, but would do so for two siblings or for eight cousins.

[33]Alcock (1989) documents cases where cooperation is positively associated with the degree of kinship (pp. 492-493),

Altruism is not limited to close relatives,[34] however, among "unrelated" animals altruism is generally characterized by reciprocity. The "theory of reciprocal altruism" described by George C. Williams (1966) is: "Simply stated, an individual who maximizes his friendships and minimizes his antagonisms will have an evolutionary advantage, and selection should favor those characteristics that promote the optimization of personal relationships."[35]

An abundance of evidence supports the theory of reciprocal altruism:

> Vampire Bats...also turn out to be reciprocally altruistic. Any given bat has sporadic success in its nightly forays...Sure enough, bats that return to the roost empty-handed are often favored with regurgitated blood from other bats--and they tend to return the favor in the future...Bat buddies. (Wilkinson, 1990, cited in Wright, 1994, p. 203)

Genetic forces have led reciprocal altruism to emerge not only among vampire bats, but also among monkeys, baboons, dolphins,

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recognition of kinship (pp. 41-42), and kinship and aggression. In one instance ground-squirrel sisters raised apart were significantly less aggressive in encounters with each other than with unrelated female ground-squirrels similarly reared.

[34]Well known economists consider altruism to be an important aspect of human behavior. Hirshleifer (1977, p. 19) writes that:"In any attempt to broaden the application of economic reasoning, to make it a general social science, a key issue is the problem of altruism (the "taste" for helping others): its extent, provenance, and determinants." In Becker's analysis of the family, altruism by the family's head can constrain a "rotten kid."

[35]Williams (1966); cited in Wright (1994, p. 190). These relationships will lead to evolutionarily desirable peer groups if formed consciously <u>or</u> subconsciously.

chimpanzees, and other social vertebrates.[36] Humanity has been molded by the same force of natural selection. Humans desire to belong to a peer group--a group of "equals." In a human society, if an individual's wealth is far greater than the next highest member's, then it is unlikely that the wealthier individual can be assisted by anyone else in the group. For example, if one individual has one-million dollars in assets and the next highest has fifty-thousand dollars, then only in rare circumstances could the wealthy individual be helped by any other member. They are not "peers;" assistance flows from the wealthy one to the many poor.

Associating with a peer group whose mean wealth is much below the individual's does not reduce risk. Individuals "want" (either consciously or sub-consciously) to be in peer groups that can assist them. In a risky world, people who associate with other people who can aid them in times of distress will do better than people who do not. To render aid means that the helping individual has to possess resources sufficient to materially affect the circumstances of the person requiring aid. Our explanation of peer group choice, like peer alliances among animals, is characterized by <u>reciprocal</u> altruism.[37]

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[36]Information on reciprocal altruism in dolphins and porpoises, is in Charles E. Taylor and Michael T. McGuire (1988). For references on chimpanzees, see de Waal (1982), de Waal and Lesleigh Luttrell (1988), and Jane Goodall (1986). For discussions on baboons, and other social vertebrates, see Alcock (1989).

[37]In modern western societies, it is common for peer groups to change with occupational circumstances. Although changing peer groups while moving up the career ladder is decried by some

An individual may think it desirable to be in a peer group with a mean wealth ten fold greater than the person possesses, but, because the individual can not reciprocate, people with that much greater wealth will not consider him/her a peer. The wealthy may or may not extend charity[38] but they will not consider the poor as peers.[39]

IV. Markowitz Utility, Social Context and Risk

The evolutionary forces discussed above led to the general specification of the utility of wealth in equation (4).[40] It posits a Markowitz function that depends not only on own wealth as shown in Figure 2, but also on social context, *vis a vis* one's peers. Again, we assume that utility varies positively not only with own wealth (x), but also with: 1) the wealth of peers (y); and 2) social status relative to peers (S). The affects of peer wealth and status are, again, straightforward: 1) To the extent that sharing is the *sine qua non* of friendship, it is beneficial to have friends or peers who have more resources to share;[41] 2) To the extent that status enhances one's ability to persuade others in matters of joint consumption, it is beneficial to be of high status.

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moralists, it is a behavior that is consistent with evolutionary success.

[38]For an economic analysis of charity see Becker (1974).

[39]Wealth is our proxy for the ability to assist and the margin that determines the peer group. Obviously there are other filters, religion being a prime example.

[40]In an earlier draft we assumed U=f[x,y,(x/y)]. Mark Machina pointed out that the partial derivatives were ill-defined. Following his advice, we specified the third argument more generally, as in equation (4), so that the partials can be defined.

[41]Even without sharing it is beneficial to have a wealthier group of friends if the goods they consume bestow positive externalities upon the group.

To operationalize status (S) in equation (4) we assume it to be function of relative wealth (r). Formally, S=S(r), where r equals the ratio (x/y). The historical lineage of this assumption traces to Duesenberry (1949) who considered relative wealth the "principal status criteria." Status is assumed to change with relative wealth as follows: $S_r>0$, $S_{rr}<0$, $S_{rrr}=0$. Throughout our analysis the marginal utility of status, f_{SS}, is set equal to zero.[42] To simplify, status enters separately and additively. Incorporating these assumptions into equation (4) gives us the reduced form equation:

(5) $\Phi(x,y) = f[x, y, S(r)]$.

A. Choosing Peers Optimally

The problem for the individual is to find a peer group that provides maximum utility by comparing the benefits and costs of having wealthier peers.[43] Differentiating equation (5) with respect to y, the necessary condition for utility to be maximized is:

(6) $\delta\Phi/\delta y = f_y + (-xf_S S_r/y^2) = 0$.[44]

Above, f_y is positive because of the benefits that go along with being in a wealthier peer (sharing) group. On the other hand, $(-xf_S S_r/y^2)$ is negative because the wealthier are one's peers, the lower is one's status. Equation (6) requires that benefits match costs at the margin.

B. Comparative Statics

Markowitz challenged future researchers to specify: 1) conditions under which personal

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[42]Elsewhere in the literature, the marginal utility of status is assumed to be constant, Brenner (1983, p. 50), or positive, Robson (1992, p. 839).

[43]There are obviously other criteria for choosing one's friends, religion being an obviously example. Our analysis abstracts from such criteria.

[44]"δ" denotes <u>total</u> partial differentiation; "∂" denotes partial differentiation. $\delta\Phi/\delta y$ has two components: 1) a direct affect, $f_y=\partial\Phi/\partial y$; and 2) an indirect affect, $(\partial\Phi/\partial S)(\partial S/\partial r)(\partial r/\partial y)$. In this paper, partial differentiation is indicated by subscripts as in equation (6). See Alpha C. Chiang (1984, pp. 201-202) for completeness on total partial differentiation.

wealth deviates his function's second inflection point; 2) the process of adjustment that would bring personal wealth and its second inflection point back into line. A comparative static analysis based on equations (5) and (6) answers this challenge and produces verifiable implications about gambling, insuring, peer group choice.[45] Our comparative statics take as their starting point an individual who is in full (or long-run) equilibrium: 1) his endowment places him below utility's second inflection point; and 2) he is in a peer group with a wealth level satisfying equation (6).

A. Peer Group Wealth Shocks

Consider a person, Smith, whose wealth endowment is x_C and who is in long-run equilibrium according to equation (6) amongst peers with wealth level $y=y_0$. Consider the consequences for Smith of an "exogenous" increase in his peers' wealth to $y=y_1$. This could occur, for example, if all in the group except Smith share the winnings from a large lottery.

Our comparative static analysis shows the *ceteris paribus* (or short-run) consequences upon Smith's taste for risk by determining the direction in which Smith's inflection points shift. The position of the inflection points are the key because they are the boundary points between convex (gambling) regions and concave (insuring) regions. "*Ceteris paribus*" means that Smith is among the same group of peers; peer substitution is precluded in the short-run. So the sudden increase in wealth of Smith's peers to $y=y_1$ temporarily strands Smith in a peer group that is "too" wealthy (Smith's optimal peer group has a wealth level of only $y=y_0$).

Panels a and b of Figure 3 show the derivative function, $\delta\Phi/\delta x$, as it corresponds to the Markowitz function. The behavior of $\delta\Phi/\delta x$ at the inflection points is key: it reaches a maximum at x_0, a minimum at x_C, and another maximum at x_1. This, in turn, implies that at the inflection points x_0, x_C, x_1, the second-derivative function ($\delta^2\Phi/\delta x^2$) is equal to zero.

[45]Methodologically, our comparative static analysis of individual utility follows in the tradition of Becker (1974) who used comparative static analysis to explain social interactions.

[insert Figure 3 here]

Therefore we can define the following implicit functions:

(8) $F(x_0;y) \equiv \delta^2\Phi/\delta x^2\Big|_{x=x_0} = 0,$

(9) $G(x_c;y) \equiv \delta^2\Phi/\delta x^2\Big|_{x=x_C} = 0,$

(10) $H(x_1;y) \equiv \delta^2\Phi/\delta x^2\Big|_{x=x_1} = 0.$

Applying the implicit function theorem to equations (8), (9), and (10), we can deduce how the inflection points shift as a result of a change in peer wealth (y). These shifts are defined by the comparative static equations below:

(11) $dx_0/dy = -(\delta F/\delta y)/(\delta F/\delta x_0),$

(12) $dx_C/dy = -(\delta G/\delta y)/(\delta G/\delta x_C),$

(13) $dx_1/dy = -(\delta H/\delta y)/(\delta H/\delta x_1).$

The signs of these result are easily determined. The denominators in equations (11), (12), and (13) are the values taken by third partial derivative of Φ at x_0, x_C, and x_1. In panel (d) of Figure 3 these denominators alternate in sign as follows: $(\delta F/\delta x_0)<0$, $(\delta G/\delta x_C)>0$, and $(\delta H/\delta x_1)<0$. Setting f_{xxy} equal to zero, the signed numerators in equations (11), (12), and (13) are all negative.[46] Thus, the desired comparative statics are: $dx_0/dy>0$, $dx_C/dy<0$ and $dx_1/dy>0$. Thus, an increase in peer wealth shifts the first and third inflection points right, and the second left.

Figure 4 illustrates the short-run impact on Smith. In the short-run, Smith's utility function shifts down from $\Phi(x,y_0)$ to $\Phi(x,y_1)$. His utility has fallen because for Smith a peer group with a wealth of y_0, not y_1, is optimal. In accordance with the comparative statics $dx_0/dy>0$, $dx_C/dy<0$ and

[46] f_{xxy} is a third cross partial derivative of Φ. The meaning of the notation f_{xxy} must <u>not</u> be confused with the <u>total</u> cross partial derivative of Φ, $\delta^3\Phi/\delta x^2\delta y$ (denoted as $\delta F/\delta y$, $\delta G/\delta y$, and $\delta H/\delta y$ in (11), (12), and (13)). For further clarification see footnote 41.

$dx_1/dy>0$, the inflection points on $\Phi(x,y_1)$ are: 1) x_2 (which is greater than x_0); 2) x_3 (which is smaller than x_C); and 3) x_4 (which is greater than x_1).

[insert Figure 4 here]

The arrows in Figure 4 show how the inflection points shift and show that: 1) in the short-run the wealth range below the initial concave (risk averse) section has narrowed; and 2) also in the short-run the wealth range below the convex (risk taking) section has widened. If Smith's endowment were equally likely to be at any position along the wealth axis, the inflection point shifts would imply a higher likelihood that the individual would be in the risk taking region, and hence be more likely to gamble. But Smith's wealth endowment is not equally likely to be at any position along the wealth axis; it is x_C and it is below a convex portion of $\Phi(x,y_1)$. Consequently, Smith will temporarily insure less, and gamble more.[47]

In the long-run, Smith will seek out a new peer group with wealth similar to the pre-shock group (that is, y_0). Once back in such a peer group Smith's utility function will return to $\Phi(x,y_0)$ and his gambling and insuring propensities will return to their pre-shock levels.

Opposite short-run behavior is implied with an exogenous <u>reduction</u> in peer group wealth. If everyone in Mr. Smith's peer group besides Smith becomes unemployed, Smith will suddenly be amongst peer whose wealth is too low relative to the long-run optimal group. The shifts in the inflection points will be in the opposite directions of those in Figure 4. In the short-run, Smith will

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[47]An illustration of Smith's increased propensity to gamble in the short-run may help to clarify the model's workings. In long-run equilibrium, Smith's utility function was $\Phi(x,y_0)$, and his wealth endowment, x_C, was beneath the second inflection point of this function. The shape of the Markowitz function precludes Smith from taking symmetric bets in this position. In the long-run, Smith will <u>not</u> take a 50% chance of losing (x_C-x_3) in return of a 50% chance of gaining (x_C-x_3). In the short-run period following the rise in peer wealth to y_1 however, Smith makes gambling and insuring decisions with reference to $\Phi(x,y_1)$. His wealth endowment x_C is below a convex portion of $\Phi(x,y_1)$. Hence, in the short run, Smith <u>will</u> take a 50% chance of losing (x_C-x_3) in return for a 50% chance of gaining (x_C-x_3). So a gamble previously unattractive to the individual is now desirable.

tend to insure more and gamble less. In the long-run, Smith will find a new peer group with wealth similar the pre-shock group. Relative wealth in the long-run peer group will be similar to that in the initial peer group, and Smith's gambling and insuring propensities will return to those exhibited prior to the shock.

John W.C. Johnstone's findings support our implications about the short-run behavior of individuals following peer wealth shocks:

> On the whole, low-status youth were more delinquent in settings of affluence than of poverty, while the behavior of high-status youngsters varied little with the community setting. Both groups thus deviated from local norms, but they did so in different ways. (1978, p. 68)

In terms of our discussion of peer group wealth shocks, the mismatched youths in Johnstone's study, whose living arrangements were determined by their parents, were constrained to be in "short-run," suboptimal peer groups; these youngsters could not choose "long-run," optimal peer arrangements. Prior to finding a new peer group: 1) individuals who suddenly find themselves among peers that are "too" wealthy will insure less and gamble more; and 2) individuals who find themselves among peers who are not wealthy enough will insure more and gamble less. While one can suggest other explanations for Johnstone's results, the match between his results and our implications is noteworthy.

B. An Individual Windfall

Consider the impact of a windfall gain or loss that alters the individual's own wealth. Let y* denote the peer group wealth that solves equation (6). Define the implicit function:

(14) $$Z(y^*;x) \equiv \delta\Phi/\delta y\big|_{y=y^*} = 0.$$

The implicit function theorem implies that the change in peer wealth following a change in x is given by:

(14) $$dy^*/dx = -(\delta Z/\delta x)/(\delta Z/\delta y^*).$$

Given the second order condition holds, this comparative static result has a positive sign so long as x and y are sufficiently strong complements.[48] Such strong complementarity is perfectly in line with the sociobioligical perspective of man as a "social animal." Assuming such complementarity, an individual who experiences a windfall gain (loss) in wealth will find a wealthier (poorer) peer group optimal.

C. An Explanation of the Allais Paradox

The Allais paradox is an often cited challenge to the expected utility hypothesis.[49] In the paradox producing survey experiment, subjects are asked their preferences regarding the choices below:[50]

Choice 1: Choose a_1 or a_2

a_1:	a_2:
1.00 chance of \$1 million	.10 chance of \$5 million
	.89 chance of \$1 million
	.01 chance of \$ 0

Choice 2: Choose a_3 or a_4

a_3:	a_4:
.10 chance of \$5 million	.11 chance of \$1 million
.90 chance of \$ 0	.89 chance of \$ 0

Given these choices, the typical respondent chooses a_1 over a_2 and a_3 over a_4. The paradox is this: the theoretical prediction that arises from applying linear probability weighting to the

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[48] The second order condition requires that the denominator of equation (14) is negative. The signed numerator is negative if the quantity $[f_{yx}+(-f_S S_r/y^2)+(-xf_S S_{rr}/y^3)]$ is positive. This will be the case when x and y are sufficiently strong complements so that $f_{yx}>>0$.

[49] For example, Harless and Camerer (1994, p. 1284) wonder: "Might future economists find it peculiar that twentieth century economists held firmly to EU [expected utility] in the face of the Allais paradox...?"

[50] For the original form see Allais (1953), p. 527. See Machina (1982) for a "non-expected utility" analysis of the paradox.

univariate function U=f(x) is that <u>if</u> a_1 is preferred to a_2, <u>then</u> a_4 will be preferred to a_3.

Our modified Markowitz model, with multivariate utility function $\Phi(x,y)=f[x,y,S®)]$, can accommodate the paradoxical behavior while maintaining linear probability weighting.[51] In our model a change in wealth that occurs with certainty (like a_1) changes customary wealth and shifts utility because a different peer group is optimal. Changes in wealth that are less than certain (like a_2, a_3, and a_4) are always evaluated with reference to an unchanged level of customary wealth.

Figure 5 is illustrative. In the figure, function Φ_0 and customary wealth x_C are relevant to the evaluation of a_2, a_3, or a_4. But if a respondent chooses a_1, his customary wealth rises by \$1 million and his utility function shifts upward to Φ_1. The utility of $\$(x_C+1)$ million on Φ_1 lies above its utility on Φ_0 because, consistent with equation (14) being positive, an increase in customary wealth implies that a wealthier peer group will be optimal.

[insert Figure 5 here]

Assigning the utility of a_1 by function Φ_1 and the utility of a_2, a_3 and a_4 by Φ_0 the Allais Paradox is accommodated:

1) $E\{\Phi_1(a_1)\}=46 > E\{\Phi_0(a_2)\}=.01(10)+.89(32)+.1(72)=36.48$;

2) $E\{\Phi_0(a_3)\}=.9(10)+.1(72)=16.2 > E\{\Phi_0(a_4)\}=.11(32)+.89(10)=12.42$.

Given the expense, no attempt to test Allais' paradox has been made in anything like its original form. However, John Conlisk (1989) gave students Allais' choices with real payoffs of \$0, \$5, and \$25 (instead of \$0, \$1m, and \$5m), and concluded that "...Allais behavior disappeared." He explains:

> There are two apparent hypothesis to explain the disappearance: (I) The disappearance is due to the switch from hypothetical to real payoffs; and (ii) the disappearance is due to the switch from large to small payoffs. (p. 401)

So financial constraints seem to preclude a "true" test of Allais' paradox. But what represents a

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[51]Neither Markowitz (1952) nor Brenner (1983) offer an explanation of the Allais paradox. Markowitz's paper predates it. Brenner thought it unworthy of explanation.

large real payoff? Our theory makes it a function of customary wealth. This requires a working definition of customary wealth, perhaps similar to Friedman's (1957) concept of permanent income. Consequently, Conlisk's results make sense viewed in this light; because the customary wealth of the American students in his experiments was not affected by an offer of a sure $5. Our theory suggest that a true test requires a large payoff relative to customary wealth. What if a group of poor people in a country whose per capita income is $300 were confronted with an Allais experiment with payoffs of $0, $300, $1,500? Such a test would be convincing and it would not be prohibitively costly.

VI.
Summary

This paper uses the Markowitz utility function for wealth and arguments derived from the theory of natural selection to specify how the taste for wealth adjusts. This specification of taste is not tautological; it leads to testable implications concerning gambling, insuring, and peer group choice. Additionally, it provides an expected utility explanation for the Allais paradox.

Natural selection molds all aspects of human behavior, but has had little impact on inquiry in the social sciences in general, and in economics in particular.[52] Economists postulate that people maximize utility and that utility is whatever people like.[53] Given

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[52]Robert H. Frank (1984), (1985a,b), Reuven Brenner (1983), Gordon Tullock (1994), Jack Hirshleifer (1977, 1978, 1986), Paul H. Rubin (1982), Rubin and Paul Jr. (1977), and recently Alan R. Rogers (1994), and Michael Waldman (1994) are exceptions. In a survey of graduate theory texts, not one mentioned evolution. A similar result was found for undergraduate texts with the exception of one reference to Darwin in Frank (1991, p. 331).

[53]"Consumer's market behavior is explained in terms of preferences, which in turn are defined only by behavior" (Paul

this tautology, what determines preferences, how and why preferences change, and what impact individual preferences have upon society, and vice-a-versa, are questions that cannot be addressed. This paper demonstrates that using the theory of natural selection to specify the taste for wealth contributes to our understanding of how people behave in the presence of risk.

A. Samuelson, 1965, p. 91).

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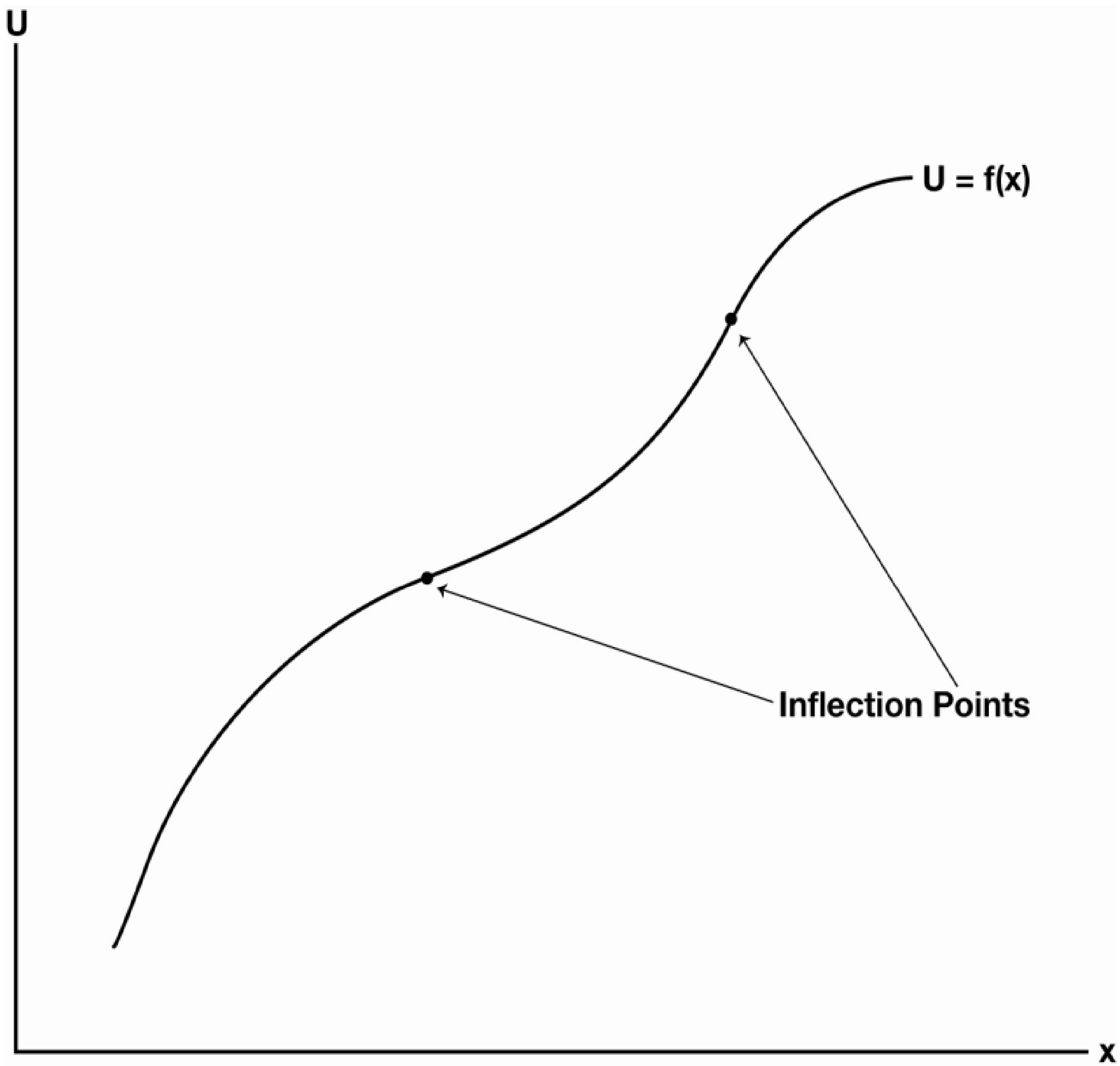

Figure 1
Friedman and Savage Utility of Wealth Function

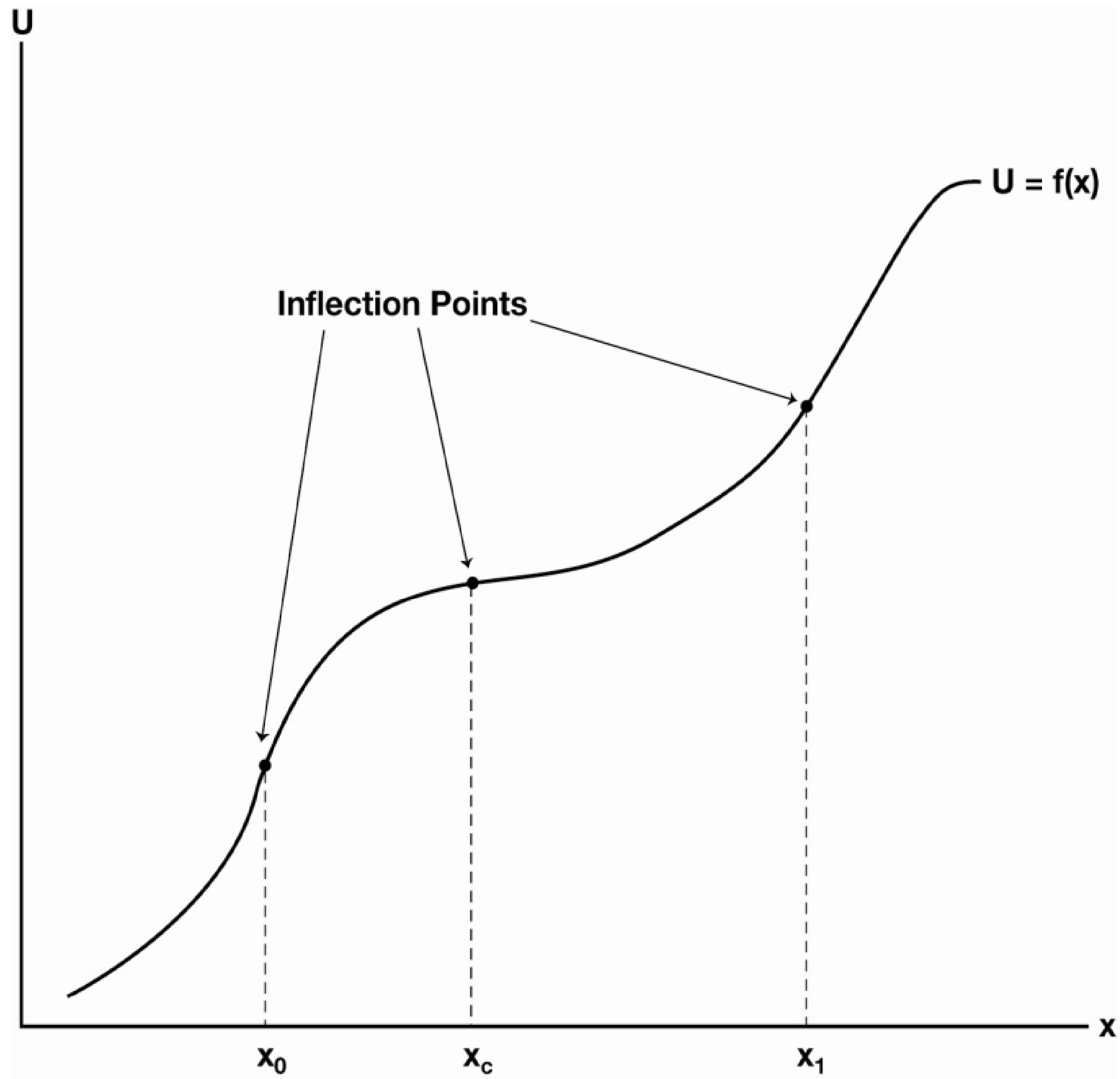

Figure 2
Markowitz Utility of Wealth Function

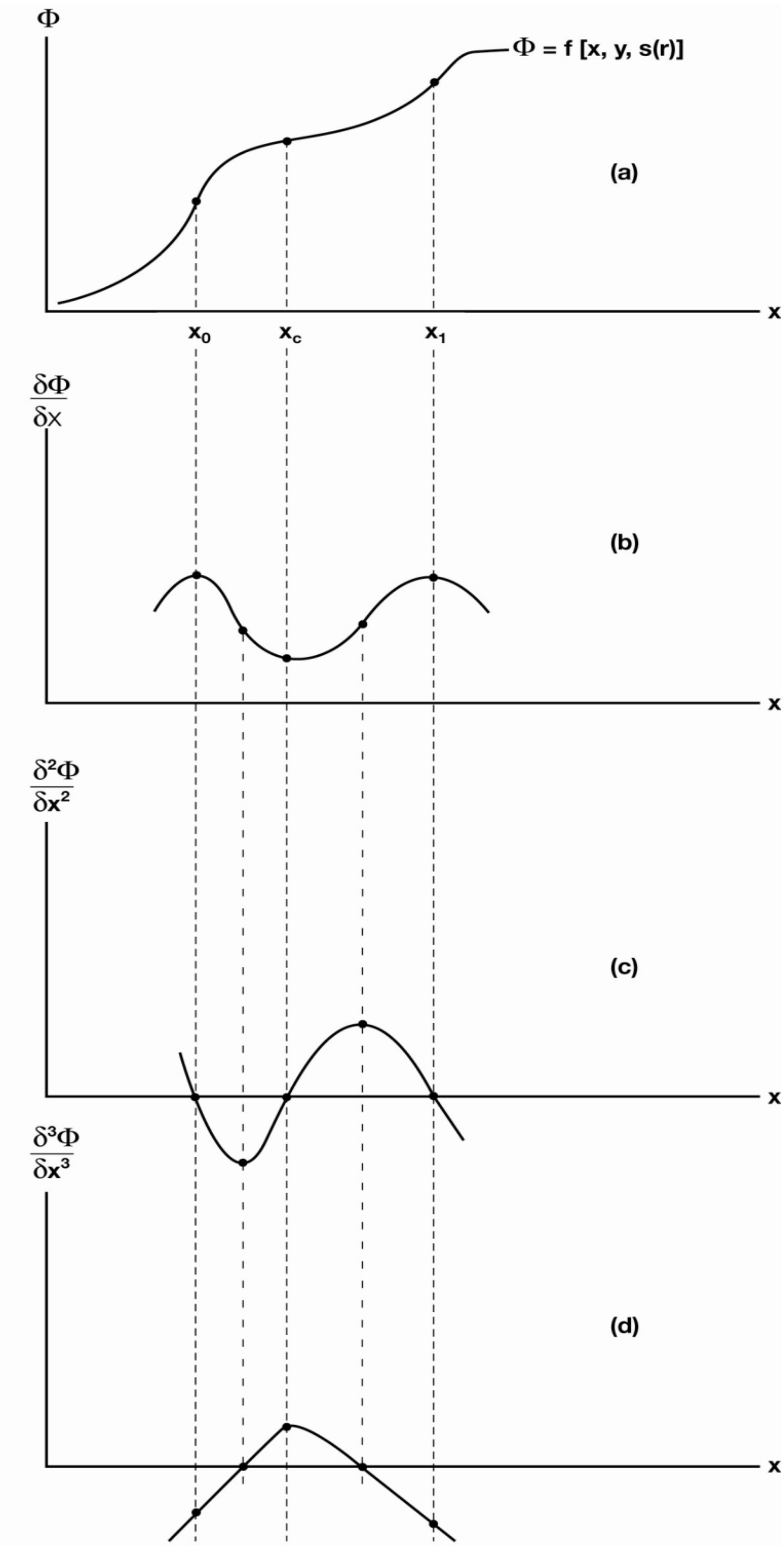

Figure 3
The Augmented Utility of Wealth Function and its Derivatives

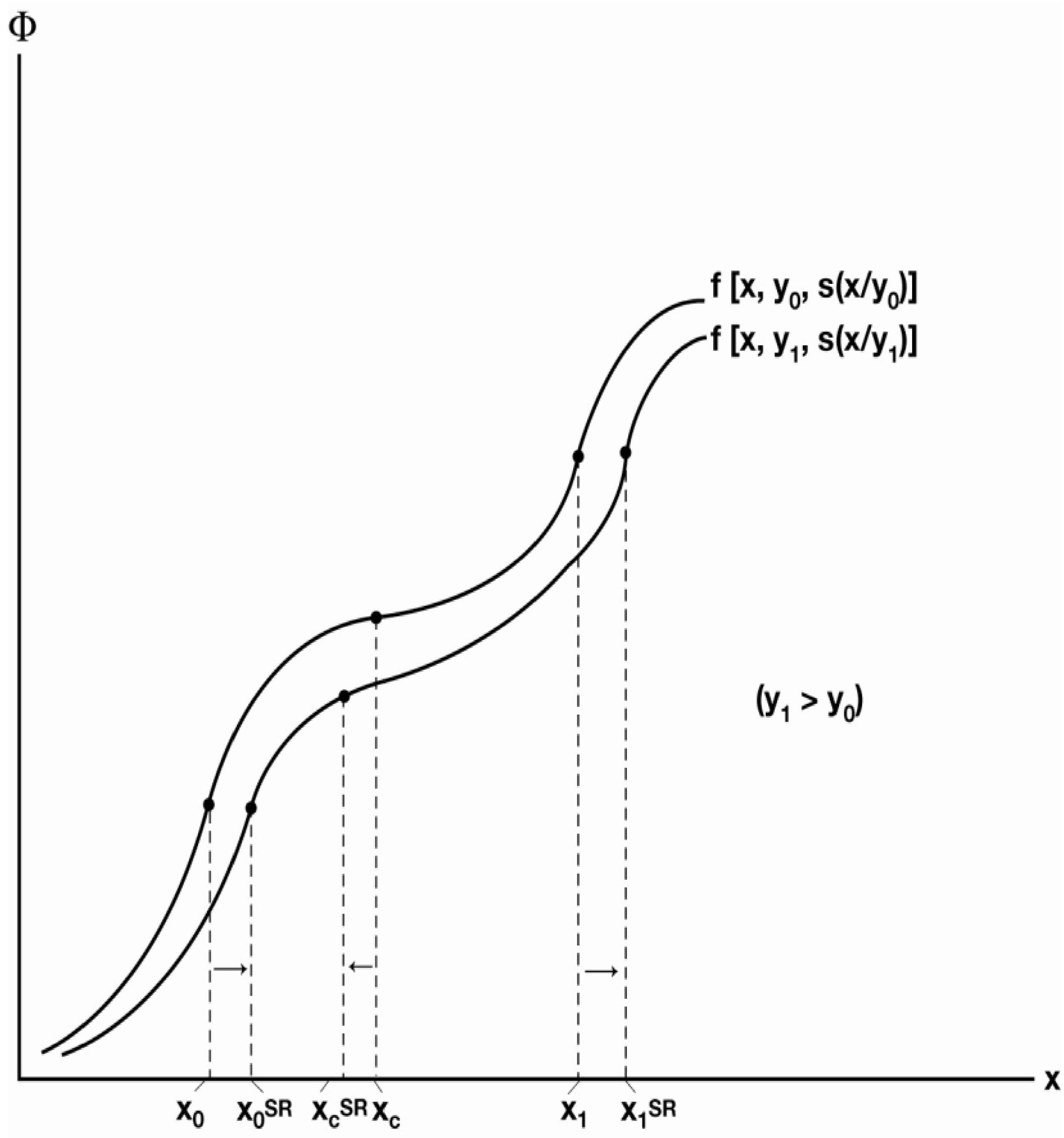

Figure 4
Short-run consequences of an exogenous increase in y

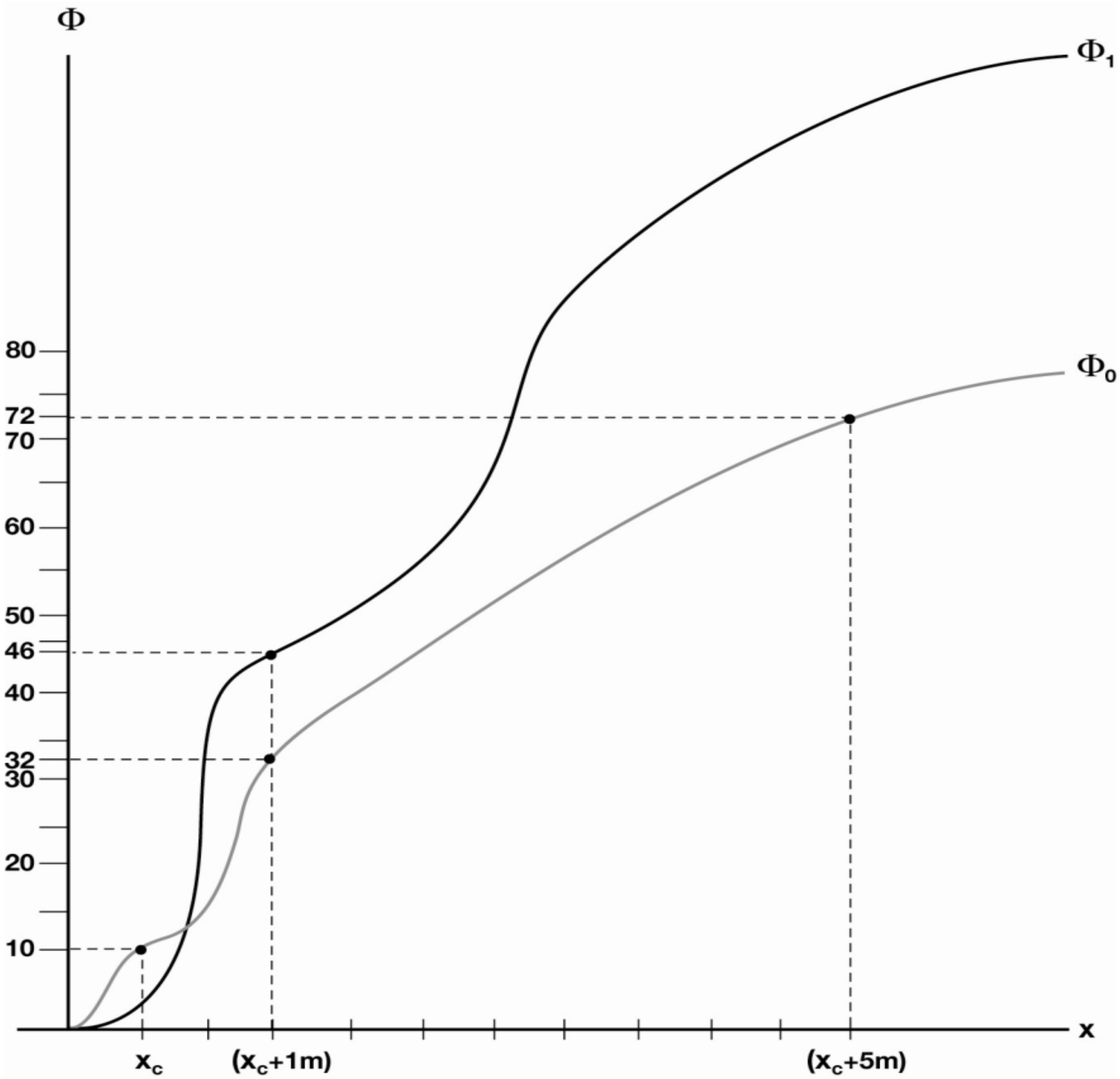

Figure 5
Augmented Markowitz Utility and Allais' Paradox