INCEIF

Kuala Lumpur

Seminar Presentation by Dr. Erbas

Knightian Uncertainty, Contemporary Research and Applications

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1.   Knightian Uncertainty

In reality, possible payoffs and associated probabilities to economic enterprise are not known with precision. There is Knightian uncertainty, or, ambiguity, as distinct from measurable risk. Frank Knight, who lends his name to distinguishing uncertainty from risk, is the first contemporary economist to substantively address the impact of uncertainty on economic decision-making, entrepreneurship, investment, and social progress. His landmark contribution is ***Risk, Uncertainty and Profit*** (1921, 2002).

2.   Ellsberg's Paradox: The Two-Color problem

3.   Expected Utility Theory (EUT) and Rational Expectations Hypothesis (REH)

a.   <u>**EUT**</u> (Savage-von Neumann-Morgenstern, 1950s): **Known** probabilities; the *Reduction* axiom (diFinetti's position, 1930s), compound lotteries and simple lotteries (Allais's critique).

b.   <u>**REH**</u>: A natural extension of EUT to macroeconomic and financial analysis: Known or pre-specified probability distributions; reduction axiom in disguise; anticipated structures; no innovation in human behavior and expectations technology. **The fallacy of precision in forecasting:** Frydman and Goldberg's critique, ***Imperfect Knowledge Economics*** (2007).

Knight (1921):

"We perceive the world before we react to it, and we react not to what we perceive, but always to what we infer ... It must be recognized further that no sharp distinction can be drawn between perception and reason ... Reason, and all consciousness, is forward-looking; and an essential element in the phenomena is its lack of automatic mechanical accuracy, its liability to error."

"Our dogma ... is the presupposition of knowledge ... that the world is made up of things, which, under the same circumstances, always behave in the same way ... but workable knowledge of the world requires much more than the assumption that the world is made up of units which maintain an unvarying identity in time ... In addition, we have to make the still more questionable assumption that the situation elements or fundamental kinds of object properties upon which we fall back for simplicity (practical finitude) in view of the unmanageable number of kinds of objects as wholes, are unvarying from one 'combination' (i.e., on object) to another."

"Prophecy seems to be a good deal like memory itself, on which it is based ... So when we try to decide what to expect in a certain situation, and how to behave ourselves accordingly, we are likely to do a lot of irrelevant mental rambling, and the first thing we know we find that we have made up our minds, that our course of actions is settled."

Knight of entrepreneurship and profit

Knight underlines that profit, as distinct from rent and interest, is the reward to making decisions and taking actions in uncertainty "not susceptible to measurement and hence to elimination".

> "It is this true uncertainty which by preventing the theoretically perfect outworking of the tendencies of competition gives the characteristic form of 'enterprise' to economic organization as a whole and accounts for the peculiar income of the entrepreneur."

4. Knight, Ellsberg: Distinguishing Uncertainty from Risk

In relation to Ellsberg's two-color problem, **Knight** observes:

> "The doctrine of real probability, if it is to be valid, must, it seems, rest on the inherent unknowability in the factors, not merely the fact of ignorance. And even then we must always consult the empirical facts, for it will not do to assume out of hand that the unknown causes in a case will distribute themselves according to the law of indifference among the different instances ... If the chance of any particular result is more or less than one half, it is held to be axiomatic that there is a greater number of possible alternatives which yield the result (or do not yield it) than of the other kind; the alternatives themselves must be equally probable. The whole mathematical theory of probability is obviously a simple application of the principles of permutations and combinations for finding out the number of

alternatives. Absolute indifference between the alternatives are taken for granted."

Knight on the inevitability of Subjective Probability Judgments:

"The ordinary decisions of life are made on the basis of 'estimates' of a crude and superficial character. In general, the future situations in relation to which we act depend upon the behavior of an indefinitely large number of objects, and is influenced by so many factors that no real effort is made to take account of them all, much less estimate and summate their separate significance."

5. Contemporary research in support of Knight's Insights from 90 years ago: Evidence from contemporary Research, Experimental Results, Brain Research, Neuroeconomics

    a. **Complexity and chaos** (W. Brock, C. Sayers, J. Schneikman, 1980s-1990s).

    b. **Bounded rationality** (Herbert Simon, 1950s-1990s).

    c. **Brain research, Probabilistic cognition and decision-making** (1990s-present) (David Linden, *The Accidental Mind*, 2007; "kluge").

      d.   <u>**Neuroeconomics**</u> **(**Colin Camerer and others, 2005); Paul Glimcher, 2003; Jason Zweig, 2007): (i) **Uncertainty and fear** (ii) **Happiness, satisfaction, euphoria: oxytocin** rush).

Comparing a gamble that pays an expected gain exceeding a sure gain, the gamble sets off images of fear in the brain, observed with brain scans; fear results in favoring the sure gain. When the decision maker knows that he cannot know the odds of making money, a brain center for processing fear (**amygdala**) becomes overactive. **Ambiguity provokes discomfort and fear, ambiguity aversion is instinctive**. Evidently, such reflexive behavior feeds off of the survival instinct and the relative success of reflexive responses to danger and a preference of immediate reward (impatience) for there may be no tomorrow, as it developed and was inherited through evolution.

      e.   <u>**Pyschology**</u> (Gerd Gigerenzer, 2007):

Gigerenzer's focus is how everyone acts on an everyday basis without conscious inference: Gut feelings and rules-of-thumb. He also underlines imperfect (probabilistic) human perception and the need for and efficacy of narratives or "inventing" rules-of-thumb. Since the subject is cognition and uncertainty, a worthy statement by Gigerenzer should be quoted here: "Intelligence means taking bets, taking risks (p. 42)."

<u>**Merton's 1/n rule of portfolio selection.**</u>

      f.   **Experimental Game Theory (Camerer**, 2003): <u>**The ultimatum game**</u>.

      g.   **Experimental economics**

      Some prominent collections of behavioral studies are by the following

editors: Robin Hogarth and Melvin Reder (1987); William Goldstein and Hogarth (1997); Daniel Kahneman, Paul Slovic and Amos Tversky (1999); Kahneman and Tversky (2000), Richard Thaler (1993, 2005), and Colin Camerer, George Loewenstein and Matthew Rabin (2004). Kahneman (2003) provides a comprehensive overview. On decision-making in ambiguity, a number of studies should be singled out. Camerer and Martin Weber (1992) provide a comprehensive review of the theoretical and empirical literature on modeling uncertainty and risk to that date. Camerer and Loewenstein (2004) provide an updated review of more recent findings from behavioral economics, with a discussion of the findings on ambiguity aversion. A summary discussion of the basic findings from behavioral economics and extensions to decision-making in uncertainty and intertemporal choice is by Camerer (2004).

Not surprisingly, the findings from behavioral economics confirm the insights and evidence from brain research, neuroeconomics, and psychology. There is ample evidence that brings into question the validity of some of the basic assumptions of expected utility theory, even the fundamental axiom of rationality. Some prominent findings are the following: asymmetric valuation of losses and gains, or, loss aversion (losses being valued more than gains for equal magnitudes, as in cumulative prospect theory); preference reversals; regret aversion; *status quo* bias (e.g., staying with the losing portfolio for too long to be justified by its performance); impact of narratives and framing (e.g., saving lives *vs.* losing lives with the same probability). Such behavioral patterns are not part and parcel of macroeconomic and financial analysis based on expected utility theory.

As Knight has pointed out, behavioral research finds that it is not only the heterogeneity of data, it is also the heterogeneity of human decisions under different circumstances.

(i)   Narratives, heuristics, decision biases

Kahneman and Tversky (1999a) note that "passive expectations and conscious anticipations can conflict, and there is evidence that the passive process exerts greater influence on the interpretation of the ambiguous stimuli ... Suppression of uncertainty and equivocation in perception suggests that we may be biologically programmed to act on the perceptual best bet, as if this bet involved no risk of error (pp. 511-513)".

(ii)   Complexity and procedural rationality

Decision-making heuristics simplify complex events to enable the construction of manageable and finite decision-making procedures (**Knight's "practical finitude", rules-of- thumb**) in uncertainty. Heuristics are **satisficing but prone to errors**. Kahneman and Tversky (1999b) observe that "the use of scenarios to assess probability is associated with a bias in favor of events for which one plausible scenario can be found, with a corresponding bias against events that can be produced in a multitude of unlikely ways (p. 207)." More certain narratives are preferred to less certain narratives. This may create an illusion of control over complex situations in uncertainty because controllable and uncontrollable events are not distinguished in decision-making; in reality, it is very difficult to distinguish them (Ellen Langer, 1999).

(iii) **Bayesian inference and modeling**

If such heuristic biases are present at the individual level, how do statistical models fare? A model is a narrative, albeit a scientifically sophisticated one. Paradigmic biases and uncertainty in model selection are familiar in economic theory, as in other disciplines. Although such paradigms are falsifiable, they may hang on for a long time as "scientific faith", even in the face of contrary evidence. Estimation and prediction based on paradigms can be even more biased in view of limitations of data and need to edit out many variables at play.

(iv) **Subjective probability weighting (CPT) (**recall diFinetti's position**)**

$$w(p) = \frac{p^{\alpha}}{[p^{\alpha} + (1 - p^{\alpha})]^{1/\alpha}}$$

Figure.

6. **Applications**

a. **Uncertainty and Institutions**

Knight:

"An uncertainty which can by any method be reduced to an objective, quantitatively determinable probability, can be reduced to complete certainty by grouping cases ...measurable uncertainties do not introduce into business any uncertainty whatever."

A well-understood method of *grouping* is **insurance**.

Knight's examination of ***Structures and Methods for Meeting Uncertainty***

(Chapter VIII, 2002) can be summarized as increasing accumulation of data (sampling) and scientific knowledge (modeling), along with consolidation and specialization through large-scale organization of economic activity. Consolidation of economic activity in large corporations, in which hierarchical production decisions can be exercised more efficiently and effectively, reduces uncertainty and transforms it into measurable (therefore, priceable) risk, so missing markets are no longer missing. Similarly, uncertainty is consolidated and its are costs diversified through integrated (grouped) and specialized markets and business organizations (e.g., insurance, banking, financial investment markets); thus, decision makers "shift" uncertainty by transferring it to specialists. Central to this process of reducing uncertainty is legal guarantees for private property and contractual freedom, which improve the prospects for control of resources (wealth) over time. Of course, consolidation, specialization, and systemic control of economic decisions and resources are the main underlying characteristics that define robust market institutions. Knight's main thesis is that such market institutions emerge mainly to deal with uncertainty. This is progress. Reducing uncertainty through institutional grouping is at the core of social and economic development.

    b.   Good institutions reduce uncertainty, Institutions as social decision-heuristics

    c.   Reducing uncertainty by vertical and horizontal integration (Erbas 2004a**)**

    d.   Preference for flexibility

    Koopmans (1964) notes that, in real life, a sequential decision problem is

never realized in full detail as a completely spelled-out program. His argument implies that future opportunity sets cannot be anticipated in full detail because of uncertainty. **Sequential decision programs are ambiguous over time**. An earlier discussion of **economically significant benefits from flexibility** is by Thomas Marschak and Richard Nelson (1962). They argue that flexibility comes at a cost, such as the cost of accepting lower payoffs or the cost of delaying some payoffs into the future. They propose a measure of flexibility in decision-making according to which the more the decision maker expects to learn from each decision outcome, the more she values flexibility. Along similar lines Kreps (1992, 1999) points out that learning from the consequence of a particular decision may diminish ambiguity over time. Avinash Dixit and Robert Pyndick (1994) underline that most **investments** take considerable time to implement and investment decisions are often irreversible, at least, significant costs are associated with reversal that may exceed the cost of waiting. Furthermore, multi-stage investments cannot be implemented all at once, and such investments may stall for a duration or even be abandoned. Investments are multi-stage or compound prospects. Splitting multi- stage investments, or, implementing them as decisions segmented over time as opposed to once-and-for-all decisions with an *ex ante* commitment for the whole time horizon, **gives the investor the option** of undertaking or halting or abandoning to hedge against uncertainty over time, and the decision maker may be willing to pay for such flexibility. Flexibility has option value. Those authors conclude with the provocative

observation that investment may be much less sensitive to interest rates and tax policies than to uncertainty in the economic environment over time.

Erbas (2004b) examines **IMF program conditionality** in the context of preference for flexibility: Compound prospects cannot be reduced to simple prospects; streamlined conditionality gives the policy maker the option of revising, continuing, or terminating a set of reforms and policies required by conditionality over time.

e. **Missing markets and uncertainty; insurance and insurability** (Erbas and Sayers, 2006): institutional quality-uncertainty- insurability nexus is highly significant determinant of insurability. So, a good case can be made that institutional quality, as it reflects on uncertainty, is a significant determinant of insurability.

f. **The Equity Premium Puzzle:** Mirakhor and Erbas (2007; forthcoming in 2010)

7. **Knightian uncertainty and macroeconomic analysis**

a. Clarifies what is meant by the popular usage of such terms as "**transparency**", "**declining risk appetite of investors**", "**investor confidence**", "**streamlined conditionality**", and so on. Such terminology has little or no theoretical justification in standard risk analysis based on EUT and Knightian uncertainty fills that gap.

To the best of my knowledge, Knightian uncertainty made its official IMF debut, albeit in a footnote, in a document presented to the IMF Board in 2008 ("Fiscal Risks—Sources, Disclosure, and Management", Fiscal Affairs Department, May 21). Recent Global Financial Stability Reports (GFSR) frequently refer to "**decreasing risk appetite**" on the basis of survey results but without explaining what it means in the context of the theory of risk. Same types of references appeared in a conference by Prof. Nouriel Roubini of New York University, held at IMF in March 2008 by IMF Institute. Prof. Roubini acknowledged that there was no theoretical basis for referring to "decreasing risk appetite" under expected utility theory and Knightian uncertainty might be instrumental in explaining what such terms meant, although they seemed to be understood intuitively.

b.   **Explains "excess" volatility**; Emerging and mature markets? What does volatility mean? It is not sufficient to say that observed data indicate a greater variance, we must also explain why because data reflects human decisions.

8.   Policy implications

a.   **Complexity and simplicity (Tanzi** 2007): **Turkish proverb:** "**Wolf likes murky weather**". Exotic instruments? Do they indemnify and spread risk or do they increase risk by increasing ambiguity? Should there be a limit on the number of generations of derivatives?

b.   Missing markets and creation of markets

c.   Vertical and horizontal integration

    d.   **Institutional strength and policy credibility**

    e.   **Libertarian paternalism and Nudges (Richard Thaler and Carl Sunstein**, 2008).

9.   **Knightian Uncertainty and Onset of Crises**

    a.   No model of crises in Knightian uncertainty (?); worthy of extensive research

    b.   **Heuristic biases** may produce overly optimistic estimates of success and events that result from slow incremental changes may be ignored in sequential decisions. Thus, for extended periods of time prior to a crisis, there is less perceived uncertainty because of heuristic biases but perceived uncertainty suddenly increases because the crisis invalidates the heuristics (e.g., **value-at-risk models; rating heuristics; stress tests**). In other words, a decision anomie arises, creating uncertainty about the heuristics at hand, and they can no longer be trusted to have analytical and much less predictive value. At a time of heightened uncertainty, investors lose confidence in their subjective judgments and heuristics, they can no longer assess asset values unambiguously, and make a mad dash to safe assets with a disastrous decline in stock values. For agents to return to investing, the fog needs to disperse, asset values and associated probabilities need to reveal themselves more clearly, new or corrected heuristics need to be adopted (by the willing hand of private agents and by the coercive hand of the government), institutional designs that increase

uncertainty need to be revised (e.g., lax regulation; vulnerabilities of regulators and rating companies to moral hazard), government rescue plans need to increase investor confidence, and so on.

c.   To borrow a term from **Karl Marx**, decision biases in uncertainty may create "**fictitious capital**", on the basis of which investors estimate net worth, profitability, risk, so on. Investors make the best guesses of risks and their net worth and proceed with investment decisions. It is possible that in good times investors use more optimistic risk heuristics so they are yield-seeking, even though that judgment may be fatally biased. Their net worth might not have been based on net claims on real goods and services. A reason why may well be that, in an environment of complexity created by increasingly sophisticated risk sharing instruments, investors are left in uncertainty about netting out the true value of their liabilities from the true value of their assets. In other words, investors don't know who owes what to whom and how much. Moreover, they don't know with a reasonable degree of precision the creditworthiness of the players (the probabilities that they will honor their obligations and how much of those obligations). Investors may know who owes what to them and what they owe to whom but the complexity of risk sharing instruments may not permit a precise and reliable analysis of who owes what to third and fourth counterparties and what they owe, and so on.

d.   Uncertainty may be high enough that an individual investor can assess only her position and her needs for emergency financing. Let her

assessment be X1 and another investors assessment be X2, and so on. If the assets and liabilities could be netted out based only on risk, then starting from the beginning of the chain would do the trick. The savior (government) pays X1 to the first investor, she pays her debt to the next investor, and so on. But if the agents and the savior don't know who owes what to whom and how much, then uncertainty sets in. Netting out does not work to a great extent because investors become aware that the distributions associated with the credit chain are not and cannot be known for extended periods of time. So, it is possible that the overall financial need has to be aggregated as ΣX_i instead of $\Sigma(X_i - X_{i-1})$ and ΣX_i can be many multiples of $\Sigma(X_i - X_{i-1})$. What is worse, there is great market uncertainty about the value of ΣX_i, many distributions are possible. This means a large part of ΣX_i was fictitious to begin with, it was not based on net claims on real goods and services. This is wealth illusion. Of course, when wealth illusion is over, the economic consequences of that negative wealth effect are not illusory but they are very real. With the sudden realization of the lack of sufficiently precise information, an abrupt move to a heuristic with an ambiguity bias becomes a reasonable conjecture. The theorem proposed in this paper can make no claim to modeling such heuristic shifts. Nevertheless, evidence from contemporary research, including behavioral economics, indicates that heuristic shifts are quite possible.

e.   For example, the IMF estimate for the original sin (subprime mortgages) in October 2008 was a "mere" US$300 billion in outstanding loans and subprime losses were estimated at an even "punier" US$50 billion (GFSR, Table 1.1, p. 15). One wonders why such a relatively small original sin has created a need for government financing whose sum by now exceeds at least forty times that loss. If it were possible to start from the beginning of the bad debt chain and trace who owed what to whom, why not inject US$50 or US$300 billion at the beginning of the chain and happily let the upstream investors be paid to cover their losses? But the upstream is murky, who owes what to whom is not known by market participants or by the government, at least not with precision. Consequently, when a relatively small fraction of payments fail, investors may shift to pessimistic uncertainty heuristics, or, at least revise their heuristics with a greater bias for uncertainty. Then, perhaps mass fear induced by uncertainty in the collective amygdala of the herd goes to work, provoking hysteria and igniting stampedes.

f.   Knight's thesis and its policy implications discussed above indicate that one of the main pillars of recovery from a crisis is implementing policies to reduce uncertainty, this time on a global scale. Along with the staggering sums allocated to financial sector recapitalization and fiscal stimulus packages, there is a need to revalidate trust in the financial system. Evidence reviewed above suggests that trust is not

an illusion because it reduces uncertainty in human interactions by

filling the holes in incomplete contracts.

g.   The columnist **David Brooks** tells (and I hope he does not foretell) a

doomsday scenario, in which economic malaise persists, despite

recapitalization and fiscal spending by the government at

unprecedented levels. The scenario has it that the psychology of

uncertainty results in a shift from a high-trust to a low-trust society.

In this dystopian world, economists and policy makers are helpless

because they can think only in terms of "economic models with

primitive views of human behavior" (The New York Times, Op-Ed,

February 13, 2009).

10.   Knight on economic theory

Knight explicitly states that uncertainty surrounding subjective probability

judgments has been neglected in economic theory:

"The conception of an objectively measurable probability or chance is simply

inapplicable ... But in fact it appears to be meaningless and fatally misleading

to speak of the probability, in an objective sense, that a judgment is correct ...

we propose to call the value of estimates a third type of probability judgment

(in addition to a priori and statistically inferred estimates of probability),

insisting on its differences from the other types rather than its similarity to

them. It is this third type of probability or uncertainty which has been

neglected in economic theory, and which we propose to put in its rightful place (words in parenthesis are mine)."

It appears that Knight's judgment on economic theory has stood the test of time after nearly 90 years. Knight's ideas have been validated by contemporary research and they remain durably inspiring for future economic research and policy formulation.

This paper is an effort to put Knight in his rightful place in modern economic thought.