The Imperfect Knowledge Imperative in Modern Macroeconomics and Finance Theory

Roman Frydman and Michael D. Goldberg
Contemporary approach to macroeconomics and finance theory

Core Premise

- Only models producing “sharp predictions” of outcomes – represented with standard probability distributions – are considered empirically relevant and deserving of scientific status.

- To produce sharp predictions, an economist must presume that non-routine change – change that does not follow mechanical rules and procedures – is unimportant for understanding outcomes.

- We refer to such models as fully predetermined.
Fully predetermined representations of rationality.

• REH is *the* way to represent how rational, profit-seeking market participants interpret the future.

The usual critique of the Rational Expectations Hypothesis

• Most individuals lack the abilities needed to understand the future and compute correctly the consequences of their decisions.

• REH-based standard of rationality works – but only for truly intelligent investors – those who have extraordinary cognitive and computational abilities.
Our critique of REH

• Stems from our arguments concerning the futility of contemporary attempts to characterize outcomes with fully predetermined models.

• Because REH imputes to individuals a single mechanical forecasting strategy *implied* by an economist’s model, it requires no assumptions about the intelligence of market participants.
A simple example of a model of an asset price

A representation in semi-reduced form of the equilibrium price at a point in time $t$:

$$P_t = a_t + b_t X_t + c_t \hat{P}_{t|t+1}$$

(1)

where $\hat{P}_{t|t+1}$ is an aggregate of market participants’ forecasts formed at $t$ of the market price at $t + 1$, $(a_t, b_t, c_t)$ is a vector of parameters, and $X_t$ is a set of causal variables.

$$\hat{P}_{t|t+1} = \alpha_t + \beta_t Z_t$$

(2)

where $Z_t$ is a vector of variables that characterizes the union of information sets underpinning market participants’ forecasts and $(\alpha_t, \beta_t)$ is a vector of parameters.
At each point in time, the causal structure of an economist’s representation is characterized by the following properties: the composition of the set of causal variables, the properties of their joint probability distribution, and a functional form that relates them to outcomes that the model aims to explain.

- To characterize adequately how market outcomes unfold over time, an economist will, in general, need models with different structures at different points in time.

- Remarkably, contemporary macroeconomists typically constrain the structure of their models to remain unchanging over time.

- In those relatively infrequent cases in which contemporary models allow for change, they presume that an economist can adequately prespecify it with mechanical deterministic or probabilistic rules.
Illustration: fully prespecifying revisions in forecasting strategies

- Time-invariant except for forecasting strategies.

- In general, the representation of their revisions may involve a change in the composition of the set of causal variables, $Z_t$, or a switch to a different functional form.

- However, without a loss of generality, we represent revisions of forecasting strategies with a one-time parametric shift at $t + 1$:

$$
\hat{P}_{t+\tau|t+\tau+1} = \alpha_{t+\tau} + \beta_{t+\tau} Z_{t+\tau} \quad (3)
$$

where $\alpha_t \neq \alpha_{t+1}$ and $\beta_t \neq \beta_{t+1}$ and $\alpha_{t+\tau} = \alpha_{t+\tau+1}$, and $\beta_{t+\tau} = \beta_{t+\tau+1}$ for all $\tau = 1, 2, 3,...$. 
Fully predetermining restrictions:
\[ \bar{\alpha} = \alpha_{t+1} - \alpha_t \quad \text{and} \quad \bar{\beta} = \beta_{t+1} - \beta_t \quad (4) \]

where \((\bar{\alpha}, \bar{\beta})\) are constants.

Fully predetermined social context, including economic policy

- Typically represented with the causal variables, referred to as “information,” which is portrayed with standard time-series models:

\[ x_t = \mu_x (1 - \rho_x) + \rho_x x_{t-1} + \epsilon_t^x \quad (5) \]
\[ z_t = \mu_z (1 - \rho_z) + \rho_z z_{t-1} + \epsilon_t^z \quad (6) \]

where \(\mu_x, \mu_z, \rho_x, \rho_z\) are constant parameters, and \(\epsilon_t^x\) and \(\epsilon_t^z\) are random “shocks” (“news”)

- An economist fully prespecifies all possible realizations of “news” and their probabilities in all time periods.
Sharp Predictions of Nothing New

Fully predetermined models produce “sharp predictions,”—conditional probability distribution of outcomes:

\[ \hat{P}_{t+\tau|t+\tau+1} - \hat{P}_{t|t+1} = \hat{A} + \hat{B}z_t + (\beta_t + \bar{\beta})\varepsilon_{(t,t+\tau)} \quad \text{for } \tau = 1, 2... \]

(7)

- The representation in (7) decomposes change in the one-period ahead forecast formed at \( t \) and \( t + \tau \) into two fully predetermined components.

1. The expectation of change \( \hat{A} + \hat{B}z_t \), which an economist presumes to know exactly, conditional on the structure of the model and information at \( t \).

2. The future “news,” \( (\beta_t + \bar{\beta})\varepsilon_{(t,t+\tau)} \).
Neither descriptive nor normative:

REH as an artifact of fully predetermined models

\[ \hat{P}_{t|t+1}^{RE} = EM [P_{t+1}|I_t] \]

- Let \( \hat{P}_{t|t+1}^{FP} \) be a fully predetermined non-REH forecast rules (such as those used in behavioral-finance models.)

\[ - (P_{t+1} - \hat{P}_{t|t+1}^{FP}) \] obviously and systematically correlated with the information, \( I_t \).

- Muth about REH: “profit opportunities would no longer exist if the aggregate expectation...is the same as the prediction of the theory.”

- Nevertheless, Muth warned: “at the risk of confusing this purely descriptive hypothesis with a pronouncement as to what firms ought to do, we call such expectations ‘rational.’” (Muth, 1961, p. 316, emphasis added).
The REH Revolution: Model Consistency as a Standard of Rationality

- Macroeconomists working in the 1960’s largely ignored it in modeling forecasting behavior.

  - The papers from Phelps’s milestone conference, eight years after Muth proposed REH, made no use of it, and REH is not even listed in the index of the conference volume.

- However, Robert Lucas focused on the inconsistency within the models developed in the 1960’s between representations on the individual and aggregate levels.
- Lucas and his followers took for granted the premise that a fully predetermined model could provide an adequate account of how “actual prices” evolve over time.

  - This led him to treat the errors implied by non-REH forecast rules as pointing to obvious, yet unrealized, profit opportunities in real-world markets.

- Remarkably, REH’s imposition of exact consistency within an economist’s model quickly became the standard way to represent how rational individuals think about the future.

  - REH was embraced by a vast majority of economists, spanning the Chicago free-market and MIT New Keynesian schools.
The predictable empirical difficulties of fully predetermined rationality

• After considering many econometric studies of REH models, Maurice Obstfeld and Kenneth Rogoff concluded in their magisterial book on international macroeconomics that the undeniable difficulties that international economists encounter in empirically explaining nominal exchange rate movements are an embarrassment, but one shared with virtually any other field that attempts to explain asset price data (Obstfeld and Rogoff, 1996, p. 625).

• We trace these empirical difficulties to the contemporary approach's core premise.
Insurmountable epistemological flaws of REH models

- The representation of aggregate outcomes and individual decision-making with a single probability distribution implied by an economist’s model has forced economists to interpret the REH forecasting strategy in two flawed ways:

  - a representation of how market participants forecast the future in the aggregate
    - this representative agent interpretation is internally incoherent
      - “rational” market is implicitly presumed to be composed of obviously irrational participants
  
  - or how every one of them does so individually
    - The unanimity of views required by REH disregards the essential distinction between individual market participants and the market-based allocation of resources (Hayek, 1948).
Contemporary macroeconomics and finance: a theory or a spurious narrative?

• Stands rationality on its head.
  – A rational, profit-seeking individual understands that the world around her will change in non-routine ways.
  – She simply cannot afford to believe that, contrary to her experience, she has found an overarching forecasting strategy, let alone that everyone else has found it as well.

• The distorted or inverted meaning of intuitively seductive notions like “rationality” is part of a broader pattern of linguistic obfuscation in contemporary macroeconomics and finance.
• Such inversions of meaning have had a profound impact on

- the public debate: when economists invoke rationality to justify their public-policy recommendations, non-economists interpret such statements to mean that the recommendations are based on “scientific” representations of how reasonable people behave in the real world;

- the development of economics itself.

  * After uncovering massive evidence that fully predetermined rationality fails to capture adequately how individuals actually make decisions, the only sensible conclusion to draw was that this standard was utterly wrong.

  * Instead, behavioral economists concluded that individuals are “less than fully rational” or “irrational.”
Our proposed alternative: Imperfect Knowledge Economics

IKE opens macroeconomics and finance models to non-routine change and the imperfect knowledge that it engenders.

Because it recognizes imperfect knowledge on the part of market participants and economists, IKE can accord a significant role to psychological factors in individual decision making while remaining compatible with individual rationality.

Jettisoning fully predetermining restrictions

\[
\hat{P}_{t+1|t+2} - \hat{P}_{t|t+1} = \hat{A}_{(t,t+1)} + \hat{B}_{(t,t+1)}z_t + \left(\beta_t + \beta_{(t,t+1)}\right)\varepsilon_{t+1}^z
\]  

(8)

where \(\hat{A}_{(t,t+1)}\), \(\hat{B}_{(t,t+1)}\), and \(\left(\alpha_{(t,t+1)}; \beta_{(t,t+1)}\right)\) represent revisions of forecasting strategies.
Animal Spirits versus Fully Predetermined Accounts of Outcomes

- The unrestricted model illustrates a situation in which participants act according to their “animal spirits,” which are largely disconnected from any fundamental considerations that might drive outcomes.

  - However, an unrestricted model has no empirical content: it is compatible with any time-path of outcomes and with any causal process that underpins them

- Contemporary models occupy the opposite methodological extreme: they fully prespecify change.

- Both extremes of the methodological spectrum are inherently in conflict – albeit for very different reasons – with the objective of developing empirically relevant economic theory.
IKE’s Non-Standard Probabilistic Formalism

• IKE stakes out an intermediate position between the “animal spirits” view, which denies any possibility for economic theory, and the contemporary presumption that a standard conditional probability distribution can fully and adequately represent outcomes.

• In contrast to contemporary models, IKE recognizes that our knowledge of the causal process underpinning outcomes is inherently imperfect.

• However, like any scientific theory, IKE must presume that purposeful behavior exhibits regularities, even if these regularities are only qualitative, context-dependent, and relevant at times that no one can fully specify in advance.
• In portraying an individual’s forecasting strategy at a given time, we make use of conditional probability distributions, but do not fully prespecify how they change over time.

  – * Instead, we rely only on qualitative conditions to represent change.

• We refer to such distributions as partially predetermined.
The Contingency of IKE’s Representations

• The conditions that make up an IKE model are not only qualitative, but also “contingent.”

  – Probabilistic representations generated by an IKE model are not only compatible with myriad post-change probability distributions, but their structure undergoes change at moments that no one can fully prespecify.

• Thus, IKE models are open to non-routine change and recognize the importance of the imperfect knowledge and diversity of forecasting strategies that such change engenders.
• The contingent and qualitative nature of the conditions that characterize IKE’s approach to macroeconomics and finance theory plays a crucial role in its ability to deliver empirically relevant accounts of swings in asset prices and risk. (companion paper).

  – These features of IKE models also play a key role in their ability to incorporate the role of both psychological factors and fundamental considerations in driving swings in asset prices and risk.

  – Furthermore, the qualitative and contingent nature of conditions that make up IKE models render them compatible with both diversity and individual rationality.
Sharp versus Contingent Predictions

- Contemporary economists’ aim to find a model that could predict the complete set of future market outcomes and probabilities is not the first such endeavor in the social sciences.

  – In his seminal refutation of the claim that “historicism” might one day enable social science to “predict the future course of history,” Karl Popper pointed out that any such approach is futile “to the extent to which [historical developments] may be influenced by the growth of our knowledge” (Popper, 1957, pp. xi-xii).

- Because market outcomes – especially outcomes in financial markets – crucially depend on changing understandings of the process and psychology that underpin those outcomes on both the individual and aggregate level, our critique of contemporary macroeconomics and finance theory can be viewed as further refutation of the historicist’s vain ambition.
• Although Popper argued against, and indeed considered dangerous, attempts to develop a fully predetermined account of history, he was quick to point out that his argument does not, of course, refute the possibility of every kind of social prediction; on the contrary, it is perfectly compatible with the possibility of testing social theories — for example economic theories — by way of predicting that certain developments will take place under certain conditions (Popper, 1957, p. xii).

• The contingent predictions generated by our IKE model of asset-price swings exemplify what Popper would regard as a feasible goal of economic theory.

– Although our model predicts that, under “certain conditions,” an asset price will undergo a sustained movement in one direction, it does not predict when such upswings or downswings will begin or end.
Beyond building on Popper’s insights concerning the possibility, scope, and character of predictions in the social sciences, our IKE model of asset-price swings exemplifies Hayek’s claim that,

“Our capacity to predict will be confined to...general characteristics of the events to be expected and not include the capacity for predicting particular individual events” (Hayek, 1994, p. )

Although an IKE model that we present in the companion paper, by design, stops short of predicting “particular individual events,” such as when an asset-price swing will begin and end, it does generate predictions concerning their “general characteristics” – for example, that they tend to be quite persistent.
• Thus, by examining the persistence and related features of swings in asset prices and risk implied by alternative models, an economist may compare explanations of economic phenomena.

  – Johansen et al (2010) and Frydman et al (2010a, b) develop such an approach to econometric testing, and conclude that an IKE model provides a significantly better account than standard and REH-based “bubble” models of swings in currency markets.

• These studies show that, despite placing imperfect knowledge and non-routine change at the center of economic analysis and limiting our ambition solely to generating qualitative predictions, IKE models may still yield “predictions which can be falsified and which therefore are of empirical significance” (Hayek, 1974). (companion paper)