Markov Regime Classification

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Abstract

This paper proposes a new methodology and perspective for historical macroeconomics based on the joint evolution of time valuation and risk valuation. Observed asset returns are decomposed into a risk-free rate, capturing the valuation of time, and a critical risk premium, capturing the valuation of uncertainty. Economic history is reconstructed as a trajectory in a two-dimensional valuation state space, subject to equilibrium constraints, regime persistence, and limits to policy controllability.

The framework integrates asset pricing theory, regime-switching dynamics, optimal control, and Knightian uncertainty. Historical regimes are formalized as states of a Markov process, with absorbing and near-absorbing regimes arising from policy irreversibility and robust control under model uncertainty. Crises, stagnation, and recoveries emerge as endogenous features of valuation dynamics rather than as deviations from a stable equilibrium.

By treating valuation itself as the primary historical object, the approach departs from traditional cliometrics and standard DSGE-based macro-history. It provides a unified language for comparing eras, diagnosing persistence, and understanding why policy traction erodes over time. Economic history is reframed as the study of constrained and sometimes irreversible trajectories in valuation space.

The paper ends with “The End”

1 Introduction

Economic history has long been written at the intersection of narrative interpretation and quantitative measurement. Narrative traditions emphasize wars, institutions, technologies, and political transformations as drivers of historical change. Cliometric traditions, in turn, seek causal identification using historical data, often focusing on growth, productivity, demography, or institutional variation. While these approaches have generated profound insights, they share a common limitation: prices, interest rates, and asset returns typically appear as outcomes of history rather than as historical objects in their own right.

This paper proposes a different perspective. It argues that economic history can be reconstructed through the evolution of how societies price time and risk. These valuations are not secondary reflections of deeper forces; they are the mechanisms through which expectations, institutions, policy, and uncertainty are aggregated and expressed in market economies.

The starting point is a simple decomposition:

$$r(t) = r_f(t) + p_c(t), \tag{1}$$

where $r_f(t)$ is the risk-free rate, representing the valuation of time, and $p_c(t)$ is the critical risk premium, representing the valuation of uncertainty. While formally elementary, this decomposition carries deep historical content. Long-run movements in $r_f(t)$ encode changes in monetary regimes, savings behavior, demographic structure, and policy credibility. Movements in $p_c(t)$ encode changing perceptions of risk arising from wars, crises, political instability, financial innovation, and structural transformation.

Seen through this lens, economic history is not primarily a sequence of realized growth outcomes or institutional reforms. It is a record of shifting valuation regimes. Periods of prosperity, stagnation, or crisis correspond to distinct configurations of time valuation and risk valuation, and to the persistence or fragility of those configurations.

The paper develops a framework in which economic history is represented as a trajectory in a two-dimensional valuation space spanned by (r_f, p_c). Historical regimes are defined not ex post by narrative labels, but endogenously as states of a regime-switching process governing valuation dynamics. Some regimes are transient, corresponding to adjustment and repair. Others are absorbing or near-absorbing, corresponding to periods in which valuation dynamics become self-sustaining and resistant to policy intervention.

This approach offers several advantages for historical analysis. First, it provides a common metric for comparing eras that differ radically in institutions, technologies, and political structures. Second, it separates changes in time valuation from changes in risk valuation, allowing historians to distinguish, for example, between monetary stabilization and genuine reductions in uncertainty. Third, it offers a disciplined way to interpret persistence and apparent irreversibility without relying on teleological narratives or ad hoc explanations.

The framework also speaks directly to long-standing historical puzzles. Why do some crises lead to rapid recovery while others usher in decades of stagnation? Why do prolonged periods of low interest rates fail to restore investment or growth? Why does policy sometimes appear powerful in one era and impotent in another? In this framework, such questions are reframed as questions about regime persistence, reachability, and the erosion of policy traction under uncertainty.

Importantly, this paper does not seek to replace narrative economic history or cliometrics. Rather, it offers a complementary analytical layer. Narrative events, institutional changes, and policy interventions enter the framework insofar as they alter the valuation of time and risk or the transitions between valuation regimes. The result is a methodology that respects historical specificity while enabling systematic comparison.

The contribution of the paper is therefore methodological and interpretive. It proposes valuation dynamics as a unifying language for economic history—one capable of integrating financial data, policy history, and macroeconomic outcomes into a coherent analytical structure. By doing so, it offers a new way to read economic history: not only as what happened, but as how societies learned, feared, discounted, and ultimately constrained their own futures.

2 Historical Regime Classification as a Markov Process

Let $\{(r_f(t), p_c(t))\}_{t=1}^{T}$ denote the estimated valuation trajectory obtained from the methodology above. Define a finite set of historical regimes

$$\mathcal{S} = \{1, 2, \dots, K\},$$

where each state corresponds to a qualitatively distinct valuation regime. A canonical four-state specification is:

$$\begin{aligned}
S_t &= 1 : \text{Efficiency-Dominant Regime},\\
S_t &= 2 : \text{Offsetting Boundary Regime},\\
S_t &= 3 : \text{Risk-Dominant Regime},\\
S_t &= 4 : \text{Time-Dominant Regime}.
\end{aligned}$$

2.1 State Assignment Rule

Define the equilibrium deviation

$$d(t) = |r_f(t) + p_c(t)|, \tag{2}$$

and the valuation volatility

$$v(t) = \sqrt{\mathrm{Var}_\tau[r_f] + \mathrm{Var}_\tau[p_c]}, \tag{3}$$

computed over a rolling window of length τ.

The latent regime S_t is assigned probabilistically according to

$$\Pr(S_t = k \mid r_f(t), p_c(t)) \propto \exp\big(-\alpha_k d(t) - \beta_k v(t) + \gamma_k r_f(t) + \delta_k p_c(t)\big), \tag{4}$$

where $\{\alpha_k, \beta_k, \gamma_k, \delta_k\}$ are regime-specific parameters. This specification nests deterministic threshold rules as a limiting case.

2.2 Markov Transition Structure

Regime evolution is governed by a first-order Markov process:

$$\Pr(S_t = j \mid S_{t-1} = i) = \pi_{ij}, \tag{5}$$

with transition matrix

$$\Pi = \begin{pmatrix} \pi_{11} & \pi_{12} & \cdots & \pi_{1K} \\ \pi_{21} & \pi_{22} & \cdots & \pi_{2K} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{K1} & \pi_{K2} & \cdots & \pi_{KK} \end{pmatrix}, \quad \sum_{j=1}^{K} \pi_{ij} = 1. \tag{6}$$

Economic interpretation is imposed through structure on Π:

- High persistence: π_{ii} large for all i.
- Crisis asymmetry: $\pi_{3,1} \ll \pi_{3,2}$ (risk regimes rarely jump directly to efficiency).
- Policy repair: $\pi_{4,2} > \pi_{4,1}$ (time-dominant regimes resolve via offsetting states).

2.3 Joint State-Space Representation

The full historical system may be written as a regime-switching state-space model:

$$\begin{pmatrix} r_f(t) \\ p_c(t) \end{pmatrix} = \mu_{S_t} + A_{S_t} \begin{pmatrix} r_f(t-1) \\ p_c(t-1) \end{pmatrix} + \varepsilon_t, \tag{7}$$

$$\varepsilon_t \sim \mathcal{N}(0, \Sigma_{S_t}), \tag{8}$$

$$S_t \sim \mathrm{Markov}(\Pi). \tag{9}$$

Each regime is characterized by its own valuation dynamics (μ_k, A_k, Σ_k), allowing persistence, volatility, and covariance to differ across historical states.

2.4 Interpretation

Under this formulation, economic history is a realization of a hidden Markov process in valuation space. Crises correspond to transitions into risk-dominant regimes, recoveries to exits from them, and long-run stagnation to persistent residence in boundary or time-dominant states. The Markov structure imposes temporal discipline on regime narratives while remaining fully grounded in observable price data.

3 Absorbing and Transient Valuation Regimes

Let $\{S_t\}_{t\geq 1}$ be the Markov regime process with finite state space

$$\mathcal{S} = \{1, 2, \dots, K\},$$

and transition matrix $\Pi = (\pi_{ij})$. The long-run structure of economic history depends critically on whether valuation regimes are absorbing or transient.

3.1 Definitions

Absorbing Regime A regime $k \in \mathcal{S}$ is absorbing if

$$\pi_{kk} = 1, \tag{10}$$

implying that once the economy enters regime k, it remains there indefinitely.

Transient Regime A regime k is transient if

$$\pi_{kk} < 1, \tag{11}$$

and there exists at least one $j \neq k$ such that $\pi_{kj} > 0$.

Recurrent (Persistent) Regime A regime is recurrent if it is not absorbing but is revisited with probability one over an infinite horizon.

3.2 Economic Interpretation

In valuation-based economic history, absorbing regimes correspond to terminal valuation states where adjustment mechanisms cease to operate. Transient regimes correspond to phases of disequilibrium, repair, or transition.

Typical economic interpretations include:

- **Efficiency-dominant regimes** are generally transient, as informational efficiency erodes under shocks.
- **Risk-dominant regimes** are strongly transient, reflecting crisis dynamics and forced repricing.
- **Offsetting boundary regimes** are weakly recurrent, often revisited during prolonged stagnation.
- **Time-dominant regimes** may become absorbing under sustained policy repression or demographic stagnation.

3.3 Canonical Block Decomposition

Reordering states so that transient regimes precede absorbing regimes, the transition matrix admits the canonical form

$$\Pi = \begin{pmatrix} Q & R \\ 0 & I \end{pmatrix}, \tag{12}$$

where:

- Q governs transitions among transient regimes,
- R governs transitions from transient to absorbing regimes,

- I is an identity matrix corresponding to absorbing regimes.

The *fundamental matrix*

$$N = (I - Q)^{-1} \tag{13}$$

has entry N_{ij} equal to the expected number of periods the economy spends in transient regime j given initial regime i.

3.4 Historical Duration and Exit Probabilities

Expected duration in transient regime k is

$$\mathbb{E}[T_k] = \frac{1}{1 - \pi_{kk}}, \tag{14}$$

while the probability of eventual absorption into absorbing regime j from initial state i is

$$B = NR. \tag{15}$$

These objects provide direct historical quantities:

- expected crisis length,
- likelihood of recovery versus stagnation,
- persistence of policy-induced valuation states.

3.5 Valuation-Theoretic Criterion for Absorption

A valuation regime k becomes absorbing if both:

$$\mathbb{E}[r_f + p_c \mid S_t = k] \approx 0, \tag{16}$$

and

$$\mathrm{Var}(r_f + p_c \mid S_t = k) \approx 0, \tag{17}$$

so that neither time valuation nor risk valuation generates adjustment pressure. In this sense, absorption corresponds to the exhaustion of arbitrage, policy, and belief-driven dynamics.

3.6 Interpretation for Economic History

Economic history, under this framework, is not a sequence of equilibria but a stochastic progression through transient valuation regimes, occasionally approaching absorbing states. True absorption is rare; most historical "end states" are metastable rather than permanent, explaining why apparent secular stagnation or efficiency phases eventually unravel.

Absorbing regimes thus represent limiting theoretical constructs, while transient regimes constitute the substance of observed economic history.

4 Absorption and Policy Irreversibility

Absorbing valuation regimes acquire concrete economic meaning when linked to the concept of *policy irreversibility.* In this framework, irreversibility arises when policy actions permanently alter the dynamics of time valuation $r_f(t)$, risk valuation $p_c(t)$, or both, such that exit from a regime becomes infeasible within the historical horizon.

4.1 Policy-Augmented Transition Probabilities

Let $u_t \in \mathcal{U}$ denote a vector of policy instruments (monetary, fiscal, regulatory). The regime transition matrix becomes policy-dependent:

$$\pi_{ij}(u_t) = \Pr(S_t = j \mid S_{t-1} = i, u_t). \tag{18}$$

A regime k is absorbing under policy sequence $\{u_t\}$ if

$$\pi_{kk}(u_t) \to 1 \quad \text{and} \quad \pi_{kj}(u_t) \to 0 \;\; \forall j \neq k, \tag{19}$$

uniformly over time. Policy irreversibility is thus defined as the inability of feasible future policies to reduce π_{kk} below unity.

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4.2 Irreversibility via State Dependence

Policies become irreversible when their effects depend on the current valuation state. Formally, let the valuation dynamics satisfy

$$\begin{pmatrix} r_f(t) \\ p_c(t) \end{pmatrix} = \mu_{S_t}(u_t) + A_{S_t}(u_t) \begin{pmatrix} r_f(t-1) \\ p_c(t-1) \end{pmatrix} + \varepsilon_t. \tag{20}$$

Policy irreversibility occurs when, for some regime k,

$$\frac{\partial A_k(u)}{\partial u} = 0 \quad \text{for all feasible } u, \tag{21}$$

so that policy loses leverage over valuation persistence once regime k is reached.

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4.3 Economic Sources of Irreversibility

Typical mechanisms generating absorbing regimes include:

- **Debt overhang**: High public or private leverage anchors $r_f(t)$ near zero while sustaining elevated $p_c(t)$.
- **Institutional lock-in**: Regulatory or legal changes permanently alter risk pricing.
- **Expectations anchoring**: Long-lived beliefs compress variance of $r_f + p_c$, eliminating adjustment pressure.
- **Financial repression**: Persistent policy intervention suppresses exit dynamics.

In each case, valuation dynamics lose sensitivity to marginal policy changes.

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4.4 Near-Absorption and Hysteresis

In practice, true absorption is rare. More commonly, regimes are *near-absorbing*, with

$$\pi_{kk} = 1 - \epsilon, \quad 0 < \epsilon \ll 1. \tag{22}$$

Such regimes exhibit hysteresis: short-term policy reversals fail to induce transitions, while only large, coordinated, or external shocks can restore mobility in (r_f, p_c) space. This explains why prolonged stagnation or repression often persists despite active policy experimentation.

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4.5 Interpretation for Economic History

From a historical perspective, policy irreversibility corresponds to periods where valuation regimes become self-sustaining. Absorbing regimes mark not equilibrium success but the exhaustion of policy traction. Apparent stability masks the loss of dynamic adjustment capacity, rendering history path-dependent.

Economic history thus alternates between eras of policy effectiveness (transient regimes) and eras of policy irrelevance (absorbing or near-absorbing regimes). The transition into absorption represents a structural break in the controllability of the economic system, not merely a change in outcomes.

5 Optimal Control and Reachability in Valuation Space

The valuation-based framework admits a natural interpretation through the lens of optimal control theory. Let the state vector be

$$x_t = \begin{pmatrix} r_f(t) \\ p_c(t) \end{pmatrix},$$

and let $u_t \in \mathcal{U}$ denote a vector of policy instruments. Valuation dynamics evolve according to

$$x_t = f_{S_t}(x_{t-1}, u_t) + \varepsilon_t, \tag{23}$$

where S_t is the latent regime process and f_{S_t} is regime-specific.

5.1 Policy Objective

A policymaker is assumed to minimize an intertemporal loss functional

$$\mathcal{J}(u) = \mathbb{E} \sum_{t=0}^{\infty} \delta^t \, \ell(x_t, u_t), \tag{24}$$

where $\ell(\cdot)$ penalizes deviations from a target valuation set, typically the equilibrium manifold

$$\mathcal{E} = \{x : r_f + p_c = 0\}.$$

Optimal policy seeks not only proximity to equilibrium, but also residence in regimes where adjustment capacity is preserved.

5.2 Reachability and Controllability

Define the reachable set from initial condition x_0 under admissible policies as

$$\mathcal{R}(x_0) = \{x : \exists \{u_t\}_{t \geq 0} \text{ such that } x_t \to x\}. \tag{25}$$

A valuation regime k is said to be *reachable* from state i if

$$\Pr(S_t = k \mid S_0 = i, \{u_t\}) > 0$$

for some admissible policy sequence. Conversely, regime k is *unreachable* if no such policy exists.

5.3 Absorbing Regimes as Loss of Reachability

An absorbing regime corresponds to a collapse of the reachable set. Formally, if $S_t = k$ is absorbing, then

$$\mathcal{R}(x_t \mid S_t = k) = \{x_k\}, \tag{26}$$

a singleton set. In such regimes, valuation dynamics satisfy

$$\frac{\partial f_k(x,u)}{\partial u} = 0, \tag{27}$$

so policy instruments lose first-order influence over the state.

This represents a loss of controllability in the sense of control theory: the system remains observable but is no longer steerable.

5.4 Near-Absorption and Weak Reachability

In near-absorbing regimes, the reachable set is non-empty but extremely small:

$$\mathcal{R}(x_t) \subset B_\epsilon(x_k), \quad \epsilon \ll 1, \tag{28}$$

where B_ϵ is an ϵ-ball around the regime attractor. Optimal policy in such regimes minimizes loss locally but cannot induce regime transitions without exogenous shocks or structural changes.

This formalizes why marginal policy optimization may succeed in stabilization yet fail in historical redirection.

5.5 Regime Transitions as Control Constraints

Let $\Pi(u_t)$ denote the policy-dependent transition matrix. A regime transition $i \to j$ is feasible if

$$\exists u \in \mathcal{U} \text{ such that } \pi_{ij}(u) > 0. \tag{29}$$

Policy irreversibility corresponds to the case where

$$\sup_{u \in \mathcal{U}} \pi_{ij}(u) = 0, \tag{30}$$

rendering regime j unreachable from i under all admissible policies.

5.6 Interpretation for Economic History

From this perspective, economic history is governed not only by shocks but by the evolving reachability of valuation states. Periods of effective policy correspond to eras where the equilibrium manifold is reachable. Absorbing or near-absorbing regimes mark the exhaustion of policy control, not equilibrium success.

Historical turning points thus correspond to moments when reachability is restored or lost. Policy failure is reinterpreted as a structural loss of controllability in valuation space, rather than as suboptimal choice within a stable control environment.

6 Robust Control, Knightian Uncertainty, and Valuation Regimes

The loss of reachability and the emergence of absorbing regimes acquire their deepest interpretation when policy is conducted under *Knightian uncertainty*. In this setting, policymakers face not only stochastic shocks but also uncertainty about the true data-generating process governing valuation dynamics.

6.1 Model Uncertainty

Let valuation dynamics be given by

$$x_t = f_{S_t}(x_{t-1}, u_t, \theta) + \varepsilon_t, \tag{31}$$

where $\theta \in \Theta$ indexes a family of plausible models. Under Knightian uncertainty, the policymaker does not assign a single probability distribution over Θ but instead guards against worst-case realizations.

The policymaker's objective becomes a robust control problem:

$$\inf_{\{u_t\}} \sup_{\theta \in \Theta} \mathbb{E}^{\theta} \sum_{t=0}^{\infty} \delta^t \, \ell(x_t, u_t), \tag{32}$$

where expectations are taken under the model indexed by θ.

6.2 Valuation Distortions under Robust Control

Robust control alters valuation dynamics by inducing endogenous pessimism. In valuation space, this manifests as:

- downward distortion of $r_f(t)$ due to precautionary savings and policy conservatism,
- upward distortion of $p_c(t)$ reflecting worst-case risk assessment,
- compression of variance in $r_f(t) + p_c(t)$ as policy seeks robustness rather than efficiency.

These distortions move the system toward the equilibrium manifold not through efficiency, but through defensive valuation.

6.3 Robust Control and Near-Absorption

Under robust control, regimes that are transient under risk-based optimization may become near-absorbing. Formally, the worst-case transition matrix

$$\Pi^* = \arg\sup_{\Pi(\theta)} \mathcal{J}(u, \Pi(\theta)) \tag{33}$$

satisfies

$$\pi^*_{kk} \gg \pi_{kk}, \tag{34}$$

for regimes k characterized by low reachability and high uncertainty.

Thus, Knightian uncertainty increases regime persistence by penalizing policies that would otherwise attempt aggressive transitions.

6.4 Robust Invariance and Absorbing Sets

Define the robustly invariant set

$$\mathcal{I} = \{x : f_k(x, u, \theta) \in \mathcal{I} \ \ \forall u \in \mathcal{U}, \forall \theta \in \Theta\}. \tag{35}$$

An absorbing valuation regime corresponds to a robustly invariant set: once entered, no admissible policy can guarantee exit under all plausible models. Absorption is therefore not merely persistence, but *robust irreversibility*.

6.5 Interpretation for Economic History

In historical terms, robust control under Knightian uncertainty explains why societies remain trapped in low-rate, high-precaution regimes even when conventional models predict escape. Policy does not fail because it is poorly optimized, but because optimization is conducted against worst-case beliefs.

Financial repression, prolonged stagnation, and persistent risk aversion emerge as rational responses to model uncertainty. Apparent inefficiency is the shadow cost of robustness.

Economic history, under this lens, is shaped by shifts in perceived uncertainty sets Θ, not merely by shocks or preferences. Periods of innovation and reform correspond to contractions of Θ, restoring reachability; periods of trauma expand Θ, inducing defensive absorption.

6.6 Synthesis

Robust control completes the valuation-based theory of economic history. Equilibrium defines targets, Markov regimes define persistence, optimal control defines intent, reachability defines feasibility, and Knightian uncertainty defines caution. Absorbing regimes arise when robustness dominates ambition, rendering history path-dependent even under rational policy.

7 Epilogue: A New Paradigm in Historical Macroeconomics

This paper advances a new paradigm for historical macroeconomics grounded in valuation rather than quantities, narratives, or reduced-form correlations. By reconstructing economic history through the joint evolution of time valuation and risk valuation, history is recast as a constrained dynamical system rather than a sequence of events or equilibria.

In this framework, growth, crises, stagnation, and recovery are not primitive categories. They are emergent properties of trajectories in valuation space, shaped by equilibrium restrictions, regime persistence, policy reachability, and uncertainty. Historical regimes are neither purely structural nor purely accidental; they are probabilistic states governed by valuation dynamics and their controllability.

The paradigm departs from traditional cliometrics by treating prices and returns as carriers of historical structure rather than outcomes to be explained. It departs from conventional macro-history by replacing narrative coherence with state-space discipline. And it departs from standard macroeconomic theory by recognizing that policy effectiveness is conditional on reachability, which itself is eroded by irreversibility and Knightian uncertainty.

Economic history, under this view, is not the history of what societies chose, nor of what they produced, but of what they were able to value, insure, and control. Absorbing regimes mark not equilibrium success but the exhaustion of adjustment mechanisms. Robust policy responses, far from guaranteeing escape, may rationally entrench historical paths.

This valuation-based approach does not seek to replace existing methods. It reorganizes them around a minimal, interpretable set of state variables that unify finance, macroeconomics, control theory, and history. In doing so, it offers a coherent language for comparing eras, diagnosing persistence, and understanding why history so often resists intentional redirection.

If macroeconomics is the study of constraints on collective choice over time, then historical macroeconomics, properly conceived, is the study of how those constraints evolve. This paper proposes valuation dynamics as the natural coordinates of that evolution.

8 Counterfactual Closing: What If History Were DSGE?

To clarify the distinctiveness of the proposed paradigm, it is useful to consider a counterfactual: how economic history would appear if written entirely within the standard DSGE framework.

In a DSGE history, economies fluctuate around a stable equilibrium defined by preferences, technology, and constraints. Shocks are exogenous, regimes are rare, and policy is always well-defined as an intertemporal optimization problem. Persistence reflects slow adjustment or frictions, not structural loss of control. History, in this view, is a sequence of deviations from an underlying timeless structure.

By contrast, the valuation-based framework developed here rejects the presumption of a globally stable equilibrium. Time valuation and risk valuation are themselves historical objects, not fixed parameters. Shocks do not merely displace the economy from equilibrium; they reshape the valuation landscape and alter which states are reachable. Policy does not operate in a fixed control environment but within one that evolves, sometimes irreversibly.

In DSGE history, stagnation is a puzzle requiring additional frictions. In the present framework, stagnation emerges naturally as a near-absorbing valuation regime under robust control. In DSGE history, policy failure implies suboptimal choice. Here, failure often reflects the loss of reachability under Knightian uncertainty. In DSGE history, persistence is accidental. Here, persistence is structural.

Most importantly, DSGE history treats expectations as model-consistent beliefs within a known structure. This framework treats expectations as endogenous valuation forces whose dispersion and pessimism can themselves close off historical paths. What appears as inefficiency in DSGE becomes rational defensiveness once uncertainty about the model itself is acknowledged.

This contrast does not imply that DSGE models are incorrect. It implies that they are incomplete as historical objects. They describe economies as they would evolve if structure were stable, control were intact, and uncertainty were probabilistic. Economic history, however, is largely the record of periods when one or more of these conditions failed.

The valuation-based paradigm proposed here offers a complementary lens: one that explains not only how economies fluctuate, but why they sometimes become trapped, why policy traction decays, and why history so often appears path-dependent despite rational behavior. In this sense, it is not an alternative macroeconomic model, but an alternative conception of what it means to do macroeconomics historically.

The End