

**The Structural Architecture of Modern
Economics**
— *Analytical Ruptures and the Organization
of Economic Knowledge*

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Preface

This paper develops a structural framework for organizing the evolution of modern economic thought through a sequence of constraint-transforming contributions. Its focus is conceptual: to define and integrate a set of arcs that capture distinct modes of analytical expansion and to characterize their cross-arc interactions.

The framework presented here constitutes the foundational layer of a broader research program. Complementary work develops a network-based representation of idea propagation across contributions, providing a formal mapping of influence and methodological transmission. A separate book-length treatment extends the framework to a comprehensive exposition of the Nobel-era architecture of economic thought.

The separation between the structural framework and its network representation is deliberate. While the present paper focuses on the definition and integration of arcs as a minimal organizational structure, the network analysis operates at a different level, capturing patterns of influence and diffusion that are not reducible to the arc classification itself.

This distinction ensures analytical clarity: the arcs define the space of transformations, while networks describe how those transformations propagate.

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Abstract

This paper proposes a theory of the structure of economic knowledge for organizing modern economics based on analytical ruptures. Rather than classifying the discipline by topics, methods, or historical schools, it identifies a set of thirteen irreducible domains of reasoning, each defined by a distinct configuration of problems and constraints. Contributions are assigned to domains according to the constraint they transform, yielding a non-overlapping classification of economic knowledge.

The framework is used to map the evolution of the discipline, showing that major analytical ruptures emerge in a staggered and overlapping manner. This pattern implies that economics develops not through the replacement of dominant approaches, but through the accumulation of analytical capabilities, as new constraints are incorporated into existing structures.

A central contribution of the paper is to characterize how ideas propagate across domains. It distinguishes between formal, methodological, and interpretive channels of influence, providing a structured account of cross-domain interactions. This yields a representation of economics as a networked system of analytical transformations, in which different domains play distinct functional roles.

Taken together, the framework offers a unified perspective on the organization and evolution of economic reasoning, complementing existing classifications such as the JEL system while addressing their limitations in capturing analytical structure.

Keywords: analytical structure; economic methodology; classification of economics; analytical ruptures; knowledge architecture; cross-domain influence

JEL Classification: A10, B41, B00, A12



1. Introduction

Modern economics is a highly successful but increasingly fragmented discipline. Over the past century, it has expanded through a sequence of major theoretical, empirical, and institutional innovations, each addressing distinct problems under different analytical conditions. Yet there is no widely accepted framework that organizes these contributions into a coherent structure. The discipline is typically classified along three dimensions—fields (such as industrial organization, labor, or macroeconomics), methods (theoretical versus empirical), or historical schools (Keynesian, neoclassical, behavioral). While useful for specific purposes, these classifications overlap, evolve over time, and do not provide a stable account of how economic reasoning is structured.

This paper proposes a different organizing principle. It argues that modern economics is best understood as a system of analytical transformations, each defined by a distinct configuration of problems and constraints. These transformations—referred to here as *analytical ruptures*—expand the set of problems that can be rigorously analyzed by modifying the conditions under which economic reasoning operates. Examples include the formalization of economic systems, the introduction of strategic interaction, the incorporation of asymmetric information, the recognition of limits to rationality, and the development of credible empirical identification. Each of these shifts changes not only what can be analyzed, but also how analysis is conducted and what constitutes a valid explanation.

Building on this idea, the paper develops a structural architecture of the discipline composed of thirteen analytically distinct domains, or *arcs*. Each arc corresponds to a specific rupture and is characterized by a core problem, a binding constraint, and a transformation that relaxes or redefines that constraint. The arcs are constructed to be irreducible and non-overlapping: a contribution belongs to a given arc not because of the topic it studies, but because of the analytical structure it embodies. This yields a disciplined partition of the space of economic reasoning, in contrast to existing classifications that allow for multiple simultaneous assignments without a clear hierarchy.

The framework is then used to map the evolution of modern economics. Using Nobel-recognized contributions as a disciplined proxy for major analytical advances, the paper shows that these ruptures emerge over time in a staggered and overlapping manner. The resulting pattern is not one of sequential replacement, but of cumulative expansion: earlier analytical structures persist while new ones extend the range of problems that can be addressed. This perspective shifts the interpretation of the discipline from a sequence of paradigms or fields to a layered system of coexisting modes of reasoning.

A central contribution of the paper is to characterize how ideas propagate across these domains. While each contribution has a unique primary location, its influence may extend to other arcs through distinct channels. The framework distinguishes between formal influence, which transfers theoretical structures; methodological influence, which transfers empirical and



identification tools; and interpretive influence, which reshapes how economic phenomena are understood. This distinction allows the discipline to be represented as a networked system, in which different domains play complementary roles in the production and diffusion of knowledge.

The contribution of the paper is therefore twofold. First, it provides a non-overlapping analytical classification of modern economics based on constraint-defined transformations. Second, it introduces a structured account of cross-domain propagation, clarifying how different types of contributions interact within the discipline. Together, these elements offer a unified perspective on both the organization and the evolution of economic thought.

This perspective has several implications. It provides a basis for evaluating contributions in terms of the constraints they transform rather than their field of application, offers a way to organize economic knowledge around a set of irreducible questions, and clarifies the relationships between areas that are often treated as separate. More broadly, it suggests that the coherence of economics lies not in a shared subject matter or method, but in the structure of its analytical transformations.

Organizing economic thought around constraint transformations provides a structured map of how the discipline evolves. For research, it clarifies the frontier by identifying which constraints remain binding and which have been relaxed. For teaching, it offers a coherent architecture that connects otherwise fragmented contributions. For knowledge organization, it enables systematic comparison across contributions that operate in different domains but share common structural logic. In this sense, the framework functions not only as a classification, but as a tool for navigating the evolution of economic ideas.

The proposed classification is not intended to exhaust all possible dimensions of economic thought. Rather, it provides a minimal and non-overlapping partition based on constraint transformations, designed to isolate the primary structural contribution of each work. Alternative classifications—by method, topic, or school—remain valid, but operate along different dimensions. The present framework focuses specifically on how economic contributions relax, redefine, or reconfigure constraints within the system.

The remainder of the paper is organized as follows. Section 2 situates the framework within existing approaches to classifying economic knowledge. Section 3 introduces the analytical foundations of the framework. Section 4 presents the thirteen arcs. Section 5 maps the evolution of the discipline over time. Section 6 analyzes cross-arc influence. Section 7 reformulates the framework as a set of fundamental questions. Section 8 concludes.



2. Existing Classifications and Methodological Position

2.1 Existing Classifications and Related Approaches

The organization of economic knowledge has traditionally relied on classifications based on topics, methods, or intellectual traditions. These approaches are widely used in research, teaching, and publication, and each serves an important practical function. However, none provides a framework that captures the analytical structure of the discipline.

The most prominent classification system is the Journal of Economic Literature (JEL) taxonomy, which organizes research into a hierarchical set of subject categories. The JEL system is highly effective for indexing and retrieval, and its flexibility allows contributions to be associated with multiple codes, reflecting the multidimensional nature of economic problems. At the same time, JEL categories are not designed to be analytically irreducible. A single contribution may span several codes, combining theory, empirics, and multiple domains. The JEL system therefore identifies *where* research is located, but not *how* economic reasoning is structured.

A second approach organizes economics by fields of application, such as industrial organization, labor, macroeconomics, or development. While useful in practice, field-based classifications are inherently overlapping and unstable. Analytical tools and conceptual innovations routinely cross field boundaries, and those boundaries evolve over time. Fields therefore do not provide a stable partition of the discipline, nor do they distinguish contributions based on their underlying analytical structure.

A third strand provides historical and interpretive accounts of economic thought, associated with authors such as Joseph Schumpeter and Mark Blaug. These accounts trace the development of ideas through schools and traditions, offering valuable context. However, their classifications are narrative and context-dependent, and do not yield a structure that can organize contributions independently of their historical setting.

More abstract perspectives arise in the philosophy of science, particularly in the work of Thomas Kuhn and Imre Lakatos. These approaches emphasize paradigm shifts and research programs as drivers of scientific progress. While they highlight the role of conceptual change, they do not identify the specific constraints that define different forms of economic reasoning, nor do they provide criteria for partitioning contributions into analytically distinct domains.

Taken together, these approaches classify economic knowledge by topic, method, or historical context, but they do not yield a non-overlapping structure of economic reasoning. This limitation motivates a shift in perspective:

from classifying what economics studies to classifying how economic problems are structured.



A detailed mapping between the proposed arcs and the Journal of Economic Literature (JEL) classification system is provided in the Appendix, illustrating how the structural framework relates to, and differs from, existing topic-based taxonomies.

2.2 Contribution of This Paper

This paper proposes a framework that classifies economic reasoning by its analytical structure. Contributions are organized according to the problems they address, the constraints that define those problems, and the transformations that relax those constraints.

This perspective yields a set of domains—the thirteen arcs—that are irreducible and non-overlapping. Each contribution is assigned to a single arc based on the structure of its analytical rupture, rather than its field of application or methodological approach. The result is a disciplined partition of the discipline, in contrast to existing classifications that allow multiple simultaneous assignments without a unifying principle.

The framework also introduces a structured account of how ideas propagate across domains. By distinguishing between formal, methodological, and interpretive channels of influence, it represents economics as a networked system of analytical transformations, rather than a collection of loosely connected fields.

Importantly, this framework is complementary to existing systems. The JEL classification remains indispensable for indexing and retrieval, and field-based classifications remain useful for organizing applications. The contribution of the present paper is to provide a conceptual map of economic reasoning, clarifying its internal structure and its modes of evolution.

2.3 Methodological Position of This Paper

This paper does not aim to provide a history of economic thought in the conventional sense. Its objective is to reconstruct the structural transformations that have shaped modern economic reasoning.

The unit of analysis is the *analytical rupture*—a contribution that changes what constitutes a valid question, an acceptable explanation, or a tractable object of analysis.

In this respect, the paper is situated between two traditions in the philosophy of science. From Thomas Kuhn, it adopts the idea that progress involves discontinuities that redefine the space of meaningful inquiry. From Imre Lakatos, it adopts the view that knowledge evolves through overlapping research programs, in which new frameworks incorporate and reinterpret existing ones rather than replacing them entirely.

The resulting structure is neither a sequence of isolated revolutions nor a smooth accumulation of results. The framework therefore adopts a structural–evolutionary view of economic



knowledge, in which progress is driven by constraint-transforming ruptures that accumulate as layered components of a coherent analytical system.

This perspective is consistent with the evolutionary view of economic analysis associated with Joseph Schumpeter, and with the distinction emphasized by Mark Blaug between contributions that refine existing frameworks and those that alter the structure of the discipline.

Within this framework, the arcs do not correspond to fields or schools of thought. Each arc represents a distinct dimension of economic reasoning, defined by a fundamental question and a corresponding constraint structure.

The notion of analytical rupture developed here differs from Kuhnian paradigm shifts in that ruptures do not entail the replacement of prior frameworks, but their accumulation. Earlier analytical structures remain valid within their domains and are recursively embedded in later analytical structures. In this sense, the framework is closer to a Lakatosian view of progressive expansion, in which new analytical capabilities extend the set of tractable problems without rendering previous ones obsolete. The arc structure can therefore be understood as a layered system of coexisting domains, rather than a sequence of mutually exclusive paradigms.

2.4 Summary

Existing approaches classify economic knowledge by topic, method, or historical development. This paper classifies it by analytical structure. This shift allows the discipline to be represented as a non-overlapping system of constraint-transforming domains, providing a unified account of both its organization and its evolution. The remainder of the paper operationalizes this perspective.

Section 3 introduces the set of irreducible domains—referred to as arcs—each defined by a fundamental question and a corresponding constraint structure.

Together, they provide a minimal and non-overlapping partition of modern economic reasoning within the space of constraint transformations considered in this paper.



3. Analytical Framework

This section develops the conceptual foundations of the framework. It formalizes the basic elements of economic reasoning—problems, constraints, and analytical ruptures—and uses them to define a partition of the discipline into a set of irreducible domains.

3.1 Problems and Constraints

Economic analysis can be characterized as the study of how agents, systems, or institutions address well-defined problems under a set of constraints. A problem specifies the object of analysis—such as allocation, coordination, risk, growth, or welfare—while constraints determine the conditions under which feasible solutions can be characterized.

A constraint is defined as a structural limitation on feasible economic outcomes arising from:

- (i) technological feasibility,
- (ii) informational availability,
- (iii) strategic interdependence, or
- (iv) institutional rules.

A contribution constitutes a rupture if it endogenizes or relaxes one of these constraint classes.

These constraints extend beyond standard resource or technological limitations. More fundamentally, they include the informational, behavioral, institutional, and methodological conditions that govern what can be meaningfully analyzed. For example, the assumption of complete information permits the characterization of competitive equilibria, while asymmetric information introduces incentive compatibility constraints that alter feasible outcomes. Similarly, the assumption of full rationality enables optimization-based analysis, whereas bounded rationality requires alternative representations of behavior. On the empirical side, the absence of credible identification constrains the ability to draw causal inference, independently of the underlying theoretical model.

Constraints therefore define the analytical environment of economic reasoning. They determine not only the set of feasible outcomes, but also the class of questions that can be posed and the criteria by which answers are evaluated.

3.2 Analytical Ruptures

The central concept of the framework is that of an analytical rupture. An analytical rupture is defined as a transformation that modifies the constraint structure of analysis in a way that expands the set of problems that can be rigorously addressed.

This definition distinguishes ruptures from incremental advances. Extensions that refine existing models, broaden their applications, or improve estimation do not constitute ruptures



unless they alter the underlying constraints that define the analytical environment. By contrast, contributions such as the formalization of equilibrium, the introduction of strategic interaction, the incorporation of asymmetric information, or the development of credible identification strategies each represent ruptures because they change the conditions under which economic reasoning is valid.

Analytical ruptures have three defining properties:

1. Constraint transformation: They relax, redefine, or introduce constraints that were previously binding.
2. Expansion of scope: They enable the analysis of classes of problems that could not be rigorously addressed before.
3. Generativity: They give rise to new lines of research that apply the transformed framework across multiple domains.

These properties imply that ruptures are not merely historical events but structural changes in the logic of analysis. A key implication is that analytical ruptures are defined by irreducibility in constraint space. A contribution qualifies as a rupture only if the removal of its defining constraint eliminates the ability to explain the class of phenomena it addresses. If the same phenomena can be represented within a prior framework without invoking the new constraint, the contribution is not a rupture but an extension. This criterion provides the basis for distinguishing structural transformations from incremental advances.

3.3 Analytical Domains (Arcs)

The framework organizes analytical ruptures into a set of domains, referred to as arcs. An arc is not a field, a method, or a historical period, but a structural domain of reasoning defined by a common problem and a shared constraint system. For an arc to be valid, two conditions must hold: (i) contributions within the arc must address the same fundamental problem, and (ii) they must rely on a common constraint structure that defines the admissible set of explanations.

Formally, an arc can be represented as a triplet:

Arc = (Problem, Constraint, Rupture)

where the rupture modifies the constraint in a way that enables new forms of analysis of the underlying problem.

For example, the introduction of strategic interaction modifies the independence constraint that underlies price-taking behavior, allowing for the analysis of interdependent decision-making. The incorporation of asymmetric information introduces incentive constraints that reshape feasible allocations. The development of identification strategies alters the methodological constraints governing empirical inference.



These conditions ensure that arcs are defined by the structure of reasoning rather than by application domain, and that differences across arcs reflect differences in constraint systems rather than differences in subject matter.

3.4 Why Thirteen Arcs?

The identification of thirteen arcs is not an arbitrary classification choice, but the outcome of imposing structural constraints on how economic reasoning can be partitioned.

The construction of the arcs follows four requirements that are implicit in the framework developed in Sections 3.1–3.3.

First, irreducibility: each arc must correspond to a distinct constraint structure that cannot be decomposed into more primitive analytical domains without loss of explanatory content. If a domain can be reconstructed as a combination of other constraint structures, it does not constitute a separate arc.

Second, non-overlap: each arc must be defined by a constraint transformation that is not shared with any other arc. This ensures that contributions can be assigned a unique primary location based on the constraint they modify, rather than on thematic or methodological proximity.

Third, collective completeness: the set of arcs must span the full range of fundamental constraint transformations that define modern economic reasoning. Any major analytical rupture—understood as a transformation that expands the set of tractable problems—must be representable within at least one arc.

Fourth, minimality under coverage: the number of arcs must be the smallest set that satisfies irreducibility, non-overlap, and completeness. A smaller set would fail to represent at least one fundamental constraint transformation, while a larger set would introduce redundancy by splitting domains that share the same underlying structure.

Under these conditions, the discipline admits a minimal partition into thirteen arcs at the level of granularity considered in this paper.

This result implies that the arcs should not be interpreted as a taxonomy of topics or fields, but as a structural representation of the constraint space that defines economic reasoning.

The identification of thirteen arcs should not be interpreted as a uniquely determined outcome in a strict mathematical sense. Rather, it reflects a stable analytical resolution under the imposed criteria. Alternative partitions are possible, but they either merge structurally distinct constraint transformations or fragment coherent ones. For example, merging growth and structural transformation collapses distinct constraint structures, while separating information and incentives fragments a unified constraint domain. The thirteen-arc structure should



therefore be understood as a disciplined equilibrium of classification at a specific level of abstraction.

The proposed classification is not intended to exhaust all possible dimensions of economic thought. Rather, it provides a minimal and non-overlapping partition within the space of constraint transformations, complementing alternative classifications based on method, topic, or intellectual tradition.

3.5 Irreducibility and Non-Overlap

Given the structural requirements outlined above, a central property of the framework is that arcs be irreducible and non-overlapping.

An arc is irreducible if its defining constraint structure cannot be expressed as a combination of other arcs without loss of analytical content. Irreducibility is defined with respect to constraint space, not empirical domain. For instance, models of asymmetric information cannot be reduced to standard allocation models without eliminating the informational constraint that defines them. Similarly, bounded rationality cannot be subsumed within full optimization without altering the behavioral assumptions that characterize it.

Non-overlap follows from irreducibility. Because each arc is defined by a distinct constraint transformation, a given contribution has a unique primary location within the framework. While contributions may influence multiple domains, their classification is determined by the constraint they transform, not by the range of their applications.

This property distinguishes the framework from existing classifications and ensures that it provides a partition of the space of analytical transformations, rather than a flexible tagging system.

3.6 Cross-Domain Propagation

Although arcs are non-overlapping in their primary classification, economic ideas propagate across domains. Contributions developed in one arc may affect others by providing theoretical structures, empirical tools, or conceptual reinterpretations.

The framework distinguishes three types of propagation:

- Formal propagation, involving the transfer of theoretical structures or solution concepts;
- Methodological propagation, involving the transfer of empirical strategies or identification techniques;
- Interpretive propagation, involving changes in how problems are conceptualized or evaluated.



This distinction allows the framework to capture interconnections across domains without compromising the non-overlapping nature of the primary classification.

3.7 Operational Identification of Ruptures

To ensure that the classification is transparent and reproducible, the framework defines an explicit decision protocol for identifying analytical ruptures and assigning contributions to arcs. This protocol operationalizes the definitions of analytical ruptures (Section 3.2), analytical domains (Section 3.3), and their structural constraints (Sections 3.4–3.6).

The procedure consists of two stages: (i) rupture qualification, and (ii) arc assignment.

Stage 1: Rupture Qualification

A contribution is classified as an analytical rupture if and only if it satisfies the following three conditions jointly:

1. Constraint transformation: it introduces, relaxes, or redefines a constraint that governs the admissible set of economic explanations;
2. Expansion of scope: it enables the analysis of a class of problems that cannot be rigorously addressed under previously existing constraint structures;
3. Generativity: it gives rise to a sustained line of research applying the transformed framework across multiple contexts.

Contributions that fail any of these conditions are classified as extensions, refinements, or applications within an existing arc.

Stage 2: Arc Assignment

Conditional on qualifying as a rupture, assignment to an arc follows a four-step decision sequence.

Step 1 — Minimal contribution

Identify the minimal non-substitutable analytical innovation required to explain the relevant class of phenomena. This step isolates the core rupture from auxiliary developments or subsequent extensions.

Step 2 — Constraint characterization

Specify the constraint structure that defines the validity of the explanation. This includes identifying the binding restriction—informational, behavioral, institutional, or methodological—that must be imposed for the analysis to hold.

Step 3 — Irreducibility test

Evaluate whether the same class of phenomena can be explained within previously established arcs without invoking the identified constraint. If such a representation exists without loss of explanatory power, the candidate rupture is rejected as non-fundamental.



Step 4 — Non-substitutability criterion

If multiple arcs appear applicable, assign the contribution to the arc whose constraint structure is indispensable for the explanation. Formally, the selected arc is the one whose removal would generate the greatest loss of analytical coherence.

This protocol ensures that classification is determined by constraint structure rather than by topic, method, or interpretation. It converts the framework from a descriptive taxonomy into a rule-based assignment procedure.

3.8 Operationalization

To implement this protocol empirically, the analysis relies on the contributions of Nobel laureates as canonical reference points. This choice functions as a disciplinary device rather than a claim of exclusivity. The Nobel Prize provides an externally validated set of contributions widely recognized as introducing fundamental analytical transformations, allowing the identification of minimal rupture forms in a transparent and comparable manner.

The completeness of the arc structure is a property of the constraint space defined by the framework in Sections 3.1–3.7, and does not depend on the empirical coverage of the Nobel-based mapping. The classification itself is defined independently of this mapping, which serves only as an observable subset of contributions through which the underlying structure can be approximated.

The objective is not to provide an exhaustive account of all relevant contributions, but to construct a representative mapping of the discipline’s structural evolution. Many foundational ideas originate outside the Nobel-recognized set or are shared across multiple contributors. The Nobel-based selection is therefore best understood as a disciplined proxy for the broader development of economic thought.

This operational choice also implies the presence of structural absences: analytically relevant contributions that are not captured within the Nobel-recognized set. Such absences may arise from selection biases, disciplinary boundaries, or timing, and therefore do not reflect a lack of structural importance. Within the framework, these cases can be interpreted as unobserved or underrepresented realizations of the same constraint transformations that define the arcs. The empirical mapping should therefore be interpreted as a partial observation of a broader structural system.

3.9 Implications

By organizing economic knowledge around constraint transformations and applying an explicit assignment protocol, the framework yields a stable analytical partition of the discipline that is independent of specific applications or historical context.



This structure provides a map of how economic reasoning evolves. For research, it clarifies which constraints remain binding and where new analytical advances are most likely to emerge. For teaching, it offers a coherent architecture that connects otherwise fragmented contributions into a unified sequence of problems and solutions. More broadly, it enables systematic comparison across domains that share underlying structural logic while differing in application.

The framework also clarifies the relationships between contributions by identifying the constraints that link or separate them. In this way, the evolution of economics can be interpreted as the progressive expansion of analyzable problems through successive transformations of constraint structures.

The next section presents the thirteen arcs in condensed form, translating this analytical framework into a structured representation of the main domains of economic reasoning.

3.10 The Axiomatic Chain of Economic Reasoning

The framework developed above defines economic knowledge as a system of constraint-transforming domains.

This structure can be expressed compactly as a minimal sequence of analytical transformations, in which each step introduces the necessary conditions to address a previously intractable class of problems.

The resulting sequence—referred to as the axiomatic chain of economic reasoning—summarizes the logical architecture of the discipline.

Table 1 presents this evolution of economic knowledge through a sequence of constraint-transforming steps. Each step introduces the minimal additional structure required to make previously intractable problems analyzable. The resulting system is a chain of irreducible transformations.

Table 1 — The Axiomatic Chain of Economic Reasoning

<p>I. From Philosophy to Precision Economic reasoning requires formal representation. Without a unified mathematical structure, relationships cannot be consistently defined or analyzed.</p>
<p>II. Allocation and Market Logic Given formal representation, economic systems must explain how decentralized decisions generate coherent allocations. Equilibrium provides the mechanism linking individual behavior to aggregate outcomes.</p>
<p>III. Strategy and Interaction If agents are interdependent, allocation cannot be understood without strategic behavior. Outcomes emerge from mutually consistent expectations over others' actions.</p>



IV. Information and Incentives If information is incomplete or asymmetric, strategic interaction alone is insufficient. Feasible outcomes must satisfy incentive compatibility under private information.
V. The Limits of Rationality If agents are not fully rational, optimization-based models are incomplete. Behavior must incorporate cognitive constraints and systematic deviations.
VI. Risk, Prices, and Panic If uncertainty is fundamental, outcomes depend on how risk is priced and transmitted over time. Economic systems must incorporate stochastic valuation and intertemporal trade-offs, including instability.
VII. Expectations and the State If agents are forward-looking, outcomes depend on expectations about the future and policy. Equilibrium requires consistency between beliefs, realized outcomes, and policy rules.
VIII. The Credibility of Evidence If economic relationships are empirically observed, they must be causally identified. Inference requires credible strategies that distinguish causation from correlation.
IX. Rules, Power, and Prosperity If incentives are shaped by institutions, outcomes depend on rules and power structures. Economic behavior is embedded in governance systems that define feasible actions.
X. Economic Growth If economies evolve over time, analysis must explain sustained increases in output. Growth arises from dynamic processes of accumulation and innovation.
XI. Structural Transformation and Development If growth changes economic structure, aggregate analysis is insufficient. Development requires modeling the reallocation of resources across sectors and populations.
XII. Welfare, Human Capital, and Measurement If outcomes differ across individuals, performance must be evaluated beyond output. Welfare depends on distribution, capabilities, and multidimensional measurement.
XIII. Trade and Global Systems If economies interact globally, outcomes depend on cross-border linkages. Economic systems must incorporate international constraints, specialization, and policy interdependence.

Source: *Bank and Finance Consulting Group.*

Table 1 summarizes economics as the study of how increasingly complex constraints—formal, strategic, informational, behavioral, stochastic, institutional, and global—are successively incorporated into a unified system of reasoning about allocation, dynamics, and welfare.



4. The Thirteen Arcs of Economic Reasoning

Section 4 provides a conceptual interpretation of the arcs, following the logical sequence defined by the axiomatic chain in Section 3.10. This section presents the thirteen arcs that constitute the structural architecture of modern economics. Each arc corresponds to a distinct analytical rupture and is defined by a triplet:

(Problem, Constraint, Rupture)

The formal definition of each arc is provided in **Table 2**, which establishes the analytical foundations of the framework. The role of the present section is complementary: it offers a conceptual interpretation of these definitions, clarifying the logic of each transformation and the progression across domains.

The arcs are presented using their canonical names, which function as stable identifiers of irreducible domains of economic reasoning. These names are not descriptive labels but structural markers of distinct constraint transformations.

Each arc is summarized below with a concise characterization of its defining constraint transformation in *italics*, followed by a brief discussion of its analytical content.

Arc I — From Philosophy to Precision

Formalization of economic reasoning through mathematical representation.

Economic reasoning begins with the problem of representation: how to express economic relationships in a form that is internally consistent and analytically tractable. In the absence of a unified formal structure, analysis remains qualitative and fragmented.

The rupture consists in the introduction of mathematical formalization. Economic systems become explicitly defined objects—composed of equations, optimization problems, and probabilistic elements—enabling precision, internal consistency, and systematic analysis.

This transformation establishes the conditions under which economic systems can be analyzed rigorously. However, formal representation alone does not determine how decentralized decisions generate coherent outcomes, motivating the introduction of allocation mechanisms.

Arc II — Allocation and Market Logic

Coordination of decentralized decisions through equilibrium mechanisms.

Once economic systems are formally defined, the central question becomes how resources are allocated across agents and uses. The constraint lies in the absence of a mechanism linking decentralized decisions to aggregate outcomes.



The rupture is the formalization of equilibrium. Individual decisions, coordinated through prices, generate allocations that satisfy feasibility and optimality under well-defined conditions, linking decentralized behavior to system-wide outcomes.

This framework establishes the logic of allocation, but assumes that agents act independently as price-takers. When decisions are mutually interdependent, this assumption becomes restrictive, requiring a framework of strategic interaction.

Arc III — Strategy and Interaction

Modeling outcomes as equilibria of interdependent strategic behavior.

When agents recognize their interdependence, outcomes depend on strategic behavior rather than passive adjustment to prices. The assumption of independent decision-making becomes binding.

The rupture introduces strategic interaction. Agents form expectations about others' actions, and outcomes emerge as equilibria of mutually consistent strategies, enabling the analysis of coordination, conflict, and bargaining.

These models typically assume that the structure of interaction is fully known. When information is incomplete or asymmetric, outcomes must satisfy additional constraints beyond strategic consistency.

Arc IV — Information and Incentives

Incorporation of asymmetric information and incentive compatibility constraints.

Economic interactions frequently occur under conditions of incomplete or asymmetric information. The assumption of full information becomes untenable.

The rupture incorporates informational constraints into economic analysis. Feasible outcomes must satisfy incentive compatibility and participation conditions, fundamentally altering both allocation and institutional design.

Even with informational asymmetries explicitly modeled, agents are still assumed to behave as fully rational optimizers. Relaxing this assumption introduces a new class of constraints on behavior.

Arc V — The Limits of Rationality

Relaxation of full rationality through cognitive and behavioral constraints.

Economic analysis traditionally relies on the assumption of full rationality. This assumption becomes restrictive when behavior reflects cognitive limitations and systematic deviations from optimization.



The rupture introduces bounded rationality and behavioral constraints. Economic behavior must now account for heuristics, biases, and limited cognitive capacity, expanding the domain of analysis to observed decision-making patterns.

These behavioral considerations reshape how agents perceive and evaluate uncertainty, leading to the analysis of risk and its pricing in economic systems.

Arc VI — Risk, Prices, and Panic

Integration of uncertainty, asset pricing, and financial instability.

Economic environments are inherently uncertain, and outcomes depend on how risk is priced and transmitted over time. Deterministic representations become insufficient.

The rupture integrates uncertainty and intertemporal choice into economic analysis. Asset prices, portfolio decisions, and financial systems are characterized under stochastic processes, with mechanisms that can amplify shocks and generate endogenous instability.

These frameworks rely on forward-looking behavior at the individual level. At the aggregate level, this requires consistency between expectations and realized outcomes, particularly in the presence of policy.

Arc VII — Expectations and the State

Forward-looking behavior and policy credibility in determining outcomes.

Aggregate economic outcomes depend critically on expectations about the future, especially when policy influences behavior. Static or backward-looking representations are insufficient.

The rupture introduces forward-looking, model-consistent expectations. Economic outcomes must be consistent with agents' beliefs and with policy rules, linking expectations, credibility, and macroeconomic dynamics.

The resulting systems generate complex dynamic relationships that cannot be understood without credible empirical identification.

Arc VIII — The Credibility of Evidence

Identification of causal relationships from empirical data.

Understanding economic relationships requires distinguishing causality from correlation. Without credible identification, empirical analysis remains dependent on theoretical assumptions.

The rupture consists in the development of identification strategies and empirical methods that isolate causal relationships. Economic knowledge becomes grounded in credible variation and explicit inferential frameworks.



However, these methods often treat the underlying institutional environment as given, leaving unexplained the rules that shape incentives and outcomes.

Arc IX — Rules, Power, and Prosperity

Role of institutions and governance in shaping incentives and outcomes.

Economic outcomes are embedded in institutional and political structures. Treating these as exogenous limits the scope of analysis.

The rupture incorporates institutions, governance, and power as endogenous determinants of economic outcomes. Rules, enforcement, and political dynamics define incentives and constrain feasible allocations.

While institutional analysis explains the structure of incentives, it does not by itself account for sustained increases in aggregate output over time.

Arc X — Economic Growth

Dynamic processes generating sustained increases in output.

The central question becomes the source of sustained increases in output and productivity. Static representations of economic activity are insufficient.

The rupture introduces dynamic models of accumulation and innovation. Growth is understood as an endogenous process driven by capital, knowledge, and technological change within an intertemporal framework.

These models explain aggregate expansion, but abstract from changes in the composition of economic activity across sectors and populations.

Arc XI — Structural Transformation and Development

Reallocation of resources across sectors and stages of development.

Economic development involves shifts in the structure of production, employment, and demographics. Aggregate representations obscure these dynamics.

The rupture explicitly models structural transformation. Development is characterized as the reallocation of resources across sectors and technologies, governed by productivity differences and institutional constraints.

These transformations reshape the distribution of opportunities and outcomes, raising the question of how economic performance should be evaluated.



Arc XII — Welfare, Human Capital, and Measurement

Evaluation of outcomes beyond output, including distribution and capabilities.

Evaluating economic outcomes requires criteria that extend beyond aggregate output. Narrow measures of welfare become limiting.

The rupture expands welfare analysis to include human capital, capabilities, distribution, and multidimensional measurement. Economic evaluation incorporates broader notions of well-being and intergenerational considerations.

Such evaluation within closed systems is incomplete when economies interact across borders.

Arc XIII — Trade and Global Systems

Cross-border interactions and global constraints on economic outcomes.

Economic systems interact through trade, capital flows, and global linkages. Closed-economy frameworks are insufficient to capture these interactions.

The rupture extends economic reasoning to the global domain. Outcomes are shaped by international constraints, specialization, and policy interactions across countries.

Globalization introduces new forms of interdependence that cannot be reduced to domestic equilibrium frameworks, pointing toward the possibility of future constraint transformations.

This conceptual structure is formalized in **Table 2**, which defines each arc through three elements: the core problem it addresses, the constraints that govern feasible analysis, and the structural rupture that differentiates it from other arcs. This table establishes the analytical foundations of the framework and ensures that each arc is non-overlapping and non-substitutable.

Table 2 — The Thirteen Arcs of Modern Economics: Problems, Constraints, and Structural Ruptures

Arc	Core Problem	Constraint Structure	Structural Rupture
Arc I — From Philosophy to Precision	How can economic relationships be represented in a formally analyzable way?	Economic systems must be expressed as mathematical objects combining structural equations, optimization, and probabilistic elements.	Economic reasoning becomes a formally specified system in which behavior, equilibrium conditions, and stochastic elements are represented within a unified mathematical structure.
Arc II — Allocation and Market Logic	Under what conditions do decentralized systems yield coherent and	Allocation outcomes must satisfy equilibrium consistency, feasibility, and optimality conditions	Economic systems can be characterized by equilibrium allocations that satisfy feasibility and optimality conditions, linking



	efficient allocations?	under complete markets and given preferences.	decentralized interactions to coherent allocation outcomes.
Arc III — Strategy and Interaction	How do outcomes emerge when agents act strategically rather than as price-takers?	Agents choose actions while anticipating the actions of others, and outcomes must be mutually consistent across strategies.	Economic outcomes are determined as equilibria of strategic interaction in which each agent's behavior is defined relative to the anticipated behavior of others.
Arc IV — Information and Incentives	How do asymmetric information and hidden actions affect economic outcomes?	Information is incomplete or asymmetric, and feasible outcomes must satisfy incentive compatibility and participation constraints.	Economic systems must be designed or characterized subject to informational constraints, where feasible outcomes are those consistent with agents' incentives and private information.
Arc V — The Limits of Rationality	What happens when agents do not conform to full rationality?	Decision-making is bounded by cognitive limitations, heuristics, and systematic deviations from optimization.	Economic behavior cannot be fully characterized by unconstrained optimization and must incorporate systematic deviations arising from bounded rationality.
Arc VI — Risk, Prices, and Panic	How are risk and uncertainty priced and how do they affect system stability?	Outcomes depend on stochastic processes, intertemporal trade-offs, and market structures that may amplify or propagate shocks.	Economic systems must incorporate stochastic valuation and intertemporal pricing of risk, with market structures that can generate endogenous volatility and instability.
Arc VII — Expectations and the State	How do expectations about the future shape economic outcomes and policy effectiveness?	Agents form expectations about future variables, and outcomes must be consistent with those expectations and with policy rules.	Macroeconomic outcomes are determined by forward-looking expectations that must be internally consistent with the structure of the economy and the behavior of policy.
Arc VIII — The Credibility of Evidence	How can economic relationships be empirically identified and validated?	Empirical inference must distinguish causal relationships from correlations using explicit identification strategies and credible variation.	Economic knowledge must be grounded in empirically credible identification strategies that establish causal relationships within or across models.
Arc IX — Rules, Power, and Prosperity	How do institutions and power structures shape	Economic behavior is embedded in institutional rules, governance structures, and	Economic outcomes are determined by institutional and political structures that define the rules of



	economic outcomes?	distributions of power that constrain feasible outcomes.	interaction and the distribution of power.
Arc X — Economic Growth	What determines sustained increases in output and productivity over time?	Growth depends on capital accumulation, technological change, and knowledge dynamics within an intertemporal framework.	Long-run economic growth is driven by mechanisms of capital accumulation and endogenous technological change within a dynamic system.
Arc XI — Structural Transformation and Development	How do economies transition across sectors and stages of development?	Labor allocation, sectoral productivity differences, and demographic and social structures constrain the transformation process.	Economic development involves structural reallocation of resources across sectors, governed by differences in productivity and institutional constraints.
Arc XII — Welfare, Human Capital, and Measurement	How should economic well-being be defined, measured, and evaluated?	Welfare depends on multidimensional outcomes, human capital accumulation, and measurement frameworks beyond income.	Economic evaluation must extend beyond output to incorporate human capabilities, distributional outcomes, and multidimensional measures of well-being.
Arc XIII — Trade and Global Systems	How do economies interact in a global system of exchange?	International outcomes depend on factor endowments, trade costs, scale effects, and macroeconomic and monetary constraints across countries.	Economic outcomes are shaped by global interactions in which trade, specialization, and international constraints determine patterns of production and exchange.

Source: Bank and Finance Consulting Group.

Interpretation

The thirteen arcs define a set of irreducible analytical domains, each corresponding to a distinct transformation of constraint structures. They do not represent fields or topics, but ways of formulating and solving economic problems.

Their non-overlapping nature follows from the irreducibility of the constraints they modify. The arcs are neither sequential nor hierarchical; they emerge over time and coexist as complementary layers of analysis.

The next section operationalizes this framework by mapping canonical contributions into the arcs and tracing their emergence over time.

5. Mapping the Discipline: Assignment and Evolution

The analytical framework developed in the previous sections defines a non-overlapping classification of economic reasoning based on constraint-transforming ruptures. The temporal emergence of these contributions follows the structure of the axiomatic chain presented in Table 1, with different arcs appearing as successive transformations of the constraint space. This section operationalizes that framework by (i) illustrating how contributions are assigned to arcs, and (ii) mapping their emergence over time. The objective is to show that the proposed structure is both internally consistent and empirically grounded.

5.1 Mapping of Contributions

Building on the Arc classification principle, **Table 3** presents a mapping of canonical contributions of the 99 Nobel Prize-recognized Laureates into the thirteen arcs. Each laureate is mapped to a single arc corresponding to the locus of their primary contribution, ensuring a disciplined and non-redundant classification of the evolution of economic thought. This mapping can be interpreted as an empirical realization of the axiomatic chain, where each laureate's contribution corresponds to a specific stage in the expansion of analyzable economic problems.

Table 3 — Nobel Laureates Across the Thirteen Arcs of Modern Economics

Arc	No.	Laureate	Canonical Contribution (Year)	Nobel
ARC I — From Philosophy to Precision	1	Ragnar Frisch	1926	1969
	2	Jan Tinbergen	1936	1969
	3	John Hicks	1932	1972
	4	Paul Samuelson	1938	1970
	5	Trygve Haavelmo	1943	1989
	6	Lawrence Klein	1950	1980
ARC II — Allocation and Market Logic	7	Leonid Kantorovich	1939	1975
	8	Maurice Allais	1943	1988
	9	Tjalling Koopmans	1951	1975
	10	Kenneth Arrow	1951	1972
	11	Gérard Debreu	1954	1983
ARC III — Strategy and Interaction	12	John Nash	1950	1994
	13	John Harsanyi	1953	1994
	14	Reinhard Selten	1965	1994
	15	Thomas Schelling	1960	2005
	16	Robert Aumann	1959	2005
	17	Lloyd Shapley	1953	2012
ARC IV — Information and Incentives	18	Leonid Hurwicz	1960	2007
	19	William Vickrey	1961	1996



	20	James Mirrlees	1971	1996
	21	George Akerlof	1970	2001
	22	Michael Spence	1973	2001
	23	Joseph Stiglitz	1975	2001
	24	Roger Myerson	1979	2007
	25	Eric Maskin	1999	2007
	26	Bengt Holmström	1979	2016
	27	Oliver Hart	1986	2016
	28	Jean Tirole	1993	2014
	29	Alvin Roth	1984	2012
	30	Robert Wilson	1969	2020
	31	Paul Milgrom	1982	2020
ARC V — The Limits of Rationality	32	Herbert Simon	1947	1978
	33	Daniel Kahneman	1979	2002
	34	Richard Thaler	1985	2017
ARC VI — Risk, Prices, and Panic	35	Harry Markowitz	1952	1990
	36	Franco Modigliani	1954	1985
	37	Merton Miller	1958	1990
	38	James Tobin	1958	1981
	39	William Sharpe	1964	1990
	40	Eugene Fama	1970	2013
	41	Robert Shiller	1981	2013
	42	Robert Merton	1969	1997
	43	Myron Scholes	1973	1997
	44	Douglas Diamond	1983	2022
	45	Philip Dybvig	1983	2022
	46	Ben Bernanke	1983	2022
ARC VII — Expectations and the State	47	Milton Friedman	1957	1976
	48	Edmund Phelps	1961	2006
	49	Robert Lucas	1972	1995
	50	Finn Kydland	1977	2004
	51	Edward Prescott	1977	2004
	52	Thomas Sargent	1979	2011
	53	Christopher Sims	1980	2011
	54	Peter Diamond	1965	2010
	55	Dale Mortensen	1970	2010
	56	Christopher Pissarides	1985	2010
ARC VIII — The Credibility of Evidence	57	Richard Stone	1947	1984
	58	Wassily Leontief	1941	1973
	59	Daniel McFadden	1974	2000
	60	James Heckman	1976	2000
	61	Vernon Smith	1962	2002
	62	Clive Granger	1969	2003
	63	Robert Engle	1982	2003
	64	Lars Hansen	1982	2013



	65	David Card	1990	2021
	66	Joshua Angrist	1990	2021
	67	Guido Imbens	1994	2021
	68	Michael Kremer	1993	2019
	69	Esther Duflo	2001	2019
	70	Abhijit Banerjee	2011	2019
ARC IX — Rules, Power, and Prosperity	71	Friedrich Hayek	1931	1974
	72	Gunnar Myrdal	1944	1974
	73	Ronald Coase	1937	1991
	74	George Stigler	1961	1982
	75	James Buchanan	1962	1986
	76	Robert Fogel	1964	1993
	77	Douglass North	1981	1993
	78	Oliver Williamson	1975	2009
	79	Elinor Ostrom	1990	2009
	80	Daron Acemoglu	2001	2024
	81	James Robinson	2001	2024
	82	Simon Johnson	2001	2024
ARC X — Economic Growth	83	Robert Solow	1956	1987
	84	Paul Romer	1986	2018
	85	Philippe Aghion	1992	2025
	86	Peter Howitt	1992	2025
	87	Joel Mokyr	1990	2025
ARC XI — Structural Transformation and Development	88	Arthur Lewis	1954	1979
	89	Simon Kuznets	1955	1971
	90	Claudia Goldin	1990	2023
ARC XII — Welfare, Human Capital, and Measurement	91	Theodore Schultz	1961	1979
	92	Gary Becker	1964	1992
	93	Amartya Sen	1981	1998
	94	Angus Deaton	1974	2015
	95	William Nordhaus	1977	2018
ARC XIII — Trade and Global Systems	96	Bertil Ohlin	1933	1977
	97	James Meade	1951	1977
	98	Robert Mundell	1961	1999
	99	Paul Krugman	1979	2008

Source: Bank and Finance Consulting Group.

This mapping illustrates a key property of the framework: a disciplined, non-overlapping assignment in which each contribution has a unique primary location. While many contributions are relevant to multiple areas of economics, their classification is determined by the constraint they transform.

5.2 Borderline Cases and Assignment Discipline

While most contributions admit a clear primary classification under the proposed protocol, some cases lie at the boundary between multiple arcs. These borderline cases provide a useful



test of the discipline imposed by the framework, as they require distinguishing between closely related constraint structures.

Three illustrative examples highlight how the assignment rule operates under such conditions.

First, the classification of Milton Friedman in Arc VII (Expectations and the State) rather than in Arc IX (Rules, Power, and Prosperity) or Arc VI (Risk, Prices, and Panic) reflects the nature of the constraint transformation introduced by his work. Friedman's contribution lies in linking expectations formation to macroeconomic policy, particularly through the permanent income hypothesis and the natural rate framework. While his work has implications for consumption smoothing and institutional design, its primary analytical rupture concerns the role of expectations in determining aggregate outcomes under policy regimes. The assignment therefore follows the constraint modified, rather than the range of applications.

Second, the placement of Ben Bernanke in Arc VI (Risk, Prices, and Panic) rather than in Arc VII or Arc IX reflects the centrality of financial amplification mechanisms in his work. The financial accelerator framework and related contributions identify how shocks are propagated and magnified through credit markets, introducing a constraint transformation in the pricing and transmission of risk. Although these mechanisms interact with macroeconomic policy and institutional structures, the primary rupture lies in the characterization of financial instability, which places the contribution within Arc VI.

Third, the classification of Herbert Simon in Arc V (The Limits of Rationality) highlights the distinction between primary and secondary influence. Simon's introduction of bounded rationality constitutes a direct transformation of the behavioral constraint underlying economic decision-making. At the same time, this transformation has wide-ranging implications across multiple arcs, influencing models of strategy, information, and institutional design. Within the present framework, such pervasive influence is captured through cross-arc propagation rather than through multiple primary assignments. The requirement of non-overlap therefore implies a unique primary classification, even when secondary influence is extensive.

These cases illustrate the discipline imposed by the assignment rule. Classification is determined by the constraint structure that is directly transformed, not by the breadth of applications or subsequent influence. As a result, even contributions that operate at the intersection of multiple domains admit a unique primary location within the arc structure, while their broader impact is captured through the network of cross-arc relationships.

In this sense, borderline cases do not weaken the classification, but provide the most stringent test of its internal consistency.

5.3 Consolidated Mapping of Nobel Laureates (1969-2025)

This framework is deepened at the level of individual contributions. **Table 4** provides a structured interpretation of each laureate's core intellectual rupture, linking their work to



specific constraints, conceptual innovations, and analytical mechanisms. This table transforms the classification from a static mapping into a detailed analytical account of how each contribution reshaped economic reasoning.

Table 4 operationalizes the arc-based classification by mapping each contribution to its primary constraint transformation and its secondary influences across arcs. The primary assignment reflects the domain in which the contribution introduces a structural rupture, while secondary influences capture how the same contribution propagates into other domains. This distinction allows the framework to preserve a non-overlapping classification while explicitly representing cross-arc interactions.

Table 4 — Structural Ruptures in Modern Economics: Analytical Interpretation of the Nobel Laureates (1969–2025)

ARC I — From Philosophy to Precision: The formalization of economic reasoning under mathematical and probabilistic constraints, where economic systems become analyzable as structured, estimable, and solvable models.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
1	Ragnar Frisch	1969	Economic systems must be formulated under structural and stochastic constraints , where relationships between endogenous variables and random disturbances jointly determine observable outcomes.	Foundations of econometrics; dynamic modeling.	Structural vs. reduced form, stochastic disturbances, econometrics.
2	Jan Tinbergen	1969	Economic systems must be characterized under simultaneous equation constraints , where determinacy depends on the dimensional consistency between equations, endogenous variables, and policy instruments.	Macroeconometric modeling; policy systems.	Simultaneous equations, identification, policy instruments.
3	John Hicks	1972	Economic equilibria must be determined under system-wide consistency constraints , where interdependent markets jointly satisfy equilibrium conditions governing prices and quantities.	General equilibrium; IS–LM framework.	Interdependent markets, equilibrium system, comparative statics.
4	Paul Samuelson	1970	Economic behavior must be derived under constrained optimization frameworks ,	Foundations of modern microeconomics;	Constrained optimization, comparative

			where equilibrium and comparative statics follow from the structure of objective functions and constraints.	revealed preference.	statics, revealed preference.
5	Trygve Haavelmo	1989	Economic relationships must be expressed under probabilistic constraints , where valid inference requires explicit specification of the joint distribution governing economic variables.	Probability approach to econometrics; identification.	Joint distributions, identification, statistical inference.
6	Lawrence Klein	1980	Macroeconomic systems must be implemented under large-scale structural constraints , where policy analysis depends on the joint estimation and simulation of interconnected behavioral equations.	Large-scale macroeconomic models; policy simulation.	Macroeconometric systems, simulation, structural estimation.

ARC II — Allocation and Market Logic: The determination of resource allocation under feasibility, convexity, intertemporal, and aggregation constraints, where efficiency emerges as a property of constrained systems.

No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
7	Leonid Kantorovich	1975	Resource allocation must be determined under feasibility constraints , where optimal allocations and shadow prices emerge from constrained optimization problems.	Linear programming; optimal allocation.	Feasibility, shadow prices, duality.
8	Maurice Allais	1988	Allocation must be characterized under intertemporal and uncertainty constraints , where decisions over time and risk jointly determine efficient outcomes.	Intertemporal equilibrium; decision under risk.	Intertemporal choice, uncertainty, capital allocation.
9	Tjalling Koopmans	1975	Allocation must be determined under intertemporal feasibility constraints , where optimal economic paths arise from forward-looking optimization over time.	Optimal growth theory; activity analysis.	Optimal paths, intertemporal optimization, dynamic efficiency.

10	Kenneth Arrow	1972	Allocation must be characterized under feasibility and aggregation constraints , where equilibrium existence coexists with fundamental limits on consistent collective decision-making.	General equilibrium; social choice theory.	Equilibrium existence, Pareto efficiency, impossibility theorem.
11	Gérard Debreu	1983	Allocation must be expressed under axiomatic consistency constraints , where equilibrium emerges from abstract conditions on preferences, technology, and feasibility independent of economic interpretation.	Axiomatic general equilibrium theory.	Convexity, fixed-point theorems, axiomatic equilibrium.
ARC III — Strategy and Interaction: The determination of economic outcomes under strategic interdependence, where equilibrium emerges from agents' beliefs, incentives, and constraints on coordination, credibility, and coalition formation.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
12	John Nash	1994	Economic outcomes must be determined under strategic interdependence constraints , where equilibrium arises as a fixed point of mutually consistent best responses.	Non-cooperative game theory; equilibrium analysis.	Nash equilibrium, best response, mixed strategies, fixed point.
13	John Harsanyi	1994	Strategic interaction must be characterized under incomplete information constraints , where equilibrium behavior depends on beliefs over types and common priors.	Bayesian games; incomplete information.	Types, beliefs, Bayesian equilibrium, common prior.
14	Reinhard Selten	1994	Equilibrium must be refined under credibility constraints , where only strategies consistent with sequential rationality are admissible.	Subgame perfection; equilibrium refinements.	Subgame perfect equilibrium, trembling-hand perfection, credibility.
15	Thomas Schelling	2005	Strategic outcomes must be determined under coordination constraints , where focal points and commitment devices shape expectations and equilibrium selection.	Strategic behavior; coordination and conflict.	Focal points, commitment, coordination, expectations.

16	Robert Aumann	2005	Strategic interaction must be characterized under repetition and common knowledge constraints , where long-run incentives and shared beliefs sustain equilibrium outcomes.	Repeated games; common knowledge.	Repeated equilibrium, common knowledge, folk theorem.
17	Lloyd Shapley	2012	Economic outcomes must be determined under coalition formation constraints , where stability depends on the absence of profitable deviations by groups of agents.	Cooperative game theory; matching theory.	Core, Shapley value, stable matching, coalition stability.

ARC IV — Information and Incentives: The determination of economic outcomes under asymmetric information, where incentive compatibility, revelation, and contractual feasibility constrain allocation, coordination, and institutional design.

No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
18	Leonid Hurwicz	2007	Economic institutions must be formulated under informational decentralization constraints , where feasible allocations depend on mechanisms that align incentives with privately held information.	Foundations of mechanism design.	Mechanism design, incentive compatibility, decentralization.
19	William Vickrey	1996	Allocation mechanisms must be determined under private information constraints , where truthful revelation is achieved through incentive-compatible payment rules.	Auction theory; pricing under private values.	Truthful revelation, second-price auction, dominant strategy.
20	James Mirrlees	1996	Redistribution must be characterized under hidden ability constraints , where feasible tax systems balance equity and efficiency through incentive-compatible schedules.	Optimal taxation; asymmetric information in redistribution.	Hidden types, incentive compatibility, optimal taxation.
21	George Akerlof	2001	Markets must be determined under hidden quality constraints , where adverse selection can eliminate high-quality participation and prevent efficient trade.	Market for lemons; quality uncertainty.	Adverse selection, asymmetric information, market unraveling.

22	Michael Spence	2001	Market outcomes must be characterized under signaling constraints , where informed agents use costly actions to separate types and influence equilibrium beliefs.	Signaling theory; labor markets.	Signaling, separating equilibrium, costly signals.
23	Joseph Stiglitz	2001	Economic interactions must be determined under screening constraints , where uninformed agents design menus to induce self-selection among heterogeneous types.	Screening theory; credit markets.	Screening, self-selection, information asymmetry.
24	Roger Myerson	2007	Mechanism design must be characterized under Bayesian incentive constraints , where optimal allocation rules are derived from agents' private information and strategic behavior.	Optimal auction theory; revelation principle.	Bayesian incentive compatibility, revelation principle, optimal auctions.
25	Eric Maskin	2007	Institutional outcomes must be determined under implementation constraints , where only allocations consistent with equilibrium behavior can be sustained by a given mechanism.	Implementation theory.	Nash implementation, Maskin monotonicity, feasibility.
26	Bengt Holmström	2016	Contracts must be designed under hidden action constraints , where incentives depend on the informativeness of observable signals about unobservable effort.	Principal–agent theory.	Moral hazard, informativeness principle, incentive design.
27	Oliver Hart	2016	Economic organization must be characterized under contract incompleteness constraints , where ownership and control matter when future contingencies cannot be fully specified.	Theory of the firm; incomplete contracts.	Incomplete contracts, residual control rights, hold-up.
28	Jean Tirole	2014	Regulation and market design must be determined under informational and contractual constraints ,	Industrial organization; regulation theory.	Informational rents, incentive regulation, market power.

			where optimal rules must account for private information and strategic responses.		
29	Alvin Roth	2012	Markets without prices must be designed under matching and participation constraints , where stable and efficient outcomes depend on incentive-compatible assignment mechanisms.	Matching theory; market design.	Stable matching, strategy-proofness, participation constraints.
30	Robert Wilson	2020	Auction outcomes must be characterized under common value and informational inference constraints , where bids reflect strategic responses to what winning reveals about underlying values.	Auction theory; common value models.	Common value, winner's curse, informational inference.
31	Paul Milgrom	2020	Market design must be determined under information revelation constraints , where auction formats and price dynamics affect efficiency by shaping what participants learn.	Auction theory; market design.	Linkage principle, information revelation, auction design.
ARC V — The Limits of Rationality: The characterization of economic behavior under cognitive constraints, where bounded rationality, heuristics, and systematic biases limit optimization and shape observed choices.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
32	Herbert Simon	1978	Economic decision-making must be characterized under bounded cognitive constraints , where agents satisfice rather than optimize due to limits in information processing and computation.	Bounded rationality; organizational decision-making.	Satisficing, bounded rationality, procedural rationality.
33	Daniel Kahneman	2002	Choices under uncertainty must be determined under behavioral bias constraints , where preferences and beliefs systematically deviate from expected utility through heuristics and framing effects.	Prospect theory; judgment under uncertainty.	Loss aversion, reference dependence, heuristics, biases.

34	Richard Thaler	2017	Economic behavior must be characterized under persistent behavioral constraints , where deviations from rationality are systematic, predictable, and propagate through markets and institutions.	Behavioral economics; anomalies and nudges.	Mental accounting, limited self-control, behavioral anomalies.
ARC VI — Risk, Prices, and Panic: The determination of asset prices, portfolio choices, and macroeconomic outcomes under uncertainty, where risk, intertemporal valuation, and financial frictions constrain equilibrium.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
35	Harry Markowitz	1990	Investment decisions must be characterized under risk-return trade-off constraints , where optimal portfolios depend on the joint distribution of asset returns rather than individual assets.	Portfolio theory; mean–variance analysis.	Efficient frontier, diversification, variance, covariance.
36	Franco Modigliani	1985	Firm value must be determined under capital structure constraints , where financing decisions are neutral in frictionless markets but become relevant under taxes and imperfections.	Modigliani–Miller theorem; lifecycle hypothesis.	Capital structure, irrelevance theorem, lifecycle consumption.
37	Merton Miller	1990	Financial valuation must be characterized under arbitrage constraints , where the absence of arbitrage determines the pricing of securities across capital structures.	Corporate finance theory; arbitrage pricing.	Arbitrage, capital structure, market completeness.
38	James Tobin	1981	Macroeconomic outcomes must be determined under portfolio allocation constraints , where the composition of financial assets influences investment, consumption, and monetary transmission.	Portfolio balance theory; Tobin’s q.	Portfolio balance, asset substitution, q-theory.
39	William Sharpe	1990	Asset prices must be characterized under systematic risk constraints , where expected returns depend on covariance with	CAPM; asset pricing theory.	Beta, systematic risk, security market line.

			aggregate risk rather than total variance.		
40	Eugene Fama	2013	Asset prices must be characterized under market efficiency constraints , where prices incorporate available information into equilibrium valuations and limit predictable excess returns.	Efficient market hypothesis; empirical asset pricing.	Market efficiency, random walk, information incorporation.
41	Robert Shiller	2013	Asset prices must be characterized under excess volatility constraints , where deviations from fundamentals reflect behavioral and market dynamics beyond informational efficiency.	Behavioral finance; excess volatility.	Bubbles, volatility, behavioral deviations.
42	Robert Merton	1997	Asset pricing must be determined under dynamic replication constraints , where contingent claims are valued through continuous-time trading strategies.	Continuous-time finance; option pricing.	Dynamic hedging, stochastic calculus, replication.
43	Myron Scholes	1997	Derivative prices must be characterized under no-arbitrage constraints , where valuation depends on replicating portfolios independent of preferences.	Black–Scholes model.	Option pricing, no-arbitrage, risk-neutral valuation.
44	Douglas Diamond	2022	Financial systems must be characterized under intermediation constraints , where banks transform liquidity and allocate resources under monitoring frictions.	Banking theory; delegated monitoring and financial intermediation.	Liquidity transformation, monitoring, banks.
45	Philip Dybvig	2022	Financial systems must be characterized under coordination constraints , where liquidity demand and expectations generate multiple equilibria and bank runs.	Diamond–Dybvig model; bank runs and financial fragility.	Bank runs, multiple equilibria, liquidity risk.

46	Ben Bernanke	2022	Macroeconomic dynamics must be determined under financial amplification constraints , where disruptions in credit intermediation propagate and magnify real shocks.	Financial accelerator; crises analysis.	Credit frictions, amplification, crisis transmission.
ARC VII — Expectations and the State: The determination of macroeconomic outcomes under forward-looking expectations, where equilibrium depends on credibility, policy rules, and consistency between agents' beliefs and government behavior.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
47	Milton Friedman	1976	Macroeconomic outcomes must be characterized under adaptive expectations constraints , where inflation and unemployment depend on agents' evolving expectations rather than fixed trade-offs.	Permanent income hypothesis; expectations-augmented Phillips curve.	Adaptive expectations, natural rate, inflation expectations.
48	Edmund Phelps	2006	Macroeconomic equilibrium must be determined under expectations-augmented constraints , where anticipated policy eliminates any permanent trade-off between inflation and unemployment.	Expectations-augmented Phillips curve; microfoundations.	Natural rate, expectations, inflation dynamics.
49	Robert Lucas	1995	Macroeconomic models must be characterized under rational expectations constraints , where agents' forecasts are model-consistent and invalidate policy evaluation based on historical relationships.	Rational expectations; Lucas critique.	Rational expectations, policy invariance, equilibrium consistency.
50	Finn Kydland	2004	Economic policy must be determined under time-consistency constraints , where discretionary policies generate dynamically inconsistent outcomes absent credible commitment.	Time inconsistency; rules vs discretion.	Time consistency, commitment, policy rules.
51	Edward Prescott	2004	Macroeconomic equilibrium must be characterized under dynamic consistency constraints , where optimal outcomes require credible	Dynamic macroeconomics; real business cycle theory.	Dynamic equilibrium, expectations consistency, policy credibility.

			policy rules aligned with forward-looking expectations.		
52	Thomas Sargent	2011	Macroeconomic dynamics must be determined under model-consistent expectations constraints , where equilibrium depends on how agents form and update beliefs about policy regimes.	Rational expectations econometrics; regime analysis.	Regime shifts, learning, expectations formation.
53	Christopher Sims	2011	Macroeconomic relationships must be characterized under minimal identification constraints , where causal inference is derived from the joint dynamics of variables without imposing arbitrary structural restrictions.	Vector autoregressions; empirical macroeconomics.	VAR, impulse responses, identification, dynamic systems.
54	Peter Diamond	2010	Macroeconomic outcomes must be determined under search and coordination constraints , where frictions in matching generate equilibrium unemployment despite rational expectations.	Search theory; equilibrium unemployment.	Search frictions, matching, unemployment equilibrium.
55	Dale Mortensen	2010	Labor market outcomes must be characterized under matching constraints , where job creation and destruction emerge from decentralized search processes.	Search and matching theory.	Matching function, job flows, search equilibrium.
56	Christopher Pissarides	2010	Macroeconomic equilibrium must be determined under dynamic matching constraints , where unemployment, vacancies, and wages are jointly determined over time.	Search and matching models; labor dynamics.	Search equilibrium, vacancies, unemployment dynamics.
ARC VIII — The Credibility of Evidence: The identification of causal economic relationships under data and model constraints, where empirical validity depends on credible strategies to isolate causal effects.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts

57	Richard Stone	1984	Empirical systems must be constructed under measurement consistency constraints , where national accounts define the observable structure linking economic aggregates.	National income accounting; macro data systems.	National accounts, measurement consistency, aggregates.
58	Wassily Leontief	1973	Production systems must be characterized under input–output constraints , where inter-industry relationships provide empirically identifiable structural production linkages.	Input–output analysis.	Input–output matrix, technical coefficients, sectoral linkages.
59	Daniel McFadden	2000	Individual choice must be determined under random utility constraints , where discrete decisions are modeled as probabilistic outcomes consistent with latent preferences.	Discrete choice theory.	Random utility, logit models, discrete choice.
60	James Heckman	2000	Causal inference must be characterized under selection constraints , where observed outcomes reflect endogenous participation decisions that bias estimation.	Selection models; treatment effects.	Selection bias, counterfactuals, treatment effects.
61	Vernon Smith	2002	Economic behavior must be identified under experimental control constraints , where laboratory environments isolate causal mechanisms through controlled variation.	Experimental economics.	Laboratory experiments, control, induced value theory.
62	Clive Granger	2003	Dynamic relationships must be characterized under temporal causality constraints , where causal direction is inferred from predictive content in time series.	Granger causality; cointegration.	Granger causality, cointegration, time-series dynamics.
63	Robert Engle	2003	Time-series processes must be determined under conditional variance constraints , where volatility evolves over time and	ARCH models.	Conditional heteroskedasticity, volatility clustering.

			affects inference on economic relationships.		
64	Lars Hansen	2013	Empirical models must be evaluated under moment condition constraints , where theoretical restrictions are tested against observable data through overidentifying moment conditions.	Generalized Method of Moments.	Moment conditions, GMM, overidentification tests.
65	David Card	2021	Causal effects must be identified under natural experiment constraints , where exogenous variation approximates randomized assignment in observational data.	Empirical labor economics; natural experiments.	Quasi-experiments, causal inference, identification.
66	Joshua Angrist	2021	Causal relationships must be identified under instrumental variable constraints , where exogenous variation isolates causal effects through valid instruments.	Instrumental variables; applied causal inference.	IV estimation, LATE, exogeneity.
67	Guido Imbens	2021	Causal relationships must be identified under instrumental variable constraints , where exogenous variation isolates causal effects through valid instruments.	Potential outcomes framework; causal inference theory.	Counterfactuals, treatment effects, LATE.
68	Michael Kremer	2019	Causal effects must be identified under experimental design constraints , where randomized interventions generate exogenous variation for credible causal inference.	Randomized controlled trials.	RCTs, field experiments, causal identification.
69	Esther Duflo	2019	Economic policies must be evaluated under experimental implementation constraints , where randomized designs are used to measure and compare real-world interventions.	Development economics; experimental methods.	RCTs, policy evaluation, causal inference.

70	Abhijit Banerjee	2019	Economic policies must be evaluated under experimental implementation constraints , where randomized designs are used to analyze and scale development interventions.	Development economics; experimental approaches.	Causal inference, RCTs, development policy.
ARC IX — Rules, Power, and Prosperity: The determination of economic outcomes under institutional and political constraints, where rules, enforcement, and power structures shape incentives, coordination, and long-run performance.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
71	Friedrich Hayek	1974	Economic coordination must be characterized under dispersed knowledge constraints , where decentralized price systems aggregate information unavailable to any central authority.	Price system as information mechanism; spontaneous order.	Dispersed knowledge, price signals, spontaneous order.
72	Gunnar Myrdal	1974	Economic dynamics must be determined under cumulative causation constraints , where feedback between institutions and economic outcomes generates persistent divergence rather than convergence.	Cumulative causation; development dynamics.	Circular causation, path dependence, divergence.
73	Ronald Coase	1991	Economic organization must be determined under transaction cost constraints , where the boundaries between firms and markets depend on the costs of using the price mechanism.	Theory of the firm; social cost.	Transaction costs, property rights, Coase theorem.
74	George Stigler	1982	Regulation must be characterized under political economy constraints , where policy outcomes reflect the incentives of interest groups rather than social welfare maximization.	Theory of regulation.	Regulatory capture, interest groups, political incentives.
75	James Buchanan	1986	Public decision-making must be determined under collective choice constraints , where political	Public choice theory; constitutional economics.	Collective action, constitutional rules, public choice.

			outcomes emerge from individual incentives operating within institutional rules.		
76	Robert Fogel	1993	Economic history must be evaluated under quantitative and counterfactual constraints , where institutional effects are identified through measurable comparisons rather than narrative interpretation.	Cliometrics; quantitative history.	Counterfactuals, measurement, historical inference.
77	Douglass North	1993	Economic performance must be characterized under institutional evolution constraints , where formal and informal rules shape incentives and long-run development paths.	Institutional economics; economic history.	Institutions, path dependence, institutional change.
78	Oliver Williamson	2009	Economic organization must be determined under governance and contract enforcement constraints , where alternative institutional arrangements minimize transaction costs under bounded rationality.	Transaction cost economics; governance theory.	Governance structures, opportunism, enforcement.
79	Elinor Ostrom	2009	Resource allocation must be characterized under collective governance constraints , where communities design rules to manage common resources without centralized authority or full privatization.	Commons governance; institutional diversity.	Common-pool resources, self-governance, institutional design.
80	Daron Acemoglu	2024	Economic outcomes must be determined under political-institutional constraints , where the distribution of power shapes incentives, rules, and long-run development paths.	Political economy of development; institutions and growth.	Inclusive institutions, extractive institutions, power.
81	James Robinson	2024	Economic outcomes must be determined under political-institutional constraints , where the distribution of power shapes	Institutions and development; political economy of growth.	Political institutions, state capacity, development.

			incentives, rules, and long-run development paths.		
82	Simon Johnson	2024	Economic outcomes must be determined under political-institutional constraints , where the distribution of power shapes incentives, rules, and long-run development paths.	Political economy; institutions, finance, and crises.	Elite capture, institutional fragility, power concentration.
ARC X — Economic Growth: The determination of long-run economic growth under capital accumulation and knowledge constraints, where sustained increases in productivity emerge from endogenous innovation processes.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
83	Robert Solow	1987	Economic growth must be characterized under capital accumulation constraints , where diminishing returns to capital imply that sustained growth depends on exogenous technological progress not explained within the system.	Neoclassical growth model; growth accounting.	Capital accumulation, steady state, convergence, exogenous technology.
84	Paul Romer	2018	Economic growth must be determined under knowledge accumulation constraints , where technological change arises endogenously from investment in ideas and generates increasing returns.	Endogenous growth theory.	Knowledge spillovers, increasing returns, ideas, innovation.
85	Philippe Aghion	2025	Economic growth must be determined under innovation-driven knowledge accumulation constraints , where technological progress arises from endogenous innovation processes that replace existing technologies.	Schumpeterian growth theory; creative destruction and innovation dynamics.	Creative destruction, innovation, competition.
86	Peter Howitt	2025	Economic growth must be determined under innovation-driven knowledge accumulation constraints , where	Schumpeterian growth models; continuous innovation and	Innovation cycles, diffusion, technological change.

			technological progress arises from endogenous innovation processes that replace existing technologies.	technological renewal.	
87	Joel Mokyr	2025	Long-run growth must be characterized under knowledge transmission constraints , where the accumulation and diffusion of useful knowledge enable sustained technological progress.	Historical analysis of innovation; knowledge economy.	Useful knowledge, cultural transmission, technological diffusion.

ARC XI — Structural Transformation and Development: The evolution of economic systems under sectoral, demographic, and labor reallocation constraints, where development is driven by shifts in the composition of production and employment.

No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
88	Arthur Lewis	1979	Economic development must be determined under dual-sector constraints , where surplus labor transitions from low-productivity traditional sectors to higher-productivity modern sectors.	Dual-sector model of development.	Dual economy, surplus labor, industrialization.
89	Simon Kuznets	1971	Economic development must be characterized under sectoral reallocation constraints , where growth is accompanied by systematic reallocation of output and employment across sectors.	Empirical analysis of growth and structural change.	Structural transformation, sectoral shifts, inequality dynamics.
90	Claudia Goldin	2023	Economic transformation must be determined under demographic and labor participation constraints , where long-run changes in labor supply and human capital reshape the structure of production.	Economic history of labor markets; gender and work.	Labor participation, gender dynamics, human capital, demographic change.

ARC XII — Welfare, Human Capital, and Measurement: The evaluation of economic outcomes under human capital, capability, measurement, and environmental constraints, where welfare extends beyond income to multidimensional well-being.

No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts
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91	Theodore Schultz	1979	Economic performance must be characterized under human capital constraints , where investments in education and health determine productivity and individual well-being.	Human capital theory.	Human capital, education, productivity, investment in people.
92	Gary Becker	1992	Economic behavior must be determined under extended choice constraints , where individuals allocate resources across market and nonmarket activities that shape human capital accumulation and life outcomes.	Economics of the family; human capital.	Household production, time allocation, nonmarket behavior.
93	Amartya Sen	1998	Welfare must be evaluated under capability constraints , where well-being depends on individuals' real freedoms to achieve valued functionings rather than on income alone.	Capability approach; welfare economics.	Capabilities, functionings, freedom, welfare evaluation.
94	Angus Deaton	2015	Welfare must be measured under micro-level data constraints , where valid inference about living standards depends on reliable household-level consumption and survey data.	Consumption analysis; poverty measurement.	Consumption, poverty, household surveys, measurement.
95	William Nordhaus	2018	Economic performance must be determined under environmental and intertemporal constraints , where welfare depends on the sustainable management of natural resources and climate dynamics over time.	Climate economics; integrated assessment models.	Climate change, sustainability, intergenerational welfare.
ARC XIII — Trade and Global Systems: The determination of economic outcomes under international trade, monetary, and spatial constraints, where cross-border interactions shape specialization, policy effectiveness, and the geographic distribution of activity.					
No.	Laureate	Year	Structural Rupture	Core Contributions	Key Concepts

96	Bertil Ohlin	1977	Trade patterns must be characterized under factor endowment constraints , where differences in relative factor abundance determine specialization and exchange across countries.	Heckscher–Ohlin model.	Comparative advantage, factor endowments, specialization.
97	James Meade	1977	Open economies must be determined under internal and external balance constraints , where policy must jointly satisfy domestic stability and balance-of-payments equilibrium.	Theory of international economic policy.	Internal balance, external balance, policy instruments.
98	Robert Mundell	1999	Macroeconomic policy must be characterized under exchange rate and capital mobility constraints , where policy effectiveness depends on the international monetary regime.	Mundell–Fleming model; optimal currency areas.	Exchange rates, capital mobility, policy trilemma.
99	Paul Krugman	2008	Trade and economic geography must be determined under increasing returns and spatial interaction constraints , where market size, transport costs, and agglomeration shape the location of economic activity.	New trade theory; new economic geography.	Increasing returns, agglomeration, economic geography.

Source: Bank and Finance Consulting Group.

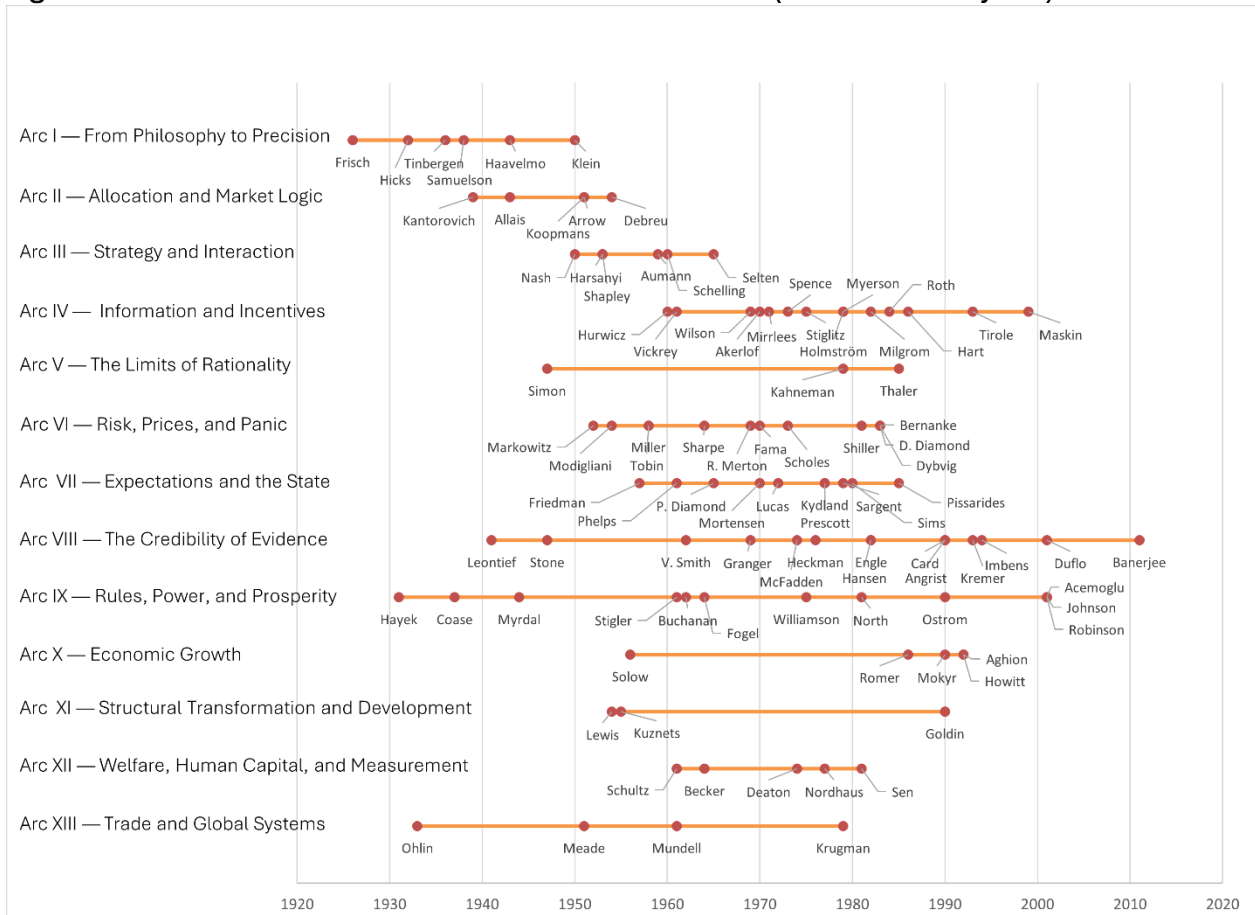
Together, these categories illustrate how the discipline evolved through a series of structural expansions in analytical scope.

5.4 Temporal Representation

The assignment of contributions provides the basis for a temporal mapping of the discipline. **Figure 1** plots canonical contributions associated with each Nobel Prize–recognized Laureate, within each arc along a common timeline, combining two dimensions: time (horizontal axis) and analytical structure (vertical axis). For each contribution, a representative date is assigned corresponding to the earliest work that embodies the relevant rupture. This approach provides a transparent and consistent basis for locating contributions in time, while ensuring comparability across arcs.



Figure 1 – The Intellectual Timeline of Modern Economics (99 Laureates by Arc)



Source: Bank and Finance Consulting Group.

The figure allows the identification of major inflection points in the evolution of economic reasoning. It shows that modern economics did not evolve as a linear sequence of ideas. Instead, it developed through overlapping waves of innovation, with multiple arcs emerging, coexisting, and interacting over time. Foundational contributions often precede formal recognition by decades, and major conceptual shifts tend to cluster in periods of methodological or empirical transformation.

5.5 Overlapping Emergence and Layering

A central feature of the temporal mapping is that arcs do not emerge sequentially. Instead, they appear in a staggered and overlapping pattern. Foundational arcs—such as formalization (Arc I) and allocation (Arc II)—develop early, but subsequent arcs do not replace them. Rather, they extend the analytical framework by introducing new constraints.

For example, strategic interaction (Arc III) and asymmetric information (Arc IV) modify the conditions under which equilibrium analysis applies. Behavioral constraints (Arc V) and financial dynamics (Arc VI) expand the range of environments that can be analyzed.



Expectations (Arc VII) and identification (Arc VIII) introduce additional dimensions that reshape both theory and empirics.

The resulting structure is one of cumulative layering, in which new analytical domains coexist with and build upon earlier ones.

5.6 Clusters and Persistence

The timeline also reveals periods of clustered innovation, in which multiple analytical ruptures emerge in close temporal proximity. These clusters reflect interdependencies across domains: advances in one arc often create conditions for progress in others.

At the same time, earlier arcs exhibit strong persistence. Foundational analytical structures remain central to economic reasoning long after their introduction, even as they are modified by later developments. This combination of clustering and persistence suggests that the evolution of economics is best understood as the accumulation of analytical capabilities, rather than as a sequence of paradigm replacements.

5.7 Interpretation

Taken together, the assignment and temporal mapping provide a unified view of the discipline. Economics emerges as a system in which contributions are organized by analytical structure and evolve through overlapping transformations. The framework therefore integrates two dimensions that are often treated separately: the classification of knowledge and its historical development.

The next section examines how ideas propagate across arcs, introducing a structured account of cross-domain influence.

6. Cross-Arc Influence and the Propagation of Economic Ideas

The previous section maps contributions into a non-overlapping set of analytical domains and traces their emergence over time. This section introduces a second layer of the framework: the propagation of ideas across arcs. While each contribution has a unique primary location, its influence often extends beyond that domain. Understanding these interactions is essential for interpreting economics as a networked system of analytical transformations.

6.1 Primary Location and Secondary Influence

The framework distinguishes between primary classification and secondary influence. Each contribution is assigned to a single arc corresponding to the constraint it transforms. This assignment is unique and defines the analytical identity of the contribution.

At the same time, contributions may affect other arcs by altering the tools, methods, or conceptual frameworks used in those domains. These effects are treated as secondary influences, which do not redefine the primary classification but capture the transmission of ideas across the discipline.

This distinction preserves the non-overlapping structure of the arcs while allowing for a structured representation of interconnections.

6.2 Channels of Propagation

Cross-arc influence operates through three analytically distinct channels:

- **Formal influence (oF):** The transfer of theoretical structures, models, or solution concepts developed in one arc to another. Examples include the use of equilibrium concepts in information economics or the application of dynamic optimization in macroeconomics and growth theory.
- **Methodological influence (oM):** The transfer of empirical strategies, identification techniques, or measurement tools that enable analysis in other domains. Advances in econometrics and causal inference, for instance, allow questions in labor, development, and public economics to be addressed under more credible identification conditions.
- **Interpretive influence (oi):** The transfer of conceptual frameworks that reshape how economic phenomena are understood or evaluated, without necessarily altering formal models or empirical methods. This includes the influence of institutional or welfare perspectives on the interpretation of outcomes in other domains.

These channels are defined to be mutually distinct. They separate the transmission of theoretical structure from the transmission of empirical capability and from broader conceptual reinterpretation.

6.3 Structure of the Cross-Arc Network

The cross-arc relationships identified above can be represented as a structured network of analytical propagation. Rather than viewing contributions as isolated within a single domain, the framework captures how each contribution generates influence across multiple arcs through distinct channels.

Table 5 provides a systematic mapping of these relationships by assigning each contribution to a single primary arc and a limited set of secondary influences, each explicitly typed according to the channels defined above. The primary assignment reflects the domain in which the contribution introduces an irreducible analytical rupture, while secondary links capture how the same contribution propagates into adjacent domains through formal, methodological, or interpretive mechanisms.

Taken together, this mapping reveals economics as an interconnected system of constraint transformations rather than a set of isolated contributions. In this sense, Table 5 provides an empirical representation of the networked structure of economic ideas implied by the framework.

The structure of the network reveals three regularities:

- (i) foundational arcs propagate formally;
- (ii) empirical arcs propagate methodologically;
- (iii) institutional and welfare arcs propagate interpretively.

Table 5 — Cross-Arc Influence of Nobel Laureates in Modern Economics

Key No	● Primary rupture Laureate	Year	oF Formal influence			oM Methodological influence					oI Interpretive influence					
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	
1	Ragnar Frisch	1969	●								oF	oM				
2	Jan Tinbergen	1969	●								oF	oM				
3	John Hicks	1972	●	oF								oI				
4	Paul Samuelson	1970	●	oF	oF	oF		oF				oM				
5	Trygve Haavelmo	1989	●									oM				
6	Lawrence Klein	1980	●								oF	oM				
7	Leonid Kantorovich	1975		●			oF		oF					oF		
8	Maurice Allais	1988		●			oF	oI	oF					oI		oI
9	Tjalling Koopmans	1975		●			oF		oF					oF		
10	Kenneth Arrow	1972		●	oF	oF							oI	oI		oI
11	Gerard Debreu	1983		●			oF									
12	John Nash	1994			●	oF		oF	oI		oF					



13	John Harsanyi	1994	●	oF		ol			
14	Reinhard Selten	1994	●	oF		ol			
15	Thomas Schelling	2005	●	ol	ol	ol	ol		
16	Robert Aumann	2005	●	oF		ol		oF	
17	Lloyd Shapley	2012	●	oF				oF	
18	Leonid Hurwicz	2007	oF	●				oF	
19	William Vickrey	1996	oF	●		oF			
20	James Mirrlees	1996	oF	●				oF	ol
21	George Akerlof	2001		●	ol	ol	ol	ol	ol
22	Michael Spence	2001	oF	●		oF	ol		
23	Joseph Stiglitz	2001	oF	●		oF	ol	oF	ol ol
24	Roger Myerson	2007	oF	●		ol		oF	
25	Eric Maskin	2007	oF	●				oF	
26	Bengt Holmstrom	2016		●		oF		oF	
27	Oliver Hart	2016		●				oF	
28	Jean Tirole	2014	oF	●		oF	ol	oF	
29	Alvin Roth	2012	oF	●				oF	
30	Robert Wilson	2020	oF	●		oF			
31	Paul Milgrom	2020	oF	●		oF		oF	
32	Herbert Simon	1978	ol	ol	ol	●		ol	ol ol
33	Daniel Kahneman	2002	ol	ol	ol	●	ol	ol	ol ol
34	Richard Thaler	2017	ol	ol	ol	●	ol	ol	ol ol
35	Harry Markowitz	1990		oF		●			
36	Franco Modigliani	1985		oF		●	oF	ol	
37	Merton Miller	1990		oF		●	oF	ol	
38	James Tobin	1981		oF		●	oF	ol	
39	William Sharpe	1990		oF		●			
40	Eugene Fama	2013		oF	ol	●			
41	Robert Shiller	2013		ol	ol	●	ol	ol	
42	Robert Merton	1997		oF		●	oF		
43	Myron Scholes	1997		oF		●			
44	Douglas Diamond	2022		oF		●	oF	ol	
45	Philip Dybvig	2022		oF		●	oF	ol	
46	Ben Bernanke	2022				●	oF	ol	
47	Milton Friedman	1976			ol	ol	●	oM	ol
48	Edmund Phelps	2006			ol	ol	●	oM	ol
49	Robert Lucas	1995	oF	oF		oF	●	oM	ol oF
50	Finn Kydland	2004				oF	●	oM	ol
51	Edward Prescott	2004				oF	●	oM	ol
52	Thomas Sargent	2011	oF			oF	●	oM	ol
53	Christopher Sims	2011				oF	●	oM	
54	Peter Diamond	2010	oF			oF	●		ol
55	Dale Mortensen	2010	oF			oF	●		ol



56	Christopher Pissarides	2010				oF		oF	●		ol			
57	Richard Stone	1984								●		oM	oM	oM
58	Wassily Leontief	1973				oF		oF		●		oM	oM	
59	Daniel McFadden	2000				oM	oM			●		oM		oM
60	James Heckman	2000				oM	oM	oM		●		oM	oM	oM
61	Vernon Smith	2002				oM	oM	oM		●				oM
62	Clive Granger	2003						oM	oM	●				
63	Robert Engle	2003						oM	oM	●				
64	Lars Hansen	2013						oM	oM	●				
65	David Card	2021				oM	oM	oM		●		oM		
66	Joshua Angrist	2021				oM	oM	oM		●		oM		
67	Guido Imbens	2021				oM	oM	oM		●		oM		
68	Michael Kremer	2019				oM	oM			●		ol	ol	
69	Esther Duflo	2019				oM	oM			●		ol	ol	
70	Abhijit Banerjee	2019				oM	oM			●		ol	ol	
71	Friedrich Hayek	1974				ol	oF	ol			ol	●	ol	ol
72	Gunnar Myrdal	1974				ol		ol			ol	●	ol	ol
73	Ronald Coase	1991				oF	oF	oF				●	ol	
74	George Stigler	1982				ol	ol	ol			ol	●		
75	James Buchanan	1986				ol	oF	ol			ol	●		ol
76	Robert Fogel	1993									oM	●	ol	ol
77	Douglass North	1993				ol	oF	ol			ol	●	ol	ol
78	Oliver Williamson	2009				oF	oF	oF				●		
79	Elinor Ostrom	2009				ol	oF	ol				●	ol	ol
80	Daron Acemoglu	2024				ol	oF	ol			ol	●	ol	ol
81	James Robinson	2024				ol	oF	ol			ol	●	ol	ol
82	Simon Johnson	2024				ol	oF	ol			ol	●	ol	ol
83	Robert Solow	1987				oF		oF	oF			●	ol	ol
84	Paul Romer	2018				oF		oF	oF			●	ol	ol
85	Philippe Aghion	2025				oF		oF	oF			●	ol	ol
86	Peter Howitt	2025				oF		oF	oF			●	ol	ol
87	Joel Mokyr	2025										ol	●	ol
88	Arthur Lewis	1979				oF						ol	ol	●
89	Simon Kuznets	1971									oM	ol	ol	●
90	Claudia Goldin	2023									oM	ol	ol	●
91	Theodore Schultz	1979				oF						ol	ol	ol
92	Gary Becker	1992				oF	oF	oF				ol	ol	ol
93	Amartya Sen	1998				ol		ol	ol			ol	ol	ol
94	Angus Deaton	2015				ol					oM	ol	ol	ol
95	William Nordhaus	2018									ol	ol	ol	ol
96	Bertil Ohlin	1977				oF					oF		ol	ol
97	James Meade	1977				oF					oF		ol	ol
98	Robert Mundell	1999				oF		oF	oF				ol	ol

Source: Bank and Finance Consulting Group.

Taken together, these regularities reveal a structured pattern of propagation across arcs.

First, the discipline exhibits a layered architecture of influence. Foundational arcs—such as formalization (Arc I), allocation (Arc II), and strategic interaction (Arc III)—generate predominantly formal influence. These arcs provide analytical building blocks that are reused across multiple domains.

Second, certain arcs function as methodological hubs. In particular, the arc concerned with empirical identification (Arc VIII) propagates primarily through methodological influence, enabling analysis across a wide range of applications without altering their underlying theoretical structure.

Third, later arcs—such as institutions (Arc IX), growth (Arc X), and welfare (Arc XII)—propagate more frequently through interpretive channels, shaping how outcomes are understood and evaluated rather than redefining the core analytical tools.

These patterns imply that different arcs play distinct functional roles within the discipline: some generate structure, others enable inference, and others shape interpretation.

6.4 Constraints on Propagation

The framework imposes explicit constraints on cross-arc influence. Influence is not assigned based on general relevance or thematic overlap, but on specific transmission mechanisms.

In particular:

- Formal influence is restricted to cases where a theoretical structure is directly used in another arc.
- Methodological influence is limited to domains where empirical or identification tools are actively employed.
- Interpretive influence is assigned only when a contribution substantively alters the conceptual framing of problems in another domain.

These restrictions ensure that the cross-arc network remains sparse and disciplined, avoiding the inflation that would arise if all contributions were allowed to influence all domains.

6.5 Economics as a Networked System

The resulting structure can be interpreted as a network of analytical domains connected by well-defined channels of propagation. This networked structure can be interpreted as the propagation of constraint transformations across the stages of the axiomatic chain (Table 1), linking earlier and later domains through formal, methodological, and interpretive channels.



The network is neither hierarchical nor fully connected. Instead, it consists of:

- Core nodes, which generate formal structures with broad applicability;
- Methodological nodes, which enable empirical analysis across domains;
- Interpretive nodes, which shape the conceptual understanding of economic phenomena.

This perspective complements the temporal mapping developed in Section 5. While the timeline identifies when analytical ruptures occur, the cross-arc mapping identifies how their effects spread across the discipline.

6.6 Implications

Viewing economics as a system of structured propagation has several implications and clarifies how influence operates not only within domains, but across successive stages of the axiomatic chain.

First, it clarifies why contributions in different domains are often closely connected despite belonging to distinct analytical categories: they are linked through specific channels of transmission rather than through shared primary structures. Second, it highlights the central role of methodological advances, which enable progress across multiple domains without altering their theoretical foundations. Third, it provides a basis for evaluating new contributions in terms of both their primary rupture and their potential for cross-domain influence.

More broadly, the analysis suggests that the development of economics involves not only the introduction of new analytical frameworks, but also the structured diffusion of those frameworks across domains.

The next section reformulates the analytical structure as a set of fundamental questions, providing an intuitive representation of the architecture.



7. Fundamental Questions of Economic Reasoning

The previous sections develop a structural classification of modern economics based on analytical ruptures and their propagation across domains. While this framework provides a precise account of the discipline’s internal logic, its full structure is inherently abstract. This section offers a complementary representation by reformulating each arc as a fundamental question of economic reasoning. These questions correspond directly to the elements of the axiomatic chain (Table 1), each representing a distinct transformation of the constraint structure that defines economic reasoning.

The purpose of this reformulation is twofold. First, it provides a synthetic and accessible representation of the architecture, translating analytical structure into a set of core inquiries. Second, it makes explicit the scope and irreducibility of each domain by identifying the question it uniquely addresses.

7.1 From Analytical Structure to Questions

Each arc is defined by a triplet (*Problem, Constraint, Rupture*). This structure can be expressed compactly as a question that captures the central analytical challenge introduced by the rupture. The resulting questions are not summaries of fields or topics, but formulations of the core problems that become tractable once specific constraints are transformed.

This perspective emphasizes that economic progress can be interpreted as the progressive ability to answer new questions under increasingly rich constraint structures.

7.2 The Thirteen Fundamental Questions

Table 6 presents the thirteen arcs in question form.

Table 6 — Fundamental Questions Across the Thirteen Arcs

Arc	Fundamental Question
Arc I	How can economic systems be formally represented and analyzed?
Arc II	How are resources allocated across agents and uses?
Arc III	How do strategic interactions among agents shape outcomes?
Arc IV	How does incomplete or asymmetric information affect incentives and outcomes?
Arc V	What are the limits of rational decision-making?
Arc VI	How are risk and uncertainty priced and transmitted over time?
Arc VII	How do expectations shape aggregate dynamics and policy outcomes?
Arc VIII	How can causal economic relationships be credibly identified?
Arc IX	How do institutions and governance structures shape economic performance?
Arc X	What drives long-run economic growth?
Arc XI	How do economies transform across sectors and over time?
Arc XII	How should economic outcomes be evaluated in terms of welfare and well-being?
Arc XIII	How do economies interact through trade and global integration?

Source: Bank and Finance Consulting Group.

7.3 Irreducibility

A key property of this set is that the questions are mutually irreducible. Each corresponds to a distinct constraint structure and analytical transformation. No question can be fully answered within the framework of another without eliminating the constraint that defines it.

For example, the allocation problem (Arc II) cannot capture strategic interdependence (Arc III) without altering the independence assumption. Similarly, credible identification (Arc VIII) cannot be reduced to theoretical modeling without addressing the methodological constraints that govern empirical inference. Attempts to collapse these questions into a smaller set would therefore eliminate essential distinctions in economic reasoning.

This irreducibility reinforces the claim that the arcs define a minimal and non-overlapping partition of the space of analytical transformations at the level of abstraction adopted here.

7.4 Complementarity with the Structural Framework

The question-based representation complements the analytical framework developed in Sections 3–6, including the axiomatic chain (Table 1), by translating its sequence of constraint transformations into a set of core inquiries. While the earlier sections emphasize the mechanics of constraint transformation, the present formulation highlights their conceptual content. The two perspectives are equivalent in scope but differ in their level of abstraction.

In particular, the question-based representation provides a common language for connecting theoretical, empirical, and applied work. It clarifies how contributions in different domains address distinct aspects of economic reasoning, while remaining part of a unified analytical structure.

7.5 Interpretation

Taken together, the thirteen questions provide a compact representation of economics as a set of core inquiries, each associated with a specific analytical transformation. They summarize the architecture of the discipline in a form that is both accessible and analytically grounded.

At the same time, their simplicity should not obscure the underlying structure. Each question corresponds to a distinct domain defined by constraints and ruptures, and their interactions—captured through cross-arc influence—generate the full complexity of modern economics.

The final section synthesizes the main contributions of the paper and discusses implications for the organization and evolution of economic knowledge.

8. Conclusion

This paper proposes a theory of the structure of economic knowledge for organizing modern economics based on analytical ruptures. By classifying contributions according to the constraints they transform, it identifies a set of thirteen irreducible and non-overlapping domains of reasoning. This approach provides a disciplined partition of the discipline that differs from existing classifications based on topics, methods, or historical traditions.

Two elements define the contribution. First, the framework offers a constraint-based classification in which each contribution has a unique primary location determined by its analytical transformation. This resolves the overlap inherent in field-based and JEL classifications, while remaining compatible with their practical use for indexing and communication. Second, the paper introduces a structured account of cross-domain propagation, distinguishing between formal, methodological, and interpretive channels through which ideas diffuse across domains. This yields a representation of economics as a networked system of analytical transformations, rather than a collection of loosely connected fields.

Taken together, these elements support a reinterpretation of the evolution of economics. The discipline does not progress through successive replacement of dominant approaches, nor does it fragment into independent areas. Instead, it evolves through the accumulation of analytical capabilities, as successive ruptures expand the set of problems that can be rigorously addressed. Earlier structures persist and are reused, while new domains introduce additional constraints and methods. The resulting architecture is layered, with multiple modes of reasoning coexisting and interacting. The framework abstracts from the historical contingencies, institutional dynamics, and sociological factors that also shape the development of the discipline, in order to isolate its underlying analytical structure.

This framework implies a reinterpretation of economics as a discipline organized by constraint-transforming capabilities rather than fields or methods. For research, it provides a criterion for evaluating contributions in terms of the constraints they transform and their capacity to propagate across domains. For teaching, it suggests organizing economic knowledge around a set of irreducible questions, clarifying the relationships between areas that are often presented in isolation. More broadly, it offers a way to understand the coherence of economics not as a shared subject matter or method, but as a structure of problem-solving under evolving constraints.

The analysis also opens several directions for further work. The mapping developed here relies on Nobel-recognized contributions as a disciplined proxy for major analytical ruptures; extending the framework to a broader set of contributions could refine the boundaries of the arcs and the structure of cross-domain influence. In addition, the network perspective invites formalization, including the measurement of influence across domains and the identification of central nodes in the propagation of ideas. Finally, the approach may be applicable beyond



economics, providing a template for organizing knowledge in other disciplines characterized by overlapping methods and evolving problem structures. This perspective unifies classification, evolution, and interaction within a single analytical framework.

More generally, the framework suggests a shift in perspective: from viewing economics as a collection of topics or techniques to understanding it as a structured system of analytical transformations evolving under changing constraints. From this viewpoint, the axiomatic chain provides a minimal and non-overlapping representation at the level of abstraction adopted here, organizing these transformations into a sequence in which successive constraint expansions progressively enlarge the space of analyzable problems. Making this structure explicit clarifies not only the internal organization of the discipline, but also the mechanisms through which new knowledge is generated, extended, and transmitted across domains. In this sense, the coherence of economics lies not in a unified method or subject matter, but in the structure of its constraint-transforming capabilities.

This framework does not merely organize past contributions; it provides a predictive lens for identifying future ruptures. New arcs emerge when existing constraint structures fail to accommodate novel forms of economic interaction. Emerging domains such as algorithmic decision-making, platform economies, and climate-economy interactions suggest the presence of constraint structures not fully captured by the current arcs. Related developments in macroeconomic modeling with heterogeneous agents and in dynamic contract theory point to tensions within existing domains that may signal further structural differentiation. These directions suggest that the arc structure is not closed, but evolves as new constraint transformations become analytically necessary.

Appendix — Mapping of Arcs to JEL Classification Codes

This appendix maps the thirteen arcs defined in the paper to the Journal of Economic Literature (JEL) classification system. The objective is not to establish a one-to-one correspondence, but to illustrate how contributions organized by analytical structure relate to existing topic-based classifications.

Because JEL categories are not analytically irreducible, each arc typically spans multiple codes. The mapping below identifies the primary JEL domains most closely associated with each arc.

Table A1 — Arcs and Corresponding JEL Codes

Arc	Description (Short)	Primary JEL Codes	Interpretation
I	Formalization of economic systems	B23, C00, C60	Mathematical methods and formal representation
II	Allocation under constraints	D50–D61, C61	Optimization, general equilibrium
III	Strategic interaction	C70–C73, D80–D84	Game theory and strategic behavior
IV	Information and asymmetry	D82–D83, D80	Information economics, contracts
V	Behavioral foundations	D90–D91	Behavioral economics, bounded rationality
VI	Risk and finance	G10–G12, D81	Asset pricing, decision under uncertainty
VII	Expectations and macro dynamics	E30–E32, E37	Rational expectations, macro dynamics
VIII	Econometrics and identification	C10–C58	Econometric methods, causal inference
IX	Institutions and governance	D02, D70–D78, K20	Institutions, political economy, law
X	Economic growth	O40–O47	Growth theory and innovation
XI	Structural transformation	O10–O14, O30	Development, sectoral change
XII	Welfare and distribution	D60–D63, I30–I38	Welfare economics, inequality
XIII	Trade and globalization	F10–F15, F60	International trade and macro linkages

Source: Bank and Finance Consulting Group.

The mapping illustrates that while the JEL classification organizes economic research by fields and topics, the arc-based framework organizes it by constraint structures and analytical transformations. As a result, each arc spans multiple JEL categories, and individual contributions often correspond to multiple codes within a single arc.



This comparison highlights the complementary nature of the two systems: the JEL classification provides a practical taxonomy for organizing research output, while the arc-based framework provides a conceptual structure for understanding the evolution of economic reasoning.

The absence of a one-to-one correspondence between arcs and JEL codes further underscores that the proposed framework captures a deeper structural dimension of the discipline.

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