Entropy Economics

The Living Basis of Value and Production

A Book

by James Galbraith and Jing Chen

University of Chicago Press, 2025

Presentation to

The University of Texas Energy Seminar

October 21, 2025

The Standard Textbook View

- Exchange is the primary economic activity
- Markets are the key institution
- Prices rest on preferences or utilities
- Markets are efficient, except when they fail
- Regulation addresses “market failure”
- Production is a derivative activity, also organized in markets for labor, capital, etc.
- Equilibrium, once achieved, is stable unless disturbed. Progress is normal.

Basic Principles of EE

- Production is the central economic activity
- All production requires low-entropy resources
- Which must be extracted with a surplus
- To do this, requires fixed investment
- Which is carried out according to a plan.
- Useful work is based on inequalities - of temperature, pressure, income, wealth.
- But these *must* be regulated.
- More complex systems are more efficient, but more fragile. And nothing lasts forever!

Theory of Value

Economic value depends on scarcity and on the degree of market power or monopoly. Scarcity can be represented as a probability; monopoly can be modeled by the base of the log function. New products are inherently scarce and monopolized but become less so with time; value is therefore an evolving, non-equilibrium construct.

$$V(P) = -log_b P$$

$$V(X) = \sum_{i=1}^{n} P_i(-log_b P_i)$$

Adding across products or processes, one can measure the value of a collection of goods and services; the equation is identical to the entropy measure in physics and Information theory. Also notice the similarity to Theil's inequality measure.

Scarcity and Value

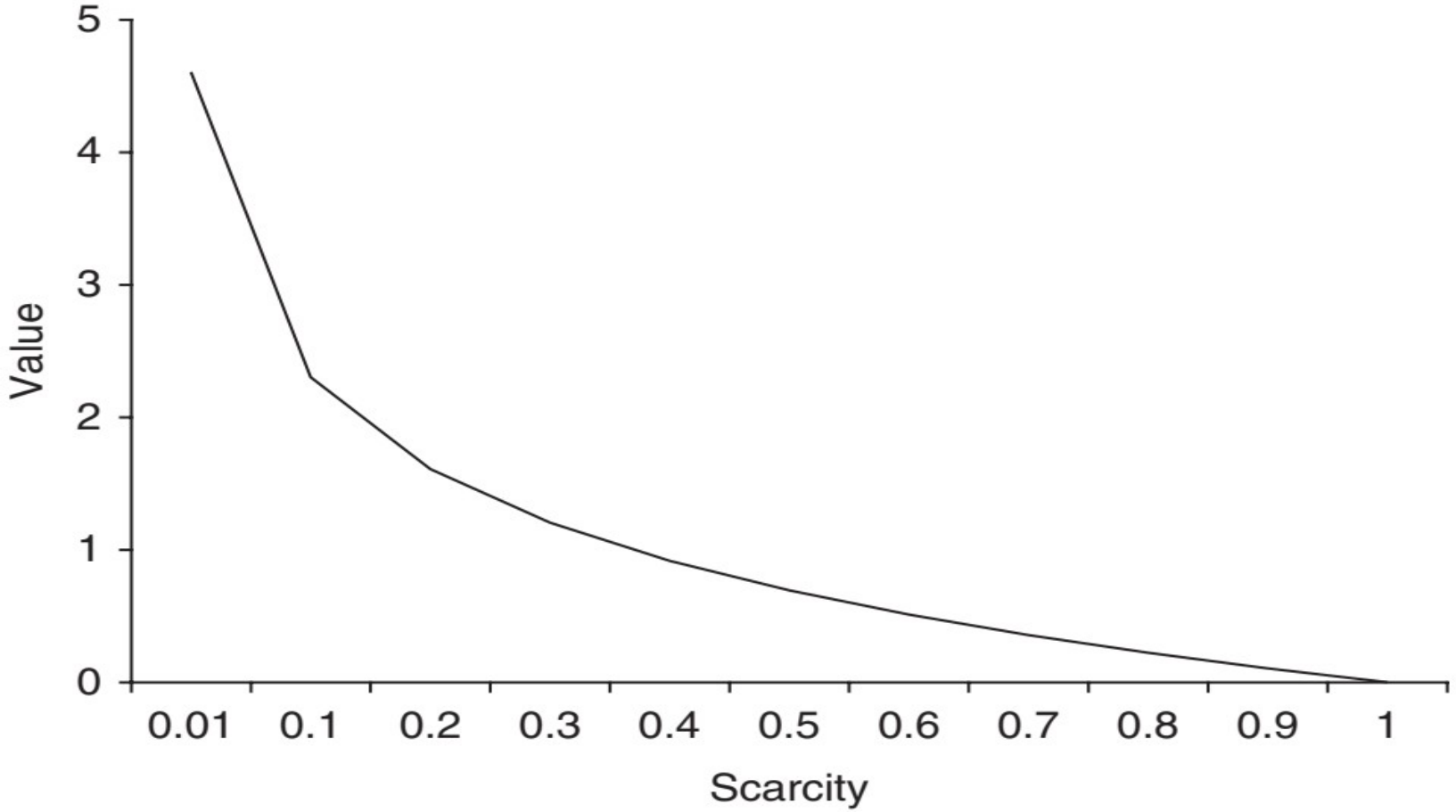


FIGURE 4.1 Value and scarcity.

Monopoly and Value

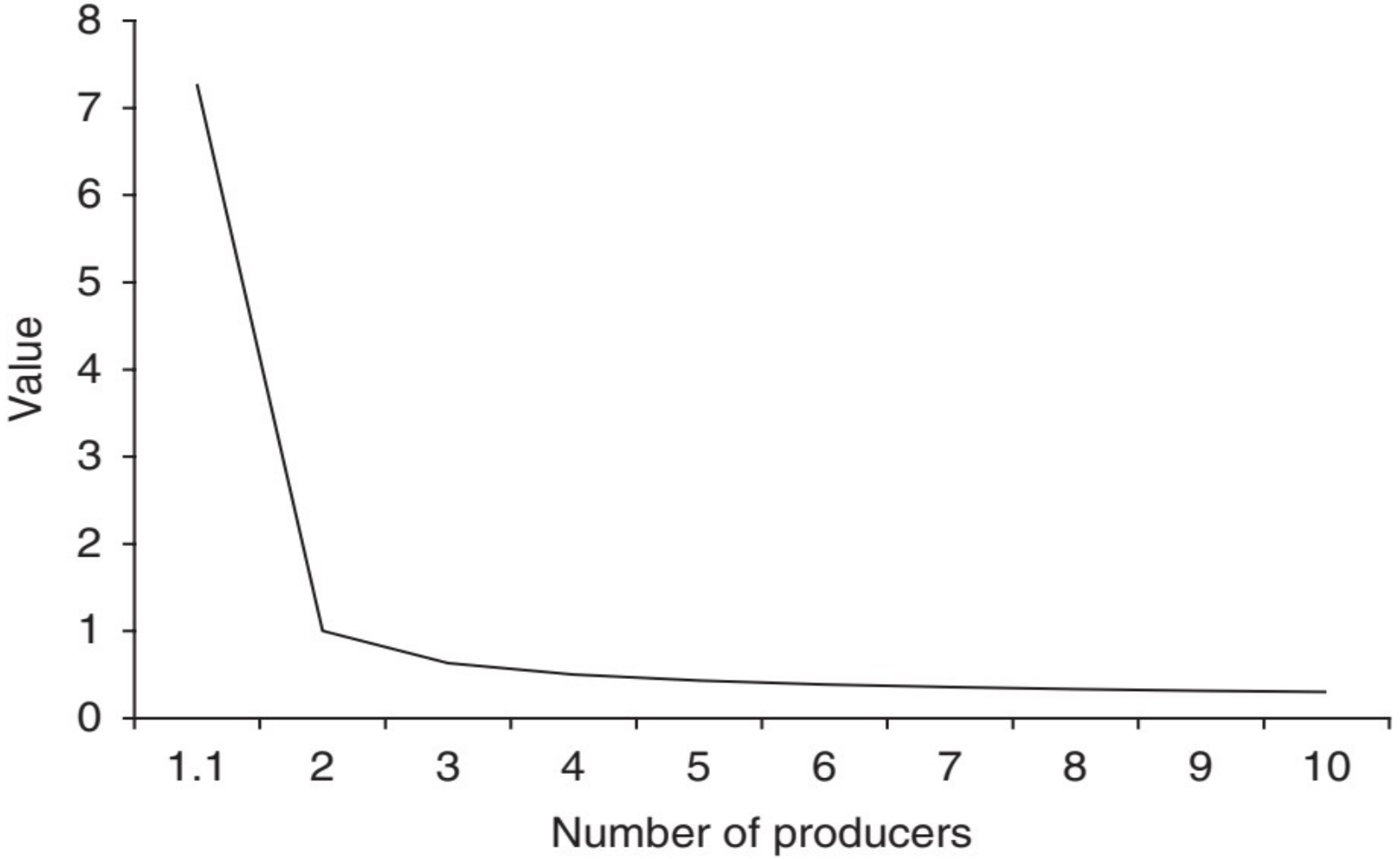


FIGURE 4.2 Value and the number of producers.

Example of Market Integration

TABLE 4.1. Summary of value changes with market integration

	Segmented market		Integrated market
	Resource-poor region	Resource-rich region	
Market size	1,000	100	1,100
Scarcity	0.2	0.9	0.26
Unit price	1.61	0.11	1.33
Value in segregation	321.89	9.48	331.37 (sum in segregation)
Value in integration	266.64	120	386.62
Difference in value	−55.25	110.51	55.25

Integrating a resource-rich and resource-poor region brings gains to resource producers in the resource-rich region and to consumers in the resource-poor region. But consumers in the resource-rich region and producers in the resource-poor region will be unhappy.

Key Elements of Production Decisions

- Output Scale
- Fixed Investment Required
- Variable (Resource) Cost Expected
- Project Duration
- Discount Rate
- Uncertainty
- Expected Profit

These are the familiar elements of any business decision, including household decisions on such matters as buying a car or a house, having children, and more. Our theory combines and expresses these in a single mathematical expression, similar to the Black-Scholes options theory.

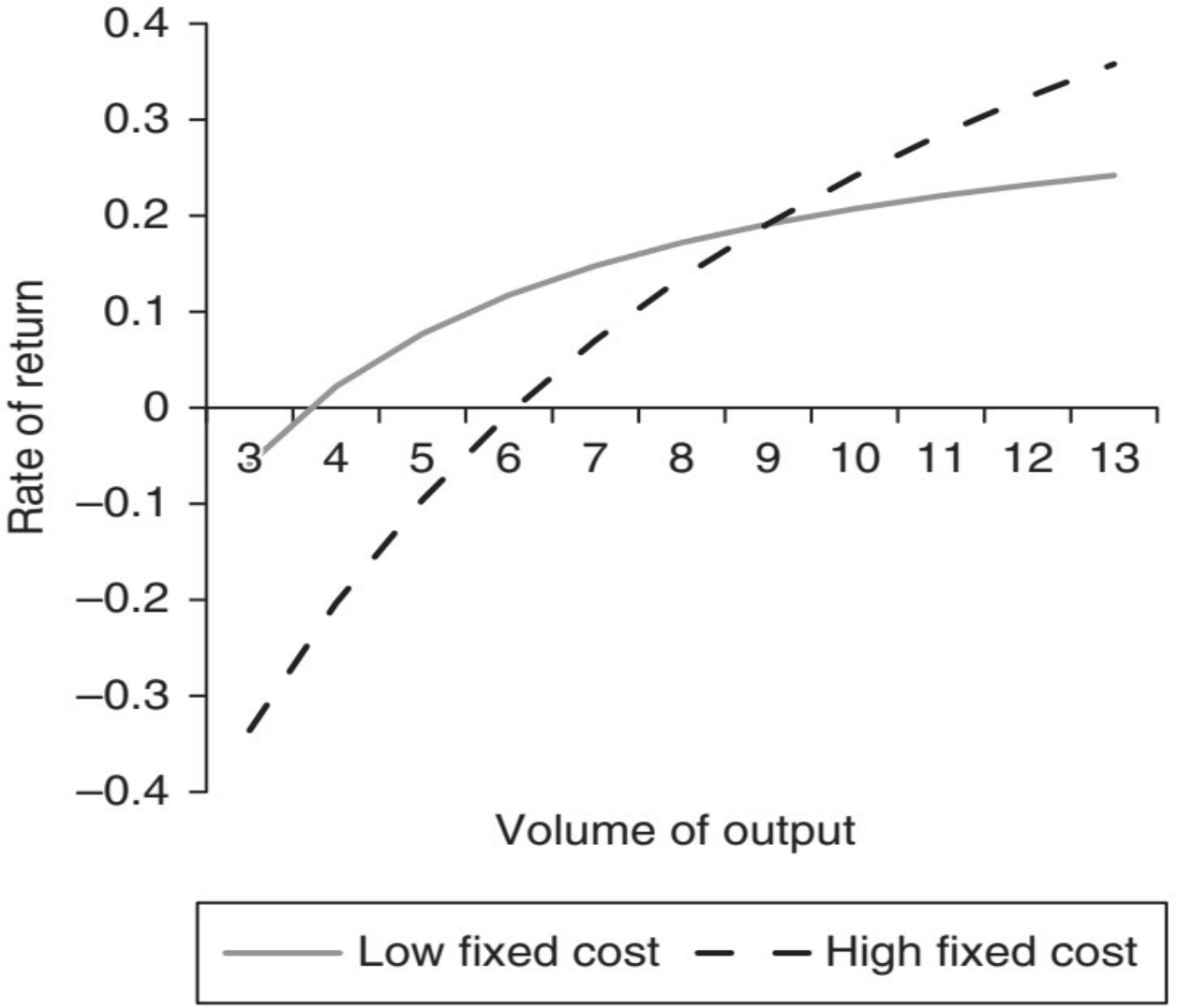
Production Theory Covers:

- Fixed cost and variable cost under different conditions of uncertainty.
- Rate of return and volume of output under different levels of fixed cost.
- Fixed cost and net present value (or rate of return).
- Project duration and net present value.
- Variable cost and discount rates under different levels of fixed cost.
- Profits at low and high discount rates as project duration changes.
- Discount rates required for breaking even as project duration increases.
- Variable cost as discount rates fall, at different levels of uncertainty.
- Volume of output and rate of return when uncertainty increases with output.
- Effect on returns of increasing fixed cost to reduce uncertainty.
- Rate of return and output scale at differing levels of resource cost, with different levels of fixed cost.
- Rate of return and market size of a system with a given fixed cost, at different levels of resource cost.

Each of these relationships can be calculated from the model. In the text accompanying the graphics, we provide relevant examples from biological, mechanical, and economic systems.

The above may seem complicated, but it all derives from a single basic equation!

Theory of Production: Examples



Projects with high fixed costs have a higher break-even point
And a steeper curve of profitability, other things equal.

The Effects of Increased Uncertainty on Rates of Return

TABLE 7.3. Discount rates, investment, uncertainty, and rates of return

	Initial expectation		Sad result	
Discount rate	0.03	0.1	0.03	0.1
Annual output	1	1	1	1
Fixed cost	7.1	3.9	7.1	3.9
Duration of project	35.7	13.6	35.7	13.6
Uncertainty	0.3	0.3	0.8	0.8
Variable cost	0.46	0.42	0.97	0.86
NPV	***12.3***	***4.0***	***−6.2***	***−2.0***

Columns on left and right differ in the amount of uncertainty expected against the amount actually experienced.
Projects with high fixed costs are more vulnerable to increased uncertainty

Minsky's Great Insight: Stability Destabilizes

TABLE 7.4. Stability is destabilizing

Uncertainty	0.3	0.55	0.8	0.8
Annual output	1	1	1	1
Fixed cost	5.8	2.1	5.8	2.1
Discount rate	0.05	0.05	0.05	0.05
Duration of project	25.3	12.1	25.3	12.1
Variable cost	0.44	0.64	0.94	0.82
NPV	*8.5*	*2.3*	*−4.4*	*0.0*

Low uncertainty favors high fixed cost projects, but they do much worse if uncertainty later increases.

Cheap Resources Foster Large-Scale Fixed Investment

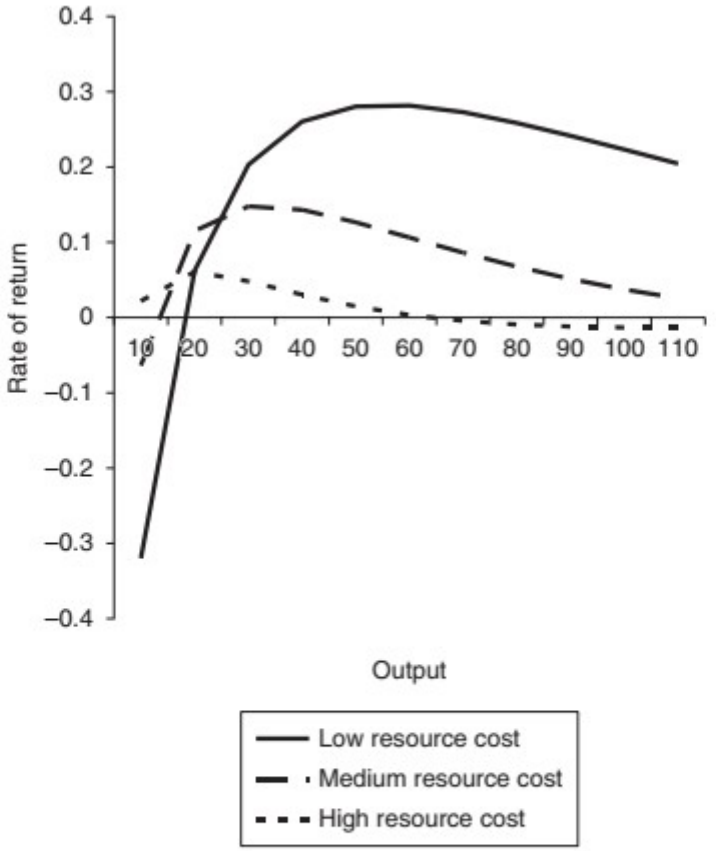


FIGURE 7.11 Resource abundance, fixed cost, market size, and rates of return: The rates of return with respect to different output scales for three different projects with different fixed costs corresponding to different levels of resource abundance.

Rates of return are lower and fall to zero sooner when resources are more costly. When resources are cheap, there is an incentive to increase output and fixed cost.

When Resource Costs Rise, Large-Scale Projects Become Unprofitable

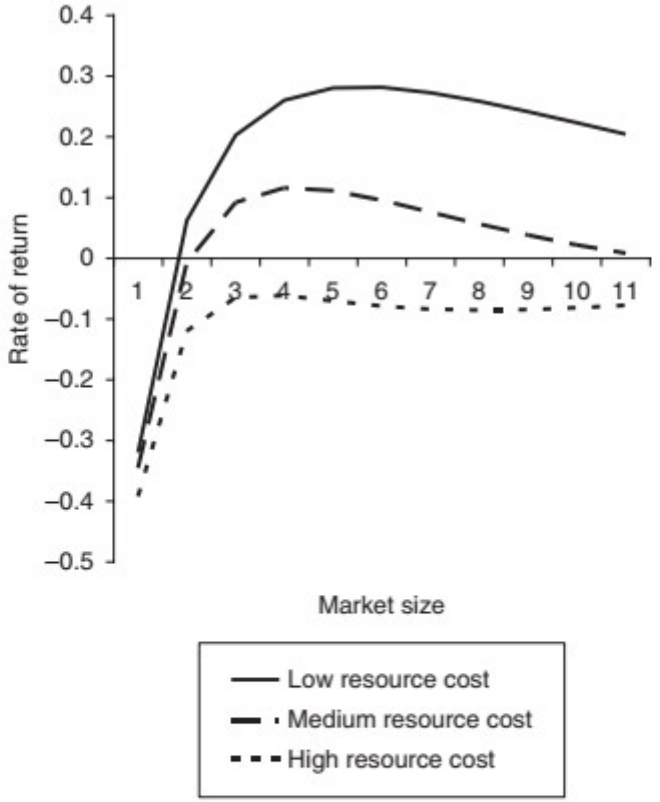


FIGURE 7.12 Resource abundance and rates of return: The rates of return with respect to different output scales for the same high-fixed-cost production system corresponding to different levels of resource abundance.

figure 7.12. Reduction of fixed cost and output size are then required to restore economic activities to positive returns.

When fixed costs are high, returns fall below zero more quickly when resource costs rise

General Conclusions

- We present foundational concepts for an economics rooted in real-world conditions and problems.
- These are closely tied to resource quality, scarcity, and the development of technologies.
- Economic processes involve valuation and production decisions, requiring fixed investments, that are inherently dynamic and unstable: there is no long-term equilibrium.
- We can at best hope to keep the system running for a while longer. (Good luck with that.)

Thank you for your attention to this matter!