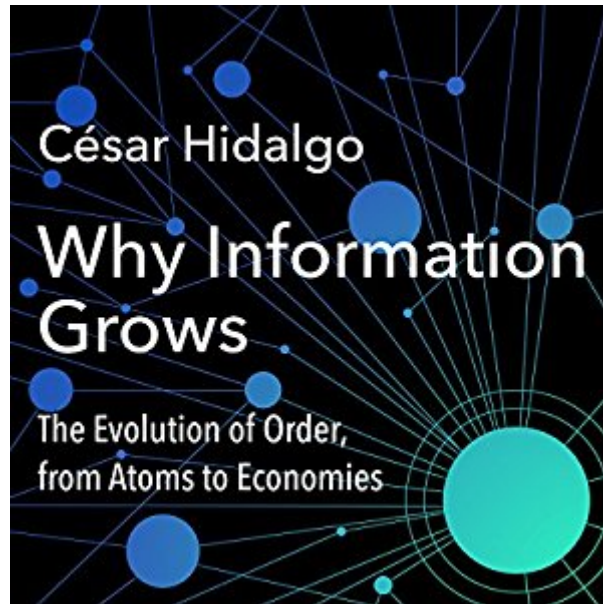


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# Why Information Grows: The Evolution Of Order, From Atoms To Economies



## Synopsis

What is economic growth? And why, historically, has it occurred in only a few places? Previous efforts to answer these questions have focused on institutions, geography, finances, and psychology. But according to MIT's anti-disciplinarian César Hidalgo, understanding the nature of economic growth demands transcending the social sciences and including the natural sciences of information, networks, and complexity. To understand the growth of economies, Hidalgo argues, we first need to understand the growth of order. At first glance, the universe seems hostile to order. Thermodynamics dictates that over time, order - or information - disappears. Whispers vanish in the wind just like the beauty of swirling cigarette smoke collapses into disorderly clouds. But thermodynamics also has loopholes that promote the growth of information in pockets. Although cities are all pockets where information grows, they are not all the same. For every Silicon Valley, Tokyo, and Paris, there are dozens of places with economies that accomplish little more than pulling rocks out of the ground. So, why does the US economy outstrip Brazil's, and Brazil's that of Chad? Why did the technology corridor along Boston's Route 128 languish, while Silicon Valley blossomed? In each case, the key is how people, firms, and the networks they form make use of information. Seen from Hidalgo's vantage, economies become distributed computers, made of networks of people, and the problem of economic development becomes the problem of making these computers more powerful. By uncovering the mechanisms that enable the growth of information in nature and society, *Why Information Grows* lays bare the origins of physical order and economic growth. Situated at the nexus of information theory, physics, sociology, and economics, this book propounds a new theory of how economies can do not just more things, but more interesting things.

## Book Information

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## Customer Reviews

César Hidalgo has written an important and ambitious book. His professional background in physics, network science, complex systems, and economics, as well as his personal experience in international travel, friendship, and fatherhood, gives him a unique perspective on the unifying theme across these diverse concerns: Information. "Why Information Grows" presents the relationship of energy, matter, and information in anecdotes, stories, and intuitive examples. Insights begin flowing right away: Like temperature and motion, information is incorporeal, but it is physical: Information is physical order, like the difference between a shuffled and sorted deck of cards. This conversational approach allows the key concepts to emerge quickly and naturally. To briefly summarize the arguments: The universe is made of energy, matter, and information. Information emerges spontaneously in out-of-equilibrium systems, like the swirls of milk in coffee. This information would be short-lived if not for the ability of solids to allow information to endure and be recombined with other information into more complex forms: Energy is needed for information to emerge, and solid matter is needed for information to endure. Information grows since matter can compute in an iterative process that uses the information embedded in solids to transform energy into different solids and new information. Computation happens in plants or bacteria, but the human brain is the ultimate incarnation of the computational capacities of matter. We organize our brain and our society to beget new forms of information, deposited in objects and language. These allow us to distribute information, both knowhow and knowledge. What's the difference between the two? We know how to walk, but most of us don't know the biomechanics of how we walk. Some rare individuals know both, and can combine that information with robotics and prosthetics to build new creations like artificial limbs. Humans have the unique ability to do what César poetically describes as "crystallize information". We create objects from our imagination and from the collective fiction we develop with others through expression and language. We eventually hit limits of what we can compute and manifest on our own, forcing us to work with others to form a distributed computer...a social network with an emergent collective intelligence. This human network leads to economies embedded in social and professional networks that predate and constrain economic activity. The inequality of the wealth of nations is an inevitable consequence of the inequality of the distribution of large networks of knowledge and knowhow. César then leverages his previous in-depth work

on economic complexity to make four important testable predictions:

- Simpler economic activities will be more ubiquitous.
- Diversified economies will be the only ones capable of executing complex economic activities
- Countries will diversify toward related products
- Over the long run (> five years), a region's level of income will approach the complexity of its economy, as approximated by product exports

Society is a collective computer, augmented by the products we produce to compute new forms of information. The social and economic problem that we are truly trying to solve is that of embodying knowledge and knowhow in networks of humans. This evolves the computational capacity of the human race, and ultimately helps information grow.

Căsar certainly could have made this a highly mathematical treatise suitable for publication in *Nature* or the *PNAS*. Indeed, for the more technical reader, the book's 25 page appendix provides copious references that back up the author's claims. I enjoyed the behind-the-scenes insight into the works of figures that were new to me like Ilya Prigogine, Francis Fukuyama, and Wassily Leontief. The book ends with a powerful moral imperative: "We worry about money and taxes instead of owning the responsibility of perpetuating this godless creation: a creation that grew from modest physical principles and which has now been bestowed upon us."

Căsar comes from and contributes to a community of thinkers and makers that learn from the past and live in the present from which a better future can emerge. By describing the importance of information from atoms to economies, he implicitly bids the reader to do the same. "Our world is different from that of early hominids only in the way in which atoms are arranged": Here's to ever-increasing information, our ability to work peacefully together in society to achieve it, and to the beautiful complexity that information and augmented computation brings.

This is a wonderful book. The way it introduces information and entropy is refreshing and clear. I don't think I ever read such an intuitive explanation of entropy, (at least a one that goes beyond entropy as disorder). It also provides an interesting and new perspectives of what economy is, and how to measure it. More than just being an alternative approach it's quite complementary, and specially convenient for the times we live in which we have a lot of data about all the data we have. Yes it's also a book about data, and it doesn't mention "Big Data". Thanks for that Căsar. It's also a book about technology and yet the word barely appears (Căsar instead uses a very poetic name the reader will find beautiful and appropriate). And yet the book has gaps (for those gaps I first finished the book but then I thought contents were good enough and that I had a very pleasurable reading). And the gaps are not small: One of the main concepts introduced in this book is that of economic complexity, an index that can be applied to regions, industries or

companies. And yet the author doesn't give a definition of it (he gives a hint, enough to show that the index is difficult to define in bare words). Well, he could have used an appendix to provide a definition! Then the author claims this index predicts future rates of growth (in conventional economic terms). Yes, it shows how that correlation exists between the economic complexity index measured for countries in 1985 and present rates of growth. But that's just one correlation, it's far from enough. Ok, he believes on his index, so thus the natural next thing to do is to show current values of economic complexity for countries, and thus give us a prediction of future economic growth (and with that, an option of testing the prediction). Mysteriously enough the author doesn't provide that information either. (Note the negative synergy of the lack of a formal definition of the index, and the lack of the current data specially when claimed that the index predicts our future). Finally, I felt there's also a gap between the first part, in which he introduces information and entropy, and how both are in essence physical (solid) phenomena and not just mathematical, and also how matter computes; and the second part in which he jumps to a bigger scale, that of societies. It's somehow difficult to understand how both parts connect. At the end of the book he gives a very good summary, which certainly helps establishing the connection. Strangely enough, it's actually outside the main body of the text, in the acknowledgments (yes I read them, they actually have interesting ideas and stories), in which César more clearly manifests the link: "As I [ ] tried to escape the rhetorics of deprivation, guilt, prosperity, optimization, equilibrium, and wealth, I learned that economic growth was nothing more than an epiphenomenon of a larger, more universal, and more relevant phenomenon. This is not the growth that captures headlines and political agendas, but the growth that makes possible the existence of life and society" even if we ignore it. This is the growth of physical order, or information. Soon I had to accept that information was what it was all about. At this point, I could no longer see the economy in terms of income, regulations, and agents. The economy was a mundane manifestation of something deeper. "Gaps or no gaps, I thoroughly recommend this book.

I began the reading of this book with much skepticism, as I consider myself an orthodox economist. However, I enjoyed every page of it. The author describes the basic principles of how information grows, at any level, to transcend to humans - a species particularly able to create and store information. Next, the author provides compelling arguments on how information and its complexity is what lies behind old fashioned aggregate factors of growth and development (physical and human capital). In this new approach to growth, the most developed of societies will be those able to support largest, and more complex, networks of persons and firms to support the manufacturing

of a manifold of products. A very pleasant reading for everybody as it does not require any specialized knowledge

WHY INFORMATION GROWS is not what I expected -- which was more insight on "the new science of networks". Instead it was about defining information itself -- what generates it and what it generates. The book further challenged me to rethink how the collective intelligence of things, people, and systems might actually work. So this is NOT a page-turner, because it keeps making you stop to think. For me, the bottom line is that Cesar A. Hidalgo is a deep thinker with a unique intelligence -- further turbo-charged (I assume) by his work with Albert-Laszlo Barabasi at Notre Dame. Like Barabasi, he is capable of finding fresh ways to look across multiple heterogeneous domains in order to show us the big picture in a bigger way. Thus anything Hidalgo generates demands serious consideration. And that includes WHY INFORMATION GROWS. I only surfed the book the first time but expect to return for a deeper dive soon.

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