BOOK REVIEW

Why Information Grows: The Evolution of Order, from Atoms to Economies CÉSAR HIDALGO, New York 2015: Basic Books, 256 pp. $ 26.99. ISBN: 0141978031, 9780141978031

Why should economic and human geographers read a book titled *Why Information Grows: The Evolution of Order from Atoms to Economies?* César Hidalgo is a statistical physicist at MIT, and the book makes ample references to matter, energy, and thermodynamics. But open it and you will see that its central question has kept human geographers busy for decades: why do economies grow faster in some part of the world than in others? To answer, Hidalgo crosses disciplines and draws inspiration from Shannon and Prigogine while building on the work of Smith and Granovetter. What comes out of this ambitious exchange between natural and social sciences is a key message: economies grow because information grows.

Building on Shannon's information theory, Hidalgo defines information as 'the order embodied in codified sequences, such as those found in music or DNA, while knowledge and knowhow refer to the ability of a system to process information' (p. 165). It essentially refers to order, from the particular arrangement of atoms in an airplane to the structure of the DNA double helix and it follows that more complex arrangements, like human beings or cars, contain more bits of information than simple ones, like single cell organisms or kitchen tools. These concepts of order, arrangements, structure, and complexity are the building blocks of the book.

Before focusing on the economy, Hidalgo explores the evolution of order in the physical world. To grow, information needs energy to emerge, matter to be stored, and computational abilities of matter to adapt and evolve. Computational abilities are particularly important, as they refer to the ability to process information, a shared ability between humans and cells. The reader might wonder how this section connects with economic growth. Starting from the physical world, Hidalgo shows what it looks like to observe the world through the lens of physics, chemistry, and biology. It also reminds us that the growth of information in the economy is a by-product of the growth of information at a much bigger scale and it makes clear that evolution in the biological world is a relentless march towards greater complexity.

This analogy is important as it allows us to understand that economies grow and evolve through the embodiment of increasingly large amounts of information into increasingly complex physical objects. Hidalgo calls this phenomenon 'crystallized imagination', and he compares apples (from trees) and Apples (from Steve Jobs) to illustrate the idea. The main difference is that apples first existed in the world and then in our head, while Apples first existed in our head and then in the world. Apples are crystallised imagination, and it is through this process that economies grow.

But the thought-provoking idea is that complex products require more than one head: 'Our need to form networks, however, emerges from one important consideration: the limited ability of humans to embody knowledge and knowhow' (p. 179). Hidalgo refers to this human limitation as the 'personbyte' theory, stating that the complexity of an economic activity reflects the size of the network to execute it. The computers that process information in the economy are not isolated individuals, they are networks of individuals. Given the complexity of an economic activity, these computers can be households, teams of inventors, firms, cities, regions or countries. This vision contrasts with the neoclassical *homo economicus* but fits very well with the conceptualisation of cities

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as networks of specialised individuals (Storper & Scott 2016) or more generally as complex systems (Batty 2013).

What comes out of this personbyte theory is a direct contribution to economic geography. Building on papers published with other colleagues, Hausmann in particular, Hidalgo *et al.* (2007) explain how economies evolve by diversifying into related activities. This part of the book is in line with the existing literature on regional path dependence in economic geography (Boschma & Frenken 2010), but it also provides a new framework: the product space (PS). The PS is a network-based representation of the economy in which nodes are products and links define the degree of relatedness between these products. Relatedness refers to the overlap between the knowledge and knowhow required to develop two different products. Hidalgo and colleagues have used the PS to predict export diversification of countries, and the PS has inspired analysis of change in the industrial, occupational, or technological structures of regions (Boschma *et al.* 2015). It also opens new perspective into the simple visualisation of complex economic data, as shown by the *Observatory of Economic Complexity* (atlas.media.mit.edu).

The relationship between product complexity and network size allows us to rethink the distribution of economic activities in brand new ways. Simple economic activities, for example, tend to be more ubiquitous, while complex economic activities will be more unequally distributed. This empirical pattern holds for both products (Hidalgo & Hausmann 2009) and technologies (Balland & Rigby 2016). Interestingly, these complex activities are not randomly distributed; they tend to be disproportionally found in regions with a diverse set of knowledge and knowhow. This leads to one of the key take-away messages of the book: 'over the long run a region's level of income will approach the complexity of its economy' (p. 180). Comparing the actual growth of regions to the growth of their economic complexity could signal opportunities for growth and risks of decline.

This book has the potential to set in motion a new agenda for researchers and policy makers, but some fundamental questions remain unanswered. Establishing the relationship between product complexity and economic growth immediately leads to the question of why are some economies capable of producing more complex goods in the first place. Geographers, in particular, will ask: why are knowledge and knowhow distributed in such a specific way? To answer this question, are we not automatically pushed back to the fundamental role of geography (Diamond 1999) or institutions (Acemoglu *et al.* 2012)? It is also not clear if this framework can help us to understand instances of unrelated diversification, the fall of leading regional economies, or the emergence of new centers of knowledge production. If what really matters to explain economic growth is the growth of knowledge and knowhow, it would be useful to focus more directly on the production and diffusion of new technological or scientific knowledge, using for instance patent documents or scientific publications.

The book is elegantly written, full of creative metaphors and inspiring anecdotes, and offers a refreshing perspective on why economies grow. The new questions that it opens are fascinating, and I hope that Hidalgo and other scholars from geography, economics, or other disciplines will use their energy, matter, and computational abilities to further push the growth of information in this direction.

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REFERENCES

ACEMOGLU, D. & J.A. ROBINSON (2012), *Why Nations Fail? The Origins of Power, Prosperity, and Poverty*. New York: Crown Publishers.

BALLAND, P.A. & D. RIGBY (2016), The Geography of Complex Knowledge. *Economic Geography* doi: 10.1080/00130095.2016.1205947

BATTY, M. (2013), *The New Science of Cities*. Cambridge MA: The MIT Press.

BOSCHMA, R., P.A. BALLAND & D. KOGLER (2015), Relatedness and Technological Change in Cities: The Rise and Fall of Technological Knowledge in US Metropolitan Areas from 1981 to 2010. *Industrial and Corporate Change* 24, pp. 223–250.

BOSCHMA, R. & K. FRENKEN (2010), Technological Relatedness and Regional Branching. *In*: H. BATHELT, M. FELDMAN & D. KOGLER, eds.,

Dynamic Geographies of Knowledge Creation and Innovation pp. 64–81. London: Routledge.

DIAMOND, J. (1999), *Guns, Germs, and Steel*. New York: Norton.

HIDALGO, C. & R. HAUSMANN (2009), The Building Blocks of Economic Complexity. *Proceedings of the National Academy of Sciences* 106, pp. 10570–10575.

HIDALGO, C.A., B. KLINGER, A.L. BARABÁSI & R. HAUSMANN (2007) The Product Space Conditions the Development of Nations. *Science* 317, pp. 482–487.

STORPER, M. & A.J. SCOTT (2016), Current Debates in Urban Theory: A Critical Assessment. *Urban Studies* 53, pp. 1114–1136.