



UNIVERSITÀ DI PARMA

ARCHIVIO DELLA RICERCA

University of Parma Research Repository

History-Friendly Modeling: An Evolutionary Tool for Strategy Research

This is the peer reviewed version of the following article:

Original

History-Friendly Modeling: An Evolutionary Tool for Strategy Research / Capone, G.; Li, D.. - In: STRATEGY SCIENCE. - ISSN 2333-2050. - 6:4(2021), pp. 436-443. [10.1287/STSC.2021.0133]

Availability:

This version is available at: 11381/2920329 since: 2024-11-21T11:02:19Z

Publisher:

INFORMS Inst.for Operations Res.and the Management Sciences

Published

DOI:10.1287/STSC.2021.0133

Terms of use:

Anyone can freely access the full text of works made available as "Open Access". Works made available

Publisher copyright

note finali coverpage

(Article begins on next page)

02 May 2026

History-friendly modeling: An evolutionary tool for strategy research

Gianluca Capone^{1,2}, Daitian Li^{3,*}

¹ Department of Economics and Management, University of Parma, Via J.F. Kennedy 6, Parma 43125, Italy. e-mail: gianluca.capone@unipr.it

² ICRIOS, Bocconi University, Via G. Roengten 1, Milan 20136, Italy

³ School of Management and Economics, University of Electronic Science and Technology of China, No. 2006, Xiyuan Avenue, Chengdu 611731, China. e-mail: lidaitian@uestc.edu.cn

* Corresponding author

Abstract

History-friendly models have been increasingly adopted to study innovation and industry evolution, the catch-up of latecomer firms and countries, and public policies. However, they have been used less in the field of strategic management. In this article, we first provide a review of the history-friendly literature, identifying its intellectual roots in evolutionary economics. Then, we discuss three possible motivations that could explain the history-friendly paradox. Finally, we propose history-friendly models as a promising tool to study current research questions in strategy.

Keywords

Evolutionary economics; history-friendly model; simulations; strategy.

Acknowledgement

We are grateful for the constructive feedback and valuable suggestions that we received from the special issue editors Gino Cattani and Franco Malerba, as well as from two anonymous reviewers. All errors are the authors' own responsibility.

Published as: G. Capone, D. Li, "History-Friendly Modeling: An Evolutionary Tool for Strategy Research", *Strategy Science*, 2021, 6: 436-443;

doi: 10.1287/stsc.2021.0133

1. History-friendly models: A quick review

History matters is a central claim of evolutionary economics, as it shapes innovation and industry evolution (Dosi and Nelson, 1994). It implies paying attention to actual dynamics, that is to the process through which a phenomenon came into existence, and focusing on case studies and dynamic quantitative analyses on the specific evolution of technologies, firms, and industries. History-friendly models were introduced in the late 1990s by evolutionary scholars as a new approach to formal analysis of industry evolution (Malerba, Nelson, Orsenigo, and Winter, 1999). As evolutionary models, they shared the main assumptions of evolutionary theory (Nelson and Winter, 1982), notably the representation of economic agents, and especially business firms, as heterogeneous entities, that are driven by “boundedly” rational decision rules (Simon, 1955; Cyert and March, 1963). However, while verbal accounts of evolutionary theory recognized these general features about how agents behave as the result of historical events and interactions with the institutional, technological and market environment, the early evolutionary models were abstract and general, and unable to account for the variety of factors emerging as relevant from the empirical research about industry evolution. So, the reason why these new models have been named history-friendly is that they are “friendly” to the actual history and real dynamics.

In this paper, we argue that history-friendly models can be a useful research tool for strategy scholars, as they can provide a unique contribution to our understanding of how firms emerge, grow, and disappear, how they create and appropriate value, and how they compete and cooperate within and across markets. History-friendly models offer a formal approach to these research questions, that does not eschew the complex role of historical and contextual factors, but actually gives them prominence. To this purpose, we first review the history-friendly literature, identifying its intellectual roots in evolutionary economics. Then, we discuss why these models have not been widely used in the strategy field, even if they share the same intellectual roots, and we highlight three possible explanations for this history-friendly paradox. Finally, we present some research areas in strategy where history-friendly models appear as particularly promising.

The history-friendly methodology consists of three main steps (Winter, 2018). First, a phenomenon of interest is selected. Second, a formal representation of the phenomenon is built, identifying the key actors, variables and behaviors that could be relevant to depict and explain the selected phenomenon. Third, the formal representation is implemented in the form of a computer simulation that allows proper manipulation of the key processes in order to answer the research questions of interest. While these elements are shared also by other modeling styles, in the history-friendly approach history plays a peculiar role in each step. First, history provides guidance in the selection of the specific and relevant phenomena to investigate. Second, history informs

the choice of how to represent the selected empirical phenomena into their stylized counterparts (i.e. the model), including key actors, institutions, and how they appear, change, and disappear over time. Third, history offers indication about the implementation and manipulation of the model: historical evidence can be used to reduce the range of arbitrary choices about key variables and their representation that are often needed in a model in absence of theory indications, as well as to select the indicators that are used to assess the results of the model. As for those aspects that cannot be assessed through historical analysis, history-friendly models rely on insights from contemporary evolutionary economics. For example, firms are usually the relevant actors and are represented as multi-dimensional entities: some of their attributes are imprinted once and for all, while others change over time; they take their decisions in a decentralized way and based on current available data. A key feature of history-friendly modeling is also flexibility. Its methodology can be adapted to quite diverse contexts, by adding or removing specific elements of interest.

We refer the reader to previous works (Garavaglia, 2010; Malerba, Nelson, Orsenigo, and Winter, 2016; Winter, 2018; Capone et al., 2019a) that have provided extensive reviews of history-friendly methodology and applications. We complement these works by adding a simple bibliometric analysis. To build our sample, we searched the Web of Science Core Collection Data¹. As some relevant journals and years were not present in the dataset, we also searched all papers citing the seminal history-friendly work (Malerba et al., 1999) and published by the end of 2020, and selected among them those papers that included a model with a history-friendly methodology or that explicitly discussed the methodology. This yielded a sample of 42 research articles on the topic of history-friendly modeling (hereafter, HFM papers), authored or co-authored by 61 scholars (hereafter, HFM scholars). The number of HFM papers has increased over time from very few examples in the early 2000s to a higher and more stable number in the last 10 years. The outlets in which these papers have been published include mostly innovation and industrial dynamics journals (Research Policy, Industrial and Corporate Change, Journal of Evolutionary Economics, Technological Forecasting and Social Change) or simulation journals (Computational Economics, Journal of Artificial Societies and Social Simulation), with notable exceptions appearing in management oriented journal such as Journal of Management Studies, Journal of Business Research and Long Range Planning. Although the number of HFM papers is not particularly large, they still have a relevant impact on later research, as shown by the number of citations. In our sample, on average, each HFM paper is cited by approximately 44 times in the

¹ We searched for articles with pre-defined strings (i.e., "history-friendly model*" OR "history-friendly simulation*" OR "history friendly model*" OR "history friendly simulation*") in the Topic Field of the database. This allows us to find any article that contains the words “history-friendly model”, “history-friendly simulation” or their variants in its Title, Abstract, Author Keywords or Keywords Plus (algorithm generated keywords that are provided by the database) sections. The search was conducted on 13 January 2021.

Scopus database².

To better understand the intellectual roots of the history-friendly approach, we extracted all publications of HFM scholars (as identified above), and we conducted a co-citation analysis³. In co-citation analysis, a link exists between two references if they are cited together in a given number of articles. The assumption is that if articles are often cited together, then they reflect a common intellectual ground (i.e., share a certain kind of similarity). To examine whether there are distinct clusters within the co-citation similarity network, we applied the Fruchterman-Reingold algorithm⁴, a force-directed layout algorithm which minimizes the “energy of the system”, assuming nodes as particles that move away from each other and edges as springs that hold the particles together (Fruchterman and Reingold, 1991). The result of this algorithm is a co-citation similarity network that places similar nodes close to each other and dissimilar nodes far from each other.

As shown in Figure 1, there are six large clusters or research communities that can be identified from the co-citation similarity network. The first cluster refers to the evolutionary economics (or also neo-Schumpeterian) community focusing on topics such as industrial dynamics or sectoral systems, which represents the largest component in the network. The seminal book by Nelson and Winter (1982) has a central position in this component, as well as in the whole network, but close to it we find the first history-friendly article written by Malerba, Nelson, Orsenigo and Winter (1999), and other foundational works of evolutionary theory on technological trajectories and sectoral systems of innovation. So, the HFM approach appears as indeed “evolutionary” and strongly intertwined with the intellectual roots of the evolutionary approach. Moving clockwise in Figure 1, we find a second cluster focusing on socio-technical transitions, often adopting a multi-level perspective and also sharing the notion of evolution as a process of “variation-selection-retention” (e.g., Geels, 2002). The third cluster is a community focusing on marketing research and psychology (Jedidi and Kohli, 2005), that shares with the evolutionary economics the emphasis on heterogeneous consumers. Fourth, we find a cluster focusing on methodological issues, with reference to multidisciplinary research and the debate on the use of computer simulations also in other fields (Watts and Strogatz, 1998). This cluster has a direct link with the history-friendly literature, as these models are essentially computer simulations and their proponents have been involved in the general debate about the methodological

² The number of times cited for a given article varies across different sources (e.g., WoS, Scopus, Google Scholar). We use the Scopus database as a main source for counting the number of citations, which is generally larger than the number of citations in Web of Science but smaller than the number of citations in Google Scholar.

³ We used the software Sci2 Tool (Sci2 Team 2009), a widely used tool in bibliometric studies (e.g., Belter, 2017).

⁴ As implemented in the Gephi (0.9.2) visualization tool.

status of simulations. The fifth cluster depicts a community focusing on public policies (Bryant and Lempert, 2010), a topic that is central to the evolutionary economics agenda, and that also history-friendly scholars have explored to extend and generalize their results. Finally, we find a cluster focusing on evolutionary economic geography (Boschma and Weterings, 2005), that shares intellectual roots and leading scholars with the evolutionary theory. Overall, these results confirm the centrality of evolutionary economics among the intellectual roots of history-friendly modeling. A second insight is that HFM scholars drew upon a wide range of intellectual grounds. Some of these – and more specifically the marketing and methodological clusters – remained quite isolated from the core of evolutionary economics, while others are engaged in a common conversation, and this is especially the case of the evolutionary economic geography community. A third, and more disappointing result, is that from our analysis emerges no cluster explicitly focusing on strategy research. Why is this the case? In the next section, we try to dig deeper into this question.

----- Insert Figure 1 here-----

2. The paradox of history-friendly models

The review and bibliographic analysis conducted in the previous section point at a sort of paradox. Evolutionary theory is the core intellectual component of history-friendly modeling and, at the same time, it is also a widely accepted theoretical framework in the strategic management field (Gavetti and Levinthal, 2004). However, despite the shared conceptual roots, history-friendly models have not entered so far the methodological toolkit of the strategy field. This certainly cannot be ascribed to a narrow-minded attitude of strategy scholars towards simulation modeling as such. Actually, in the strategy field simulation models have been adopted quite early and applied through a variety of approaches (Davis, Eisenhardt, and Bingham, 2007). So, the question remains why history-friendly simulations have not been among these approaches. Below, we discuss three possible answers: the link between the method and the subject matter, the level of abstraction, and the methodological status of counterfactuals. Although they are conceptually distinct explanations, they are not mutually exclusive and probably all played a role in determining the outcome.

The subject matter. Since their introduction, history-friendly models have been presented as aiming to capture and formally represent the mechanisms and factors identified by the empirical research as affecting industry evolution (Malerba et al., 1999). The link between the research topic and the methodology has been a main theme in the following literature, so that it is possible to identify some building blocks (demand, technological change, firm innovation behavior, entry and exit dynamics) that are common to all models, although with the specificities required by the context (Garavaglia, 2010; Capone et al., 2019a). However, we argue here that these statements

should be taken as descriptions of the current status of the art, rather than as normative elements, as they follow from historical contingencies and not from methodological principles. The focus of history-friendly models on industry evolution has been driven by the legitimate research interests of their proponents, as they were dissatisfied with the results of early evolutionary models. A further element was certainly the availability of rich historical data about the evolution of multiple industries. None of these elements is an obstacle to apply the principle of taking history seriously to research questions more relevant for strategy scholars. Recent works provide valuable examples of this opportunity. Engler, Cattani and Porac (2020) study the emergence of the minivan market within the automobile industry, and show how the complex interaction between environmental characteristics, firm capabilities, organizational incentives, and managerial beliefs determined the emergence of Chrysler as first-mover and its commercial success. Capone, Li and Malerba (2021) focus on the catching-up entry strategies of Chinese latecomer firms entering the mobile phone sector, and show that successful strategies depended on the sectoral environment, with a specific role of technological and demand conditions.

The level of abstraction. All models require some degree of abstraction, and history-friendly models are no exception (Knudsen, Levinthal, and Puranam, 2019). However, they were motivated by a dissatisfaction towards a modeling approach that paid little attention to empirical reality, and therefore leaned in the direction of close resemblance to historical observations. This choice, as any modeling choice, brought benefits and costs. On the benefits side, history provides discipline for a proper selection of the relevant mechanisms and parameters, but this comes at the cost of losing generality, and therefore external validity (Brenner and Murmann, 2016). Indeed, the right level of abstraction depends very much on the research question we want to investigate as well as the relevance of the contextual factors (Murmann, 2014). For some time, the strategy field has been engaged in a quest for abstract and general laws, that hold true irrespective of time and place (Murmann, 2012) and has neglected historical research and its attention to details and specificities (Vaara and Lamberg, 2016). However, recent years have witnessed a sort of historical turn in strategy research, motivated both by the contribution that historical methods can bring to the understanding of sustained competitive advantage and by the recognition that history is used in strategy making and should therefore be incorporated in strategy theories (Argyres et al., 2019). This renewed interest in history, and particularly in business history, has also engaged evolutionary theory in the conversation (Murmann, 2015; Quinn, 2015; Winter, 2013). History-friendly models will certainly benefit from the renewed interest of strategy scholars for history and historical methods, as they will get increasing legitimization. Moreover, this trend might also determine a practical advantage in terms of more historical episodes and data to be used as inputs for the development of history-friendly models, as happened in recent examples where authors of historical research later developed related models (e.g. the history-friendly model by Brenner and Murmann [2016] builds on the historical work by Murmann [2003], and the model by Engler,

Cattani, and Porac [2020] is based on the historical account of Engler [2015]).

The role of counterfactuals. Although history-friendly models are explicitly designed to replicate a phenomenon of interest, this is not their only objective, and indeed it is not even the main one. The purpose of history-friendly models is to shed light on the mechanisms driving that phenomenon. These mechanisms are usually put forth through appreciative theories, i.e. in the form of qualitative verbal descriptions, sometimes with the help of numbers, and structured in a reasoned but not formal way (Nelson, 2020). Formal models can complement these appreciative theories by checking their logical consistency or by selecting among competing explanations (Malerba et al., 1999). The tool employed by history-friendly models is counterfactual analysis, that consists in the falsification of an antecedent to investigate its consequences (Garavaglia, 2010). The scientific status of counterfactuals has been often discussed both in the history and the economics field (Ferguson, 1997; Cowan and Foray, 2002). From an evolutionary perspective, historical counterfactuals should not be considered as abstract alternative worlds, but rather as branches in the tree of history that have never been taken (Cowan and Foray, 2002). This view clearly implies the necessity of selecting turning events that were relevant – had a strong impact on the branch that was taken – but also plausible, that is branches that could have been easily taken depending on small random events or plausible changes in the circumstances (near-histories in the language of March, Sproull and Tamuz, 1991). The analysis is then conducted by changing the value of a parameter or the functional form of an equation and leaving unchanged the rest of the model, to evaluate the differences in the outcomes of interest between the real history scenario and the history divergent one. This tells us how robust a specific trajectory or path has been and how specific (strategic) decisions have affected the direction and evolution of the indicator under investigation. The explicit assumption of this exercise is a *ceteris paribus* clause, assuming that all other elements of the context remain the same. This choice is justified by the need to avoid an infinite number of possible futures to analyze. However, it also brings a scent of determinism, that rules out the agency of historical actors (Mordhorst, 2008). The debate about determinism and choice within the strategy field is old, but still open (De Rond and Thietart, 2007). The perception of history-friendly models and their use of apparently deterministic counterfactuals might have reduced their appeal to strategy scholars. However, we notice here that the use of formal models rather than qualitative and verbal case studies does not necessarily imply an endorsement on determinism, but it simply brings more clarity and logical consistency. Therefore, they can be added without fear to the tools employed to answer in a systematic way “what if” questions and therefore contribute to the understanding of causal mechanisms in strategy (Durand and Vaara, 2009).

3. The promise of history-friendly models for strategy research

Starting from the late 1990s, the strategy field has witnessed the bourgeoning of

multiple approaches to simulation modeling (Davis, Eisenhardt, and Bingham, 2007) and the resounding explosion of the NK fitness landscape models (Levinthal, 1997). The core of NK models is complexity, defined as non-trivial interdependence between the elements of a system (Frenken, 2006). This general insight has been applied to quite different research topics, including the persistence of heterogeneity (Levinthal, 1997), cognition (Gavetti and Levinthal, 2000), imitation (Rivkin, 2000), organizational design (Rivkin and Siggelkow, 2003), modularity (Ethiraj and Levinthal, 2004), industry life cycle (Lenox, Rockart, and Lewin, 2007), market entry (Ganco and Agarwal, 2009), shaping strategies (Gavetti, Helfat, and Marengo, 2017), industrial policy (Li and Csaszar, 2019). Sometimes, the NK framework has been integrated in a modular approach with other well-established models: for example, the work by Lenox, Rockart, and Lewin (2007) features a classical Cournot framework to model competition and a NK fitness landscape for search activities (innovation and imitation) in the cost space.

So, one may ask why history-friendly modeling has not yet received in the strategy field the level of attention of other approaches such as the NK modeling. This is partially explained in light of the discussion in the previous section and considering the high level of abstraction of the NK modeling approach. It might well be that history-friendly models, as they fully embrace the complexities of real-world situations, might be perceived as too complex, and unable to provide a more 'parsimonious' representation of those situations. Although there is no straight answer to this observation, we can provide a few remarks. First, if empirical analyses and theory considerations suggest that contextual factors related to time and place are relevant, then just ignoring them for the sake of abstraction will not serve the purpose of scientific research. Second, we also notice that a low level of abstraction does not necessarily entail a low level of generality. As discussed in Malerba et al. (2016), from history-friendly models on specific industries or firms and their evolution, some more general questions and generic mechanisms can be explored. This possibility of generalizations originating in a bottom-up way should be quite appealing for a strategy scholar.

Third, we think that users of history-friendly models might learn a valuable lesson from the success of the NK approach. Its example suggests that it is possible to decouple content-related elements and general insights, that in the case of history-friendly models are methodological principles. History-friendly models require adherence to history for the selection, building and calibration of a model, but then could be combined with other existing models that could fit the selected phenomenon. In some cases, this modular approach has already been applied: Malerba et al. (2016) model the competition between firms as an implicit Cournot framework, although modified in a behavioral manner; Engler et al. (2020) employ a fractal landscape model to represent the search environment. In terms of content, history-friendly models might actually be attractive for all active research themes in strategy. Here we identify three specific areas that we deem as particularly promising.

Catch-up strategies. The catch-up strategies of latecomer firms is a burgeoning area for strategy research (Awate, Larsen, and Mudambi, 2012; Capone et al., 2021; Kumaraswamy, Mudambi, Saranga and Tripathy, 2012; Shin, 2017). In recent years, the rise of latecomer firms from emerging economies (e.g., China, India) has stimulated interesting debates regarding how successful strategies differ between latecomers and MNEs (Mathews, 2002; Narula, 2006). There is indeed an urgent need for understanding why and how latecomers, which often started from a low level of capabilities, became prominent in a few decades (Malerba, Mani, and Adams, 2017; Mathews, 2002). However, given that catching-up is often a long and dynamic process (Li, Capone, and Malerba, 2019), prior studies often adopted the “appreciative theorizing” approach (Nelson, 2020), conducting historical case studies on specific sectors or firms within those sectors (Lee and Lim, 2001; Malerba et al., 2017; Malerba and Nelson, 2012; Mu and Lee, 2005). More recent studies have adopted the history-friendly approach to study catching-up, but focusing on the macro-level (Landini, Lee, and Malerba, 2017; Landini and Malerba, 2017) and the meso-level explanations (Li et al., 2019). One exception here is the Capone et al. (2021) article, which modeled the catch-up entry strategies of latecomer firms at the micro-level. Many open questions still remain, for example: what are the relevant dimensions of catch-up strategies? How can firms adapt and change their catch-up strategies as the sectoral environments evolve? History-friendly models can provide a great value added in answering to these questions, as they allow to explore the sectoral and institutional conditions driving the catch-up process.

Innovation strategies. History-friendly models also offer the opportunity to study the innovation strategies of established firms in advanced economies (Engler et al., 2020), as they provide a unique window into the micro-processes underlying the emergence and diffusion of radical innovations, emphasizing the crucial role of specific actors (single inventors, firms or other organizations) as well as the factors and conditions that enabled or constrained the efforts of these actors. History-friendly models also shed important light on the specific technological regime in which firms operate and innovate. This has important implications for how firms should be thinking of innovation and organize for it, especially as the new era of the fourth industrial revolution (Li, Liang, Tell and Xue, 2021) has brought the emergence of a wide range of technologies, such as artificial intelligence, internet of things, 5G, robotics (Martinelli, Mina, and Moggi, 2021). Firms face a wide range of strategic decisions regarding their innovation activities in this era. Here, innovation strategies often include, but definitely are not limited to, make versus buy decisions (Capone et al., 2021), product versus process innovations (Golovko and Valentini, 2014), adapting versus shaping behaviors (Gavetti et al., 2017). The methodological approach of history-friendly models allows to investigate these themes without simplifying the inherent complexity of the actors and the contexts in the innovation domain.

Global strategies. There is an increasing need to incorporate macro-level factors (e.g.,

institutions) into the consideration of firm strategies (Peng, Sun, Pinkham, and Chen, 2009; Peng, Wang, and Jiang, 2008). This leads to another promising direction for future history-friendly research, which is firms' global strategies. For example, it could be possible to investigate under what conditions latecomer firms can acquire strategic assets overseas and use those assets to overcome their competitive disadvantages (Luo and Tung, 2007) or how multinationals' global strategies co-evolve with changing host-country environments. Again, history-friendly models provide a unique methodological opportunity to address these questions, since they allow to specify with the necessary level of detail the elements characterizing different institutional settings, and their interaction over time.

The three themes above are proposed as examples to inspire new applications, but they are definitively not exhaustive. Broad areas of future research particularly promising for strategy could also benefit from a more widespread and flexible use of history-friendly models. The recent attention to shaping strategies – those aimed at changing the rules of the game, rather than just adapting to them – is one of such areas (Gavetti et al., 2017). History-friendly models could help to investigate the consequences of shaping versus adapting behavior taking into account the actor and the context specificities (see Helfat, 2021 in this Special Issue). The co-evolution of vertically-related industries and firms is a further promising theme of research in strategy (Helfat, 2015). Here, history-friendly models seem to be particularly useful to study the impact of different types of entrants on firm performance and industry co-evolution especially in industries where – in addition to de novo and diversifying entrants – spinoffs from the focal, the upstream and the downstream industries are salient (Capone et al., 2019b; Adams, Fontana, and Malerba, 2019). A recent and promising area of investigation in strategy deals with categories and competition (Cattani, Porac, and Thomas, 2017). The emergence of categories is a key element for the definition of market boundaries and competitive advantage, and is strongly affected by a variety of historical and structural factors (Dranove, Peteraf, and Shanley, 1998). History-friendly models would certainly resonate well with the complex dynamics of interdependence between socio-cognitive and economic dimensions inherently associated with the concept of categories.

To conclude, the history-friendly approach has progressed along its own “cumulative regime” over the past decades, but it has also renewed itself, triggered by exogenous opportunities (Malerba et al., 2016). After all, the world has constantly presented us with interesting phenomena, bringing both opportunities and challenges for strategy research. We believe that the HFM methodology will be a powerful addition to the repertoire of strategy scholars for tackling the challenges in the days to come.

References

- Adams, P., Fontana, R., & Malerba. (2019). Linking vertically related industries: Entry by employee spinouts across industry boundaries. *Industrial and Corporate Change* 28: 529-550.
- Argyres, N.S., De Massis, A., Foss, N.J., Frattini, F., Jones, G., & Silverman, B.S. (2020). History-informed strategy research: The promise of history and historical research methods in advancing strategy scholarship. *Strategic Management Journal* 41: 343-368.
- Awate, S., Larsen, M. M., & Mudambi, R. (2012). EMNE catch-up strategies in the wind turbine industry: Is there a trade-off between output and innovation capabilities? *Global Strategy Journal*, 2(3), 205–223. <https://doi.org/10.1111/j.2042-5805.2012.01034.x>
- Belter, C. W. (2017). A relevance ranking method for citation-based search results. *Scientometrics*, 112(2), 731–746.
- Boschma, R. A., & Weterings, A. B. R. (2005). The effect of regional differences on the performance of software firms in the Netherlands. *Journal of Economic Geography*, 5(5), 567–588. <https://doi.org/10.1093/jeg/lbh074>
- Brenner, T., & Murmann, J.P. (2016). Using simulation experiments to test historical explanations: The development of the German dye industry 1857-1913. *Journal of Evolutionary Economics* 26: 907-932.
- Bryant, B. P., & Lempert, R. J. (2010). Thinking inside the box: A participatory, computer-assisted approach to scenario discovery. *Technological Forecasting and Social Change*, 77(1), 34–49. <https://doi.org/10.1016/j.techfore.2009.08.002>
- Capone, G., Li, D., & Malerba, F. (2021). Catch-up and the entry strategies of latecomers: Chinese firms in the mobile phone sector. *Industrial and Corporate Change*, 30(1). <https://doi.org/10.1093/icc/dtaa061>
- Capone, G., Malerba, F., Nelson, R.R., Orsenigo, L., & Winter, S.G. (2019a). History-friendly models: Retrospective and future perspectives. *Eurasian Business Review* 9: 1-23.
- Capone, G., Malerba, F., & Orsenigo, L. (2013). Are Switching Costs Always Effective in Creating First-Mover Advantage? The Moderating Role of Demand and Technological Regimes. *Long Range Planning*, 46(4–5), 348–368. <https://doi.org/10.1016/j.lrp.2013.06.001>
- Capone, G., Malerba, F., & Orsenigo, L. (2019b). Spinoffs in context: Entry and performance across different industries. *Industrial and Corporate Change* 28: 259-282.
- Cattani, G., Porac, J.F., Thomas, H. (2017). Categories and competition. *Strategic Management Journal* 38: 64-92.
- Cowan, R. & Foray, D. (2002). Evolutionary economics and the counterfactual threat: On the nature and role of counterfactual history as an empirical tool in economics. *Journal of Evolutionary Economics* 12: 539-562.

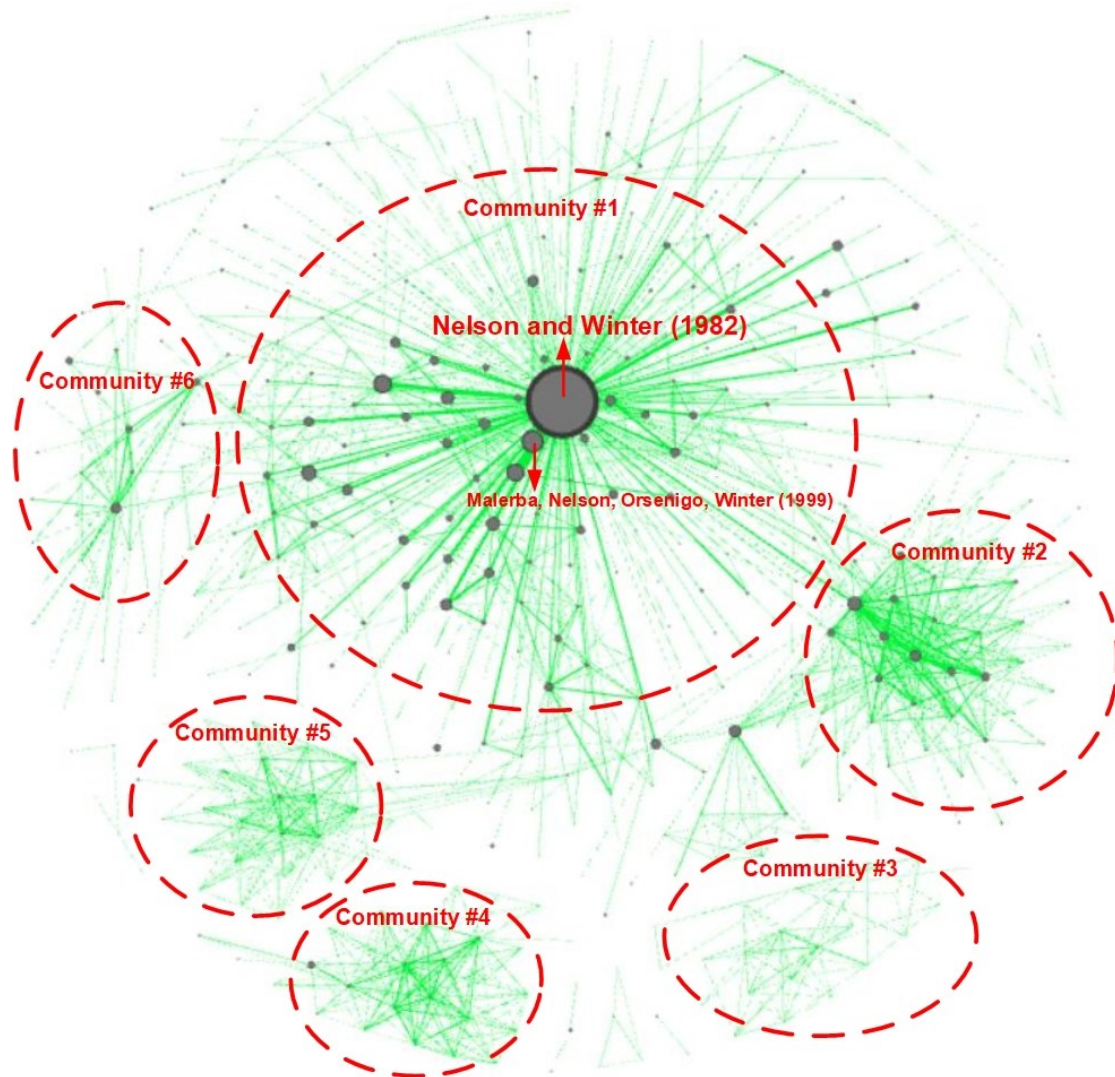
- Cyert, R.M., March, J.G. 1963. *A Behavioral Theory of the Firm*. Prentice Hall, Englewood Cliffs, NJ.
- Davis, J.P., Eisenhardt, K.M., & Bingham, C.B. (2007). Developing theory through simulation methods. *Academy of Management Review* 32: 480-499.
- De Rond, M., & Thietart, R.A. (2007). Choice, chance and inevitability in strategy. *Strategic Management Journal* 28: 535-551.
- Dosi, G., & Nelson, R.R. (1994). An introduction to evolutionary theories in economics. *Journal of Evolutionary Economics* 4: 153-172.
- Dranove, D., Peteraf, M., Shanley, M. (1998). Do strategic groups exist? An economic framework for analysis. *Strategic Management Journal* 19: 1029-1044.
- Durand, R., & Vaara, E. (2009). Causation, counterfactuals, and competitive advantage. *Strategic Management Journal* 30: 1245-1264.
- Engler, D. (2015). Is it a car or a truck? Managerial beliefs, the choice of product architecture and the emergence of the minivan market segment. *Industrial and Corporate Change* 24:697–719.
- Engler, D., Cattani, G., Porac, J. (2020). Studying the incubation of a new product market through realized and alternative histories. *Strategy Science* 5: 160-192.
- Ethiraj S.K., Levinthal D.A. (2004). Modularity and innovation in complex systems. *Management Science* 50: 159-173.
- Ferguson, N. (1997). Virtual history: Toward a “chaotic” theory of the past. In: Ferguson, N., (Ed.) *Virtual History: Alternatives and Counterfactuals*, Picador, London, pp. 1–90.
- Frenken, K. (2006). Technological innovation and complexity theory. *Economics of Innovation and New Technology* 15: 137-155.
- Garavaglia, C. (2010). Modelling industrial dynamics with “History-friendly” simulations. *Structural Change and Economic Dynamics* 21, 258-75.
- Ganco M., & Agarwal R. (2009). Performance differentials between diversifying entrants and entrepreneurial start-ups: A complexity approach. *Academy of Management Review* 34: 228-252.
- Gavetti G., Helfat C.E., & Marengo L. (2017). Searching, shaping, and the quest for superior performance. *Strategy Science* 2: 194-209.
- Gavetti G., & Levinthal D.A. (2000). Looking forward and looking backward: Cognitive and experiential search. *Administrative Science Quarterly* 45: 113-137.
- Gavetti, G., & Levinthal, D.A. (2004). The Strategy field from the perspective of Management Science: Divergent strands and possible integration. *Management Science* 50: 1309-1318.
- Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy* 31(8), 1257–1274.
- Golovko, E., & Valentini, G. (2014). Selective Learning-by-Exporting: Firm Size and Product Versus Process Innovation. *Global Strategy Journal*, 4(3), 161–180. <https://doi.org/10.1002/gsj.1080>

- Helfat, C.E., 2015. Vertical firm structure and industry evolution. *Industrial and Corporate Change* 24: 803-818.
- Helfat, C.E., 2021. What does firm shaping of markets really mean? *Strategy Science*, this issue.
- Jedidi, K., & Kohli, R. (2005). Probabilistic Subset-Conjunctive Models for Heterogeneous Consumers. *Journal of Marketing Research* 42(4), 483–494.
- Knudsen, T., Levinthal, D.A., & Puranam, P. (2019). Editorial: A model is a model. *Strategy Science* 4: 1-3.
- Kumaraswamy, A., Mudambi, R., Saranga, H., & Tripathy, A. (2012). Catch-up strategies in the Indian auto components industry: Domestic firms' responses to market liberalization. *Journal of International Business Studies*, 43(4), 368–395. <https://doi.org/10.1057/jibs.2012.4>
- Landini, F., Lee, K., & Malerba, F. (2017). A history-friendly model of the successive changes in industrial leadership and the catch-up by latecomers. *Research Policy*, 46(2), 431–446. <https://doi.org/10.1016/j.respol.2016.09.005>
- Landini, F., & Malerba, F. (2017). Public policy and catching up by developing countries in global industries: A simulation model. *Cambridge Journal of Economics*, 41(3), 927–960.
- Lenox M.J., Rockart S.F., & Lewin A.Y. (2007). Interdependency, competition, and industry dynamics. *Management Science* 53: 599-615.
- Levinthal, D.A. (1997). Adaptation on rugged landscapes. *Management Science* 43: 934-950.
- Li, C., & Csaszar, F.A. (2019). Government as landscape designer: A behavioral view of industrial policy. *Strategy Science* 4: 175-192.
- Li, D., Capone, G., & Malerba, F. (2019). The long march to catch-up: A history-friendly model of China's mobile communications industry. *Research Policy*, 48(3), 649–664. <https://doi.org/10.1016/j.respol.2018.10.019>
- Li, D., Liang, Z., Tell, F., & Xue, L. (2021). Sectoral systems of innovation in the era of the fourth industrial revolution: An introduction to the special section. *Industrial and Corporate Change*, 30(1). <https://doi.org/10.1093/icc/dtaa064>
- Luo, Y., & Tung, R. L. (2007). International expansion of emerging market enterprises: A springboard perspective. *Journal of International Business Studies*, 38(4), 481–498. <https://doi.org/10.1057/palgrave.jibs.8400275>
- Malerba, F. (2002). Innovation and market structure in the dynamics of the pharmaceutical industry and biotechnology: Towards a history-friendly model. *Industrial and Corporate Change*, 11(4), 667–703. <https://doi.org/10.1093/icc/11.4.667>
- Malerba, F., Mani, S., & Adams, P. (2017). *The Rise to Market Leadership*. Edward Elgar Publishing.
- Malerba, F., & Nelson, R. R. (2012). *Economic Development as a Learning Process: Variation Across Sectoral Systems*. Edward Elgar Publishing.
- Malerba, F., Nelson, R., Orsenigo, L., & Winter, S. (1999). "History-friendly" models

- of industry evolution: The computer industry. *Industrial and Corporate Change*, 8(1), 3–40. <https://doi.org/10.1093/icc/8.1.3>
- Malerba, F., Nelson, R., Orsenigo, L., & Winter, S. (2008a). Public policies and changing boundaries of firms in a “history-friendly” model of the co-evolution of the computer and semiconductor industries. *Journal of Economic Behavior & Organization*, 67(2), 355–380. <https://doi.org/10.1016/j.jebo.2006.10.010>
- Malerba, F., Nelson, R., Orsenigo, L., & Winter, S. (2008b). Vertical integration and disintegration of computer firms: A history-friendly model of the coevolution of the computer and semiconductor industries. *Industrial and Corporate Change*, 17(2), 197–231. <https://doi.org/10.1093/icc/dtn001>
- Malerba, F., Nelson, R.R., Orsenigo, L., Winter, S.G. (2016). *Innovation and the Evolution of Industries: History Friendly Models*. Cambridge University Press, Cambridge, UK.
- March J.G., Sproull L.S., Tamuz M. (1991). Learning from samples of one or fewer. *Organization Science* 2:1–13.
- Martinelli, A., Mina, A., & Moggi, M. (2021). The enabling technologies of industry 4.0: Examining the seeds of the fourth industrial revolution. *Industrial and Corporate Change*, 30(1). <https://doi.org/10.1093/icc/dtaa060>
- Mu, Q., & Lee, K. (2005). Knowledge diffusion, market segmentation and technological catch-up: The case of the telecommunication industry in China. *Research Policy*, 34(6), 759–783.
- Mordhorst, M. (2008). From counterfactual history to counternarrative history. *Management and Organizational History* 3: 5-26.
- Murmann, J.P. (2003). *Knowledge and competitive advantage: The coevolution of firms, technology, and national institutions*. Cambridge University Press, New York.
- Murmann, J.P. (2012). Marrying history and social science in strategy research. In S.J. Kahl, B.S. Silverman, & M.A. Cusumano (Eds.), *Advances in strategic management*, 29: 89–115.
- Murmann, J.P. (2014). Reflections on choosing the appropriate level of abstraction in social science research. *Management and Organization Review* 10: 381-389.
- Murmann, J.P. (2015). Deepening the conversation between business history and evolutionary economics. *Business History* 57: 705-715.
- Narula, R. (2006). Globalization, new ecologies, new zoologies, and the purported death of the eclectic paradigm. *Asia Pacific Journal of Management*, 23(2), 143–151.
- Nelson, R. R., & Winter, S. G. (1982). *An Evolutionary Theory of Economic Change*. Harvard University Press.
- Nelson, R. R. (2020). On "reasoned history". *Industrial and Corporate Change* 29: 1035-1036.
- Peng, M. W., Sun, S. L., Pinkham, B., & Chen, H. (2009). The Institution-Based View as a Third Leg for a Strategy Tripod. *Academy of Management Perspectives*, 23(3), 63–81.

- Peng, M. W., Wang, D. Y. L., & Jiang, Y. (2008). An institution-based view of international business strategy: A focus on emerging economies. *Journal of International Business Studies*, 39(5), 920–936.
- Quinn, J. (2015). Editorial: Re-introducing evolutionary theory to business history: Making sense of today's structures. *Business History* 57: 655-663.
- Rivkin J.W. (2000). Imitation of complex strategies. *Management Science* 46: 824-844.
- Rivkin J.W., & Siggelkow N. (2003). Balancing search and stability: Interdependencies among elements of organizational design. *Management Science* 49: 290-311.
- Sci2 Team. (2009). Science of Science (Sci2) Tool. Indiana University and SciTech Strategies, <http://sci2.cns.iu.edu>.
- Shin, J.-S. (2017). Dynamic catch-up strategy, capability expansion and changing windows of opportunity in the memory industry. *Research Policy*, 46(2), 404–416. <https://doi.org/10.1016/j.respol.2016.09.009>
- Simon, H., 1955. A behavioral model of rational choice. *Quarterly Journal of Economics* 69, 99–118.
- Watts, D. J., & Strogatz, S. H. (1998). Collective dynamics of ‘small-world’ networks. *Nature* 393(6684), 440–442.
- Winter, S.G. (2013). An evolutionary program for business history? *Enterprise & Society* 14: 498-506.
- Winter, S.G. (2018). Appendix to Chapter 4: History-Friendly Modeling. In Nelson, R.R. (Ed.). *Modern Evolutionary Economics: An Overview*. Cambridge University Press, Cambridge, UK, pp. 129-142.
- Vaara, E., & Lamberg, J. (2016). Taking historical embeddedness seriously: Three historical approaches to advance strategy process and practice research. *Academy of Management Review* 41: 633-657.

Figure 1. Co-citation similarity network



Source: data from the Web of Science Core Collection Data (e.g., SSCI index)

Note: We used “edge weights above 5” as threshold value for edge inclusion (edge weights are the number of times that two articles are cited together), and we deleted isolate nodes. Results are robust to small differences in threshold (from 3 to 6): the patterns remain qualitatively similar, although the lower the threshold, the denser the network.