

## Summary of *Innovation and Knowledge Dynamics* by Michael A. Verba

*Innovation and Knowledge Dynamics* is a collection of essays that explore the role of technological knowledge in the economy. “Learning Hubs on the Global Innovation Network” is the first essay of the book, presented in Chapter 2. This section of *Innovation and Knowledge Dynamics* models the sphere of technological knowledge as a dynamic complex network. Technological knowledge is disaggregated into distinct technology domains and the interactions and evolution between domains of technological knowledge are captured by a graph-theoretic model of the global innovation network. Subsequently, the essay explores the structure and evolution of technological knowledge at the global level, as documented by patent filings. Empirical analysis in this essay relies on a database covering 83 million patent records from more than 100 intellectual property authorities, granted during the 1991-2012 period, as well as citations between patent filings. The database provides a uniquely comprehensive view of the evolution of technological progress up to the most recent years. Modeling the evolving dynamics of knowledge on the World knowledge network reveals trends within specific technologies, influence of different technologies on each other, and the general evolution of technological progress. Among other findings, the results reveal a central and increasingly dominant role of specific, narrowly defined technologies in the world innovation system, which serve as technology “learning hubs.” Most significantly, modeling knowledge flows between technological fields provides a way to rank different technologies in terms of their importance to the flow of knowledge on the global innovation system. In a World moved by technological trends, where novelties fade away as quickly as they emerge, the question of the relative importance of different technologies arises in policy and management settings. The methodology implemented in Chapter 2 provides a way to answer such questions.

The essay titled, “Growth and Innovation in the Presence of Knowledge and R&D Accumulation Dynamics,” presented in Chapter 3, consists of theoretical work that considers aggregate knowledge creation and accumulation dynamics. It begins with re-conceptualization and synthesis of existing methods, concepts and frameworks in studies of innovation and proceeds to develop a theoretical framework that extends concepts from Endogenous Growth Theory and literature on R&D and productivity. The framework provides a scaffolding for a formal model of knowledge dynamics. The model is based on a more general knowledge production framework than commonly used in Endogenous Growth Theory and R&D productivity discussions, reconciling as special cases of a broader framework disparate analytical approaches. The model of knowledge dynamics achieves a mechanical description of the evolution of the level, change, and growth rates of knowledge and R&D stocks and their joint effect on economic growth. It also reveals the role of R&D accumulation in the creation of innovations and reflects on the theoretical possibility of long-run idea-driven growth. The analysis predicts the structure of estimation biases that can result from omission of relevant factors and failure to take into account the accumulation dynamics of knowledge and R&D. These predictions find support in a simple empirical test. Empirical estimations show that the proposed general model of knowledge dynamics provides a closer fit to the data and therefore a better explanation of innovation dynamics than its alternatives.

“The Production of Innovations: Interactions, Nonlinearities and Variable Returns to Scale” is the third essay in the compilation, contained in Chapter 4. It builds on the conceptual and theoretical work of Chapter 3 in order to explore empirically the features of technological knowledge creation at the country level. It considers the hypothesis that country-level innovation cannot be fully understood without allowing for the possibility that innovation is a nonhomothetic process. This outlook translates into a flexible functional form for the knowledge production function, which has not found wide use in the context of macroeconomic innovative performance. The empirical foundation of the paper rests on measures of innovation constructed from Triadic patent filings, which represent a class of indicators of innovative performance that is uniform across countries. Data on international R&D collaborations provides a unique way to capture accessibility of foreign knowledge to domestic inventors, and the accompanying knowledge flows. To explain innovation at the country level, the analysis is based on constructed panel data and panel regression to estimate a flexible-form international production function for new-to-the-world ideas. Methodologically, the chapter relies on techniques from production economics and productivity analysis, while the theoretical contribution integrates perspectives from literatures on economics of innovation, international knowledge spillovers, and National Systems of Innovation. The question of nonhomotheticity provides a way to test quantitatively the mostly qualitative theories underlying the National Systems of Innovation analytical framework. The study confirms certain aspects of innovation highlighted in the NSI literature: strong nonlinearities in knowledge creation, differences in dynamics of intra-country and foreign knowledge stocks, and increasing returns to scale in knowledge production when tangible and intangible input factors are taken into account.