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Review of Growth, Trade and Endogenous Technology: A Study of OECD Manufacturing. By Orlando A. Ochoa. St. Martin's Press, Inc. New York, NY. 1996. ISBN 0-312-15845-9. pp. 198.

Policymakers in industrialized countries have expressed considerable concern about spurring productivity growth and technological innovation in their manufacturing sectors. At the same time, economic theorists have developed models that offer predictions of how market structure, regulations, and policies influence the incentives for investing in technology and boosting productivity. While a growing empirical literature searches for the factors underlying technological innovation, economists are still unclear as to the precise structural, regulatory, and policy environment that is most conducive to encouraging innovation and growth. Thus, an empirical examination of the factors producing technological advancement in the manufacturing sectors of major OECD countries is an important prelude to informed policy making.

This book seeks to quantify the main mechanisms underlying manufacturing growth in Belgium, Canada, Denmark, France, Germany, Italy, Japan, Norway, Sweden, the United Kingdom, and the United States over the period 1971-1987. The model of endogenous technological change developed by Paul M. Romer guides the empirical analysis of how human capital accumulation influences manufacturing growth. More specifically, the manufacturing sector is divided into three groups: machinery and equipment, chemicals, and the rest of manufacturing. Orlando A. Ochoa uses three major variables to measure the factors fostering technological change: the number of research scientists and engineers employed in research and development (R&D) by each manufacturing sector, the share of professional, technical, and related workers in the overall labor force, and the number of research scientists and engineers employed in (R&D) activities by the government and higher education.

After a brief Introduction, Chapter 2 reviews recent theories of economic growth with particular attention to models of endogenous technological change. Chapter 3 derives estimable equations from the theoretical framework. The book quickly gives readers who are unfamiliar with recent growth theories what they need to know to follow the book's empirical investigation. While recognizing other implications of the theory, Ochoa focuses on two hypotheses. First, an increase in total human capital (in a closed economy) increases human capital devoted to R&D more than proportionately, which increases economic growth. Second, physical capital accumulation that is unaccompanied by R&D may not produce faster growth due to diminishing returns. In contrast, physical capital accumulation in conjunction with more R&D will have a positive impact on economic growth. The book does not consider the role of monopolistic competition and property rights in affecting the incentives that agents face in deciding how many resources to devote to R&D.

Three big messages emerge from the empirical findings, which the book presents in Chapters 4-7. First, the data confirm one of the major prediction's of the endogenous technological change literature. Physical capital accumulation in a manufacturing sector boosts that sector's long-run growth rate when that sector intensively employs full-time research scientists and engineers. Thus, the data are consistent with the view that R&D effort positively influences the marginal product of capital, such that diminishing returns

do not necessarily moderate the positive effects of rapid capital investment. Second, some findings are inconsistent with the predictions that emerge from endogenous growth models. Measures of the rate of growth of a country's overall level of human capital were not strongly related to growth and it was difficult to discern clear, simple links between trade and technological change. However, the rate of growth of a country's overall level of human capital was closely linked to the rate of change in the number of full-time research scientists and engineers employed in the manufacturing sectors. Thus, the limited data set may be impeding Ochoa's ability to characterize fully the relationship between country-wide increases in human capital and technological innovation in particular manufacturing sectors. Finally, the book shows that the number of research scientists and engineers employed by the government and higher education is positively associated with long-run output growth, even while controlling for the number of research scientists and engineers employed by each manufacturing sector. Thus, the book offers a useful empirical examination of some of the factors underlying manufacturing growth.

Chapter 8 offers a lucid, balanced, and nicely written summary. Professor Ochoa also readily notes some of the methodological weaknesses. Specifically, there are only a maximum of 33 observations. This critically limits the range of sensitivity analyses that can be performed. Also, while the analyses focus on sectors, there exist important questions about exogeneity since the manufacturing sector forms a large part of each country's economy. On the policy front, the endogenous technological change literature highlights the role of market structure – since innovators must receive profits to undertake the costly and risky process of invention – and property rights – since innovators must feel secure about receiving profits generated from their investments. The book ignores these crucial issues. Nonetheless, Professor Ochoa analyzes a weighty issue and this book is a useful investment for researchers seeking to augment their expertise on technology growth in OECD manufacturing sectors.

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