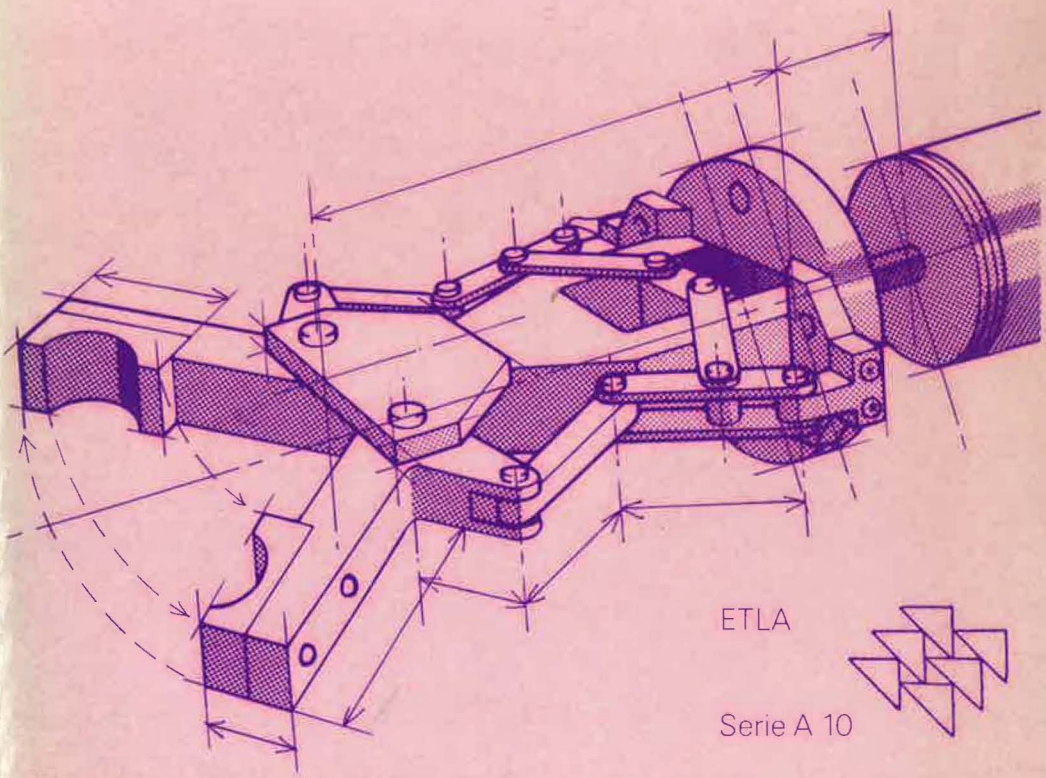
THE ECONOMICS OF INVENTION

A STUDY OF THE DETERMINANTS OF INVENTIVE ACTIVITY

GEOFFREY WYATT



ETLA

Serie A 10

"This is a first rate synthesis of the present state of the art in the economics of invention." PROFESSOR C. FREEMAN, *Science Policy Research Unit, University of Sussex.*

The Economics of Invention

A Study of the Determinants of Inventive Activity

GEOFFREY WYATT

"THIS IS A valuable contribution to the theoretical and empirical analysis of the economic determinants of invention. The results are of substantial interest to anyone interested in the area of the generation of invention." DR. Y. KATSOULACOS, *Department of Economic and Business Studies, University of Liverpool.*

This original new book presents a wide-ranging economic analysis of the determinants of invention and inventive activity.

Geoffrey Wyatt examines the argument that the volume and type of inventive activity can be induced by economic rewards. The factors influencing the supply and derived demand for inventions are analysed in some detail, including factor prices, market size and structure, and patent protection.

The empirical analysis includes an econometric re-examination of U.S. patent count data and two new approaches to estimating and interpreting the elasticity of supply of inventive output and input.

The book makes an important contribution to our understanding of the economics of invention and technical change, which are crucial to the success both of companies and national economies.

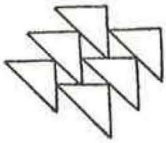
ISBN 0 7450 0283 8

ETLA — The Research Institute of the Finnish Economy
Series A10

The Economics of Invention

ETLA — The Research Institute of the Finnish Economy

Series A10



ETLA — THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY

is an independent, non-profit research institution, founded in 1946 at the initiative of Finland's central organizations of industry and employers to conduct economic and social research of interest to economic decision-makers. Today the major banks and the central association of insurance companies also support the Institute's work. In addition to monographs which deal with various economic and social problems, the Research Institute regularly publishes short-term and medium-term forecasts. The results of the work done at the institute are published in several series, and a list of its publications is available from ETLA.

Recent publications in English:
Economic Growth in a Nordic Perspective, published jointly by DøR, ETLA, IFF, IUI and IøI, Helsinki 1984, 373 p.

Markku Rahiala, *On the Identification and Estimation of Multiple Input Transfer Function Models with Autocorrelated Errors*, ETLA, Helsinki 1985, 90 p.

Finn R. Førsund, Lennart Hjalmarsson, Jussi Karko, Øyvind Eitrheim and Timo Summa, *An Intercountry Comparison of Productivity and Technical Change in the Nordic Cement Industry*, ETLA, Helsinki 1985, 128 p.

Address: ETLA, Lönnrotinkatu 4 B, 00120 Helsinki 12, Finland

The Economics of Invention

A Study of the Determinants of Inventive Activity

Geoffrey Wyatt

Senior Lecturer in Economics
Heriot-Watt University

Wheatsheaf Books

DISTRIBUTED BY HARVESTER PRESS

First published in Great Britain in 1986 by
WHEATSHEAF BOOKS LTD
A MEMBER OF THE HARVESTER PRESS PUBLISHING GROUP
Publisher: John Spiers
Director of Publications: Edward Elgar
16 Ship Street, Brighton, Sussex

British Library Cataloguing in Publication Data

Wyatt, Geoffrey James
The economics of invention: a study of the determinants of inventive activity.
1. Inventions—Economic aspects
I. Title
338′.06 HC79.I/

ISBN 0-7450-0283-8

Typeset in 10 on 12 point Times by
Mathematical Composition Setters, Ltd, Salisbury, UK.
Printed in Great Britain by
Billing and Sons, Ltd,
Worcester

THE HARVESTER PRESS GROUP
The Harvester Group comprises Harvester Press Ltd (chiefly publishing literature, fiction, philosophy, psychology, and science and trade books); Harvester Press Microform Publications Ltd (publishing in microform previously unpublished archives, scarce printed sources, and indexes to these collections); Wheatsheaf Books Ltd (chiefly publishing in economics, international politics, sociology, women's studies and related social sciences); Certain Records Ltd and John Spiers Music Ltd (music publishing).

to Sinikka

Contents

Preface

There are not many books on the economic determinants of invention, which is rather surprising if one considers the extent to which changes in technology have affected our present standard of living, and the likelihood that they will continue to do so. Perhaps the dearth is due to a feeling that the occurrence of inventions has little to do with economics. I hope that this book will convince some readers that this need not be the case.

Though the first chapter is a rather extensive introduction and summary to the remaining chapters, and can provide the busy reader with a convenient overview, it may be useful at this point to state the general framework within which the various themes are developed. The mode of analysis is 'neoclassical', in that it assumes maximising behaviour on the part of individuals, and market-determined allocations of resources. The economics is also, in the main, positive rather than normative. It may be possible to have an economic analysis of invention which is not based on 'the neoclassical paradigm', and there are plenty of normative issues to engage economists in this area. But the emphasis here is on the determinants, rather than the consequences, of inventive activity, and I believe that positive, neoclassical economics is adequate for the task.

This book is a revised version of the first eight chapters of a thesis which was eventually submitted to the University of York in 1984. The other two chapters of that thesis comprise the essence of a monograph published by the Research Institute of the Finnish Economy (ETLA) under the title *Multifactor productivity change in Finnish and Swedish industries, 1960 to 1980* (ETLA, Helsinki, 1983).

It is my privilege at this point to acknowledge debts to various people who have been helpful to me along the way. At York in the far-off days of the late 1960s John Williamson provided the initial stimulus, and Keith Hartley carried on where he left off, probably for longer than he cares to recall. Tangible support, in the form of research employment, was initially provided by Jack Wiseman, the director of the Institute for Social and Economic Research at York, and more recently by Pentti Vartia, the director of ETLA in

Helsinki where I spent an enjoyable few months in 1982. I am pleased that ETLA is including this book in their series of thesis-type publications, and I am grateful to a number of people there for support in bringing it to publication, in particular to Pekka Ylä-Anttila who heads the industrial economics group, and to Arja Selvinen and Arja Virtanen who drew the numerous diagrams. My thanks also to Jean Roberts, who typed the manuscript in various drafts. I am also grateful to the editorial staff of Wheatsheaf publishers for their expeditious handling of this joint publication.

Geoffrey Wyatt
Edinburgh,
November, 1985

Part I
Theoretical

1 Introduction and Overview

1.1 PRELIMINARIES AND CAVEATS

An invention is an addition to the stock of factual knowledge. It may be that some inventions 'just happen', but most do not; normally they are the outcome of a research process. Inventive activity is a form of research. This book, too, is a product of research, namely research into research. As usual, many of the insights reported here are truly the work of others: most research builds on prior research. To a large extent, therefore, these pages represent a synthesis, a pulling together, of what is known or conjectured about invention from the standpoint of economics. But it is not a comprehensive survey of the economics of invention. Rather, in order to focus on a theme, 'the economics of invention' has been interpreted in a particular way, and the first task of this introduction is to clarify how.

This book is about an aspect of the economics of technological change. But technological change has much wider connotations than the coverage here implies. Invention is construed as anything that adds to the set of known technological possibilities. Actual changes in technology may, however, also derive from a fuller or different utilisation of technological possibilities already in existence. Such changes do not require inventions. They are accordingly not discussed here. This means, of course, that the diffusion of new techniques of production, or the imitation of innovations, are ruled out. Nor is innovation itself, even to the extent that it implies the putting into effect of inventions, discussed more than cursorily.

It should be clear therefore that the present work has little to say about the consequences of invention as such. The focus is on the determinants of invention and inventive activity, on its causes rather than consequences. The upshot of this is that there are, undoubtedly, many aspects of economic life that are affected by invention which find no mention here. Thus, there is no discussion of technological unemployment, of the structure of industry and how it is affected by technological change, of the consequences for economic growth of endogenous technological change and so on.

(For a good discussion of many of these issues, the reader should refer to Stoneman (1983).)

An implication of focusing on the determinants of invention rather than its effects is that there is only limited discussion of normative or welfare issues. The bulk of the book is positive in the methodological sense of describing or theorising about what is rather than what ought to be. An exception to this is Chapter 5, on invention market organisation, where it is argued that the peculiar economic characteristics of invention imply the need for considerable regulation. There the desirability of competition between inventors is discussed, but the institutional framework within which inventions are produced, and in particular the assumption that patents can confer ownership on them, is taken as given. There is no extended discussion of the desirability of patents or of possible alternative social arrangements.

There are, of course, many factors that determine how much inventive activity is carried out and in what directions, but the basic supposition is that among these, importantly, are economic factors. This means that, for the most part, the scientific, technological, sociological, political, psychological and cultural determinants of inventive activity are subsumed in an implicit *ceteris paribus* clause. The present analysis, in other words, takes them as given. The realism of this assumption can only be judged with suitable empirical evidence. The empirical analysis of time-series data on numbers of patents for inventions presented in Chapter 6 is consistent with the view that at least a substantial element of inventing takes place in response to economic stimuli. But of course this does not imply that scientific, sociological, etc. factors are unimportant. There is, in the present work, no attempt made to assess the relative importance of all possible determinants of invention.

Thus the focus is on the economic determinants of inventive activity, and they are located specifically at the microeconomic level. It is argued theoretically in Chapter 3, with empirical support in Chapter 7, that the 'level of activity' is a major determinant of inventive activity. Here, this expression refers not to the conjunctural state of the national economy but to the size, measured by output or factor inputs, of the industry or sector to which the invention relates.

As a final caveat on the limited scope of the book, it should be

noted that what has come to be known as 'the Schumpeterian hypothesis' is barely touched on. The Schumpeterian hypothesis holds that larger firms are more progressive than their smaller counterparts, in the sense of being more able and willing to employ research inputs. The received empirical wisdom is that neither the smallest nor the largest firms in an industry are the most progressive in this sense. Investigating the validity of Schumpeter's conjecture has been a major preoccupation of economists, since it could have a profound influence on public policy towards big business. If true, it seems to imply a trade-off between static and dynamic efficiency. The topic is touched on in Chapter 3, only to the extent that market organisation has a bearing on the derived demand for invention at the industry level.

It has been mentioned that the central theme of this book is the responsiveness of invention to economic factors. This is developed in a neoclassical framework of supply and demand analysis. There are other approaches which provide their own insights. One such is the comparative institutions approach, according to which allocations of resources are determined either by decentralised markets or hierarchical organisations depending on which structure is the most cost-effective in the presence of behavioural constraints such as bounded rationality and opportunism, (see Williamson, 1975). Another, not unrelated, alternative approach is to eschew the full rationality assumption of the neoclassical framework in favour of 'satisficing' or rule-of-thumb decision-making behaviour. This has the disadvantage of seldom providing clear analytical predictions, though qualitative conclusions can be reached by simulation (cf. Nelson *et al.*, 1976).

Within a neoclassical framework for the determinants of invention, the pivotal element is supply. But it will be seen in Part I that there is little that can be established about the supply of inventions from an *a priori* standpoint. In comparison, economic analysis offers much greater scope on the derived demand for inventions. The basic idea that the derived demand for an invention is proportional to its extent of application is the basis for the attempt in Part II to form an empirical assessment of the responsiveness of invention supply to economic factors.